DISASTER RISK AND VULNERABILITY CONFERENCE 2014

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DISASTER RISK AND VULNERABILITY CONFERENCE 2014 DRVC 2014

DRVC 2014

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24 - 26 April 2014

Proceedings of the 2nd Disaster Risk and Vulnerability Conference

A.P. Pradeepkumar, F. J. Behr, F.T. Illiyas and E. Shaji
Editors

Disaster, Risk and Vulnerability Conference 2014

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Preface

The Disaster, Risk and Vulnerability Conference (DRVC) 2014 is an outcome of the interest that was generated and the requests for a repeat of the first DRVC, which was held in the School of Environmental Sciences (SES), MG University, Kottayam, in March 2011. The world has witnessed a series of disasters over the intervening period and the Uttarakhand flood was the most devastating and immediate amongst those. Each disaster brings upon us the onerous task of conducting a post-mortem, and inevitably the harsh reality of lessons not learned becomes evident. It is in this context that conferences like the DRVC gain importance as avenues where practitioners from diverse areas that touch upon disasters could come together and listen to each other, share ideas and experiences and discuss possible success stories that could be replicated elsewhere. The papers that populate this volume range from those utilizing technology to tackle disasters or mitigate their effects to those that look at post-disaster interventions, community-based adaptation strategies to GIS-based disaster management strategies.

The University of Kerala is specially thanked for sponsoring the conference at short notice. The Kerala State Council for Science Technology and Environment (KSCSTE) has been very quick to approve the proposal for the DRVC2014, and on behalf of the Organizing Committee I extend my sincere gratitude to the KSCSTE. The Atomic Energy Regulatory Board (AERB) has been keenly associated with the DRVC2011 and had subsequently maintained a close contact with the SES, MG University, which in turn lead to the AERB extending their sponsorship to this progamme. I thank the Secretary, AERB for his support of this conference and for readily agreeing to be part of the inaugural function. The Institute of Land and Disaster Management of the Govt of Kerala (Dept of Revenue) is a co-organizer of the conference, and I thank them for the association which has helped in the planning and execution of this event.

I also thank all my colleagues for their unstinting support in organizing this conference. All the students of the department are thanked for their generous help, and I especially thank my doctoral students, Rajesh and Prasanth, and Saran, an alumnus of the MSc Disaster Management program of SES, MGU for assisting me in all aspects of the conduct of the DRVC2014. Finally, I thank all the delegates who have send in their papers and have gathered here from far and near, for their support and presence here. I also thank the associates of this conference: the Stuttgart, Germany-based Applied Geoinformatics for Society and Environment (AGSE) headed by Prof.Dr.Ing.Franz-Josef Behr, the Stuttgart Active Alumni Group (SAAG), the Charitable Society for Humanitarian Assistance and Emergency Response Training (CHAERT), and the Indian Institute of Emergency Medical Services (IIEMS) for their contributions in the conduct of this conference.

I wish all of you a pleasant stay in Trivandrum and days of fruitful discussions in the conference, and hope to meet all of you again at the next DRVC.

Trivandrum, India
24 April 2014

Dr.A.P.Pradeepkumar
Organizing Secretary, DRVC2014

Associates

CHAERT
Charitable society for Humanitarian Assistance & Emergency Response Training

AGSE 2014

iiEMS Saving Lives

SAAG

PREDICTION OF PROPANE RELEASE CONSEQUENCES AT DIFFERENT TIME–SCALE FROM VARIOUS SOURCES USING AREAL LOCATION OF HAZARDOUS ATMOSPHERES (ALOHA)

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Abstract

Accidental release of toxic / flammable hazardous chemicals from chemical storage plants can cause serious injuries / property damage, situation becomes grievous, if the plant is situated in a densely populated area. During sudden release of a hazardous chemical from a storage tank the chemical stored inside the tank will vaporize and disperse in the atmosphere depending on the process and meteorological conditions at the time of release. The area that would be affected can be approximately calculated using fundamental principles of fluid dynamics through dispersion models. However the heavy gas dispersion calculations are very complicated and the results obtained are not truly representative of the actual scenarios. Since Liquefied Petroleum Gas (LPG) is most commonly used in industry and domestic areas, since it is a heavy gas, prediction of consequences due to LPG release is not possible by calculations, therefore an effort is being made to predict the consequence at different time – scale of LPG release using ALOHA. ALOHA (Areal Locations of Hazardous Atmospheres). This methodology discussed in this paper is useful to predict probable concentration due to hazardous chemical releases and subsequent fires/ explosion effects because of existence of possible ignition sources in the vicinity of vapor clouds. Simulation of LPG release is calculated using propane.

Keywords
Propane Release, Heavy Gas dispersion, Fire and Explosion, ALOHA, BLEVE

1. Introduction

In the past decade many chemical, petrochemical and petroleum industries from all over the world have installed manufacturing/production plants in India, depending on the location, availability of sources, climatic conditions and large man power. Most of these industries use hazardous chemicals as raw material /byproduct which when released in atmosphere may cause significant damage to human beings and property. Moreover there have been some cases of toxic / flammable release of gases at times in India which have led to great disasters. Thus, it is very important to predict release and possible consequences so that proper safety measures are taken so as to avoid any type of accidents. Proper maintenance of all the equipment involved in the production, storage or transportation of these toxic materials is absolutely necessary.

Most of the chemical industries, where hazardous chemicals are used, are large scale industries with complex processes that involve chain of chemical reactions, sophisticated procedures and massive scale of operation, the odds of accidents and disasters such as explosions and fire hazards caused by the leakage of chemicals from important production facilities, storage tanks, warehouses, and subsequently expose to public facilities in close proximity due to minor negligence are not to be underestimated. Advanced risk assessment programs should be used to maintain equipment inspection quality and equipment reliability after major maintenance.

Having thorough knowledge of all ongoing operations in the plant will help to minimize the threat of potential hazard and also assist in running a pre-rescue operation in case of an emergency situation. From the previous gas releases that have occurred like the Bhopal gas leak in UCIL on 2nd-3rd December 1984, it can be clearly concluded that there were no proper measures available for predicting the exact area that had been affected by the gas release, if there would have been accurate predictions about the affected area then the number of casualties that occurred could have been minimized. Similarly in other such accidents that have occurred over past few years in India as mentioned in Table 1, it can be judged that many lives could have been saved if the plant operator would have forecasted the impact of scale of the release beforehand.

Conventionally there was no proper method available for instantly predicting accurate impact of scale of a heavy gas release in a chemical industry. The manual methods that were known were complicated and time consuming, also the results obtained by these conventional methods were not so reliable. Meroney (1984) attempted to predict Propane

release using box model and he observed that dense cloud was rapidly diluted to low values concentration because of buoyancy effect. We have seen from the existing literature on hazard distance calculation using different heavy gas dispersion model such as box model , hat model etc. are extremely time consuming and difficult to predict accurate concentration at different time and space. Thus, there was an urgency to develop a model which would accurately predict threat zones in case of a gas release and that too immediately. The United States Environmental Protection Agency (USEPA) in collaboration with the National Oceanic and Atmospheric Administration Office (NOAA) in 1988 developed a model known as CAMEO. The CAMEO software suite was developed because NOAA recognized that emergency response personnel were often severely hampered by lack of accurate hazardous substance information. ALOHA is one of the applications in the CAMEO software suite. ALOHA (Areal Locations of Hazardous Atmospheres) is an atmospheric dispersion model used for evaluating releases of hazardous chemical vapors. ALOHA allows the user to estimate the downwind dispersion of a chemical cloud based on the toxicological/physical characteristics of the released chemical, atmospheric conditions, and specific circumstances of the release. ALOHA can estimate threat zones associated with several types of hazardous chemical releases, including toxic gas clouds, fires, and explosions. In this study, the ALOHA model has been chosen to simulate the scales of impact (threat zones) in the event of toxic chemical release. Propane is used for prediction of the gas release. The model is used to simulate the scale of threat zones and dispersion when propane is released from their storage tanks.

Table 1 Major Chemical Accidents in India

Name of Industry	Deaths	Injuries	Date of Accident	Cause of Accident
Century Rayon Factory, Ulhasnagar	9	140	17th March 1983	H_2S Gas
Mukund Iron Plant, Thane	2	-	15th March 1995	Toxic Gas
HPCL Refinery Vishakhapatnam	80	50	14th September 1997	VCE (Vapour Cloud Explosion)
GACL Vadodara	4	20	5th September 2002	Chlorine Gas Release
Kanoria Chemicals and Industrial Ltd., Renukoot	6	23	29th March 2006	Chlorine gas release
Bombay port Trust (BPT) Mumbai	-	103	14th June 2010	Chlorine gas release

2. Risk Assessment Methods

2.1 ALOHA model of dispersion

The model of dispersion chosen for the purpose of this research is the ALOHA model, which has been built upon the Gaussian dispersion model of continuous, buoyant air pollution flumes. The version of ALOHA model used for modeling is version 5.4.4. The simulation model was jointly developed by organizations including the United States Environmental Protection Agency (USEPA), Chemical Emergency Preparedness and Prevention Office (CEPPO), and National Oceanic and Atmospheric Administration Office of Response and Restoration (NOAA). The ALOHA model of dispersion is a free application provided by NOAA (National Oceanic and Atmospheric Administration) of the United States and EPA (Environmental Protection Agency) and it is the tool for the assessment of toxic gas cloud threat zones recommended by the USEPA. The model is capable of simulating the dispersion model for over 900 chemicals and is primarily used in the simulation of accidental release of hazardous substances and the dispersion of chemical vapor. The American Industrial Hygiene Association (AIHA) has published Emergency Response Planning Guideline (ERPG) values which are intended to provide estimates of concentration ranges where one might reasonably anticipate observing adverse effects. These guidelines are intended to be used as a planning tool for various Process Safety programs to determine priority concerns, to evaluate the adequacy of containment, to identify downwind areas which might need to take action during a release and to develop community emergency response plans. The need for an ERPG is based on the volatility of a chemical, its toxicity, the releasable quantity and the public's perception of the potential hazard.

ERPG definitions are as follows:

ERPG-1 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for one hour without experiencing other than mild transient adverse health effects or perceiving a clearly objectionable odor.

ERPG-2 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.

ERPG-3 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

Lower Flammability Level of propane- 2.15%

Upper Flammability Level of propane- 9.6%

2.2 Limitations

ALOHA's accuracy depends on the quality of the information given. But even the best input values possible are provided, ALOHA (like any model) can be unreliable in certain situations, and it cannot model some types of releases at all. When making concentration estimates, ALOHA assumes that the chemical is released into the atmosphere and immediately becomes mixed so that the concentration looks like a bell-shaped curve throughout the cloud (the highest concentration is downwind along the centerline). Even though that is not exactly what happens in a chemical release, this "Gaussian" assumption is fairly typical and provides reasonable concentration estimates in most cases. However, ALOHA's concentration estimates can be less accurate when any condition exists that reduces mixing in the atmosphere. For example:

- **Very low wind speeds.** At very low wind speeds (less than 3 miles per hour) the pollutant cloud does not mix quickly with the surrounding air. The concentration of the gas in the chemical cloud may remain higher than ALOHA predicts, especially near the source.
- **Very stable atmospheric conditions.** Very stable atmospheric conditions (stability classes E and F) generally occur at night or in the early morning, and may be indicated by conditions such as low-lying fog. Under these atmospheric conditions, gas concentrations within a pollutant cloud can remain high far from the source.

ALOHA does not account for the effects of:

- Byproducts from fires, explosions, or chemical reactions
- Particulates
- Chemical mixtures
- Wind shifts and terrain steering effects
- Terrain
- Hazardous fragments

Modeling Approach. Propane is stored at ambient temperature and pressure conditions inside a storage tank of 10 ft diameter and 70 ft length. The tank is filled to its maximum capacity. If a BLEVE occurs under these circumstances than what would be the threat zones due to thermal radiation is a matter of interest. Also, If a VCE takes place for the propane release at ambient temperature from a rectangular hole of 50inch length and 0.2 inch width at 0ft from the bottom of tank for 30 min time duration than what would be the threat zones that would occur in terms of flammable area and overpressure is also a matter of concern. For both the cases, four different timings have been considered 00hrs, 06 hrs, 12hrs and 18hrs and the results have been obtained that at what time would the worst case scenario occur.

Table 2. Input Data

Time Scale	00hrs	06hrs	12hrs	18hrs
Wind Speed	1.4m/s	2.5m/s	5m/s	3.5m/s
Temperature	20 deg C	25 deg C	35 deg C	28 deg C
Stability Class	F	F	C	E
Humidity	50%	50%	50%	50%
Cloud Cover	0 tenths	0 tenths	0 tenths	0 tenths

3. Results and discussions

ALOHA was used to model the gas release for the scenarios mentioned in Table 2. The hazardous chemicals chosen are propane because of its level of toxicity. The results of the simulation. Propane is one of a group of liquefied petroleum gases (LP gases). Propane is denser than air. If a leak in a propane fuel system occurs, the gas will have a tendency to sink into any enclosed area and thus poses a risk of explosion and fire. Thus, propane being hazardous requires an immediate action to be taken if released in atmosphere.

A. Toxic vapor cloud for release of propane

The most dangerous and destructive type of explosions in the chemical process industries are vapor cloud explosions (VCE). These explosions occur by a sequence of steps:

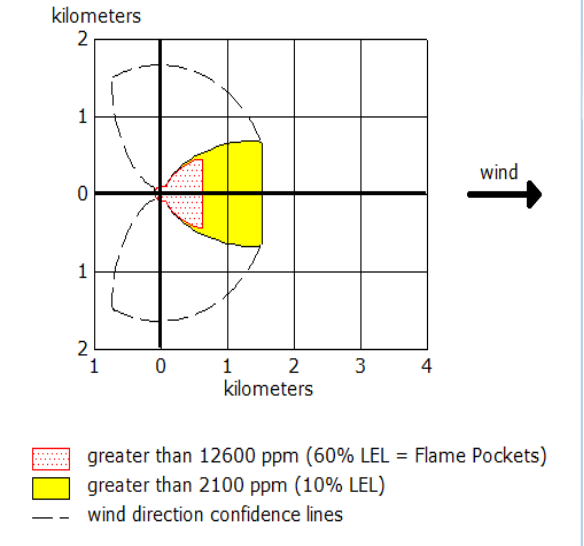
1. Sudden release of a large quantity of flammable vapor. Typically this occurs when a vessel, containing a superheated and pressurized liquid ruptures.
2. Dispersion of the vapor throughout the plant site while mixing with air.
3. Ignition of the resulting vapor cloud.

CALCULATING FLAMMABLE AREA

Fig 1 describes that the highest release of propane i.e. (>12600 ppm) occurs at a distance of 633 mts from the source and release of propane around 2100 ppm occurs at a distance of 1500 mts from the source.

Fig 2 represents the highest release of propane i.e. (>12600 ppm) occurs at a distance of 244 mts from the source and release of propane around 2100 ppm occurs at a distance of 705 mts from the source.

Case 1 : 06 00Hours



Case 2 : 12 00 Hours

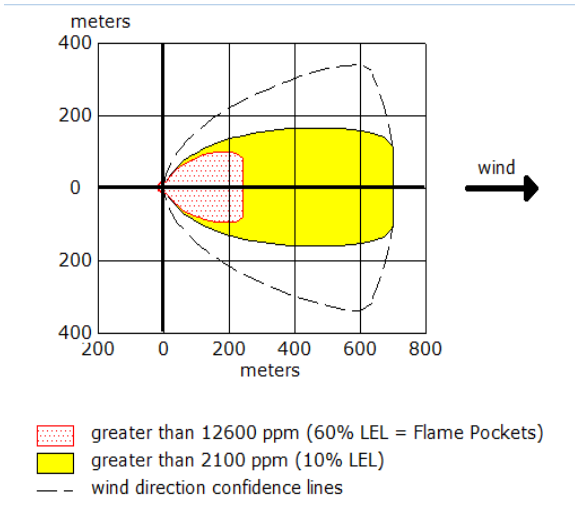
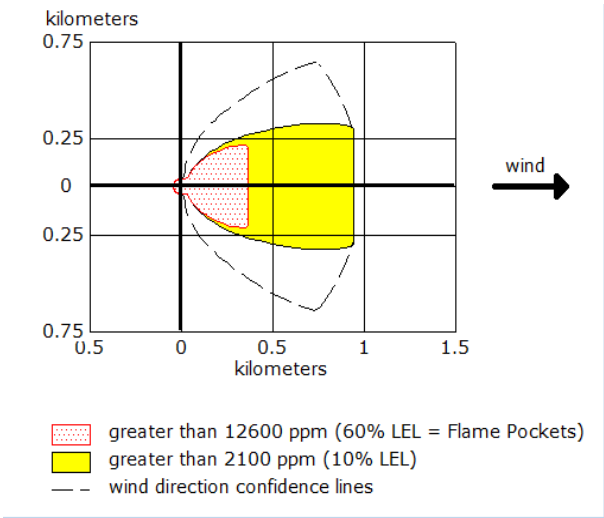


Fig 1, 2. Propane Concentrations at different Locations at 0600 hrs and 2. at 12:00 hrs

Case 3 : 18 00 Hours



Case 4 : 00:00 Hours

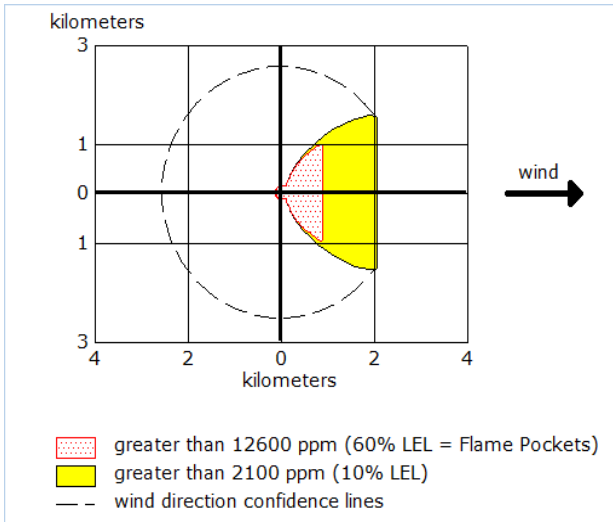


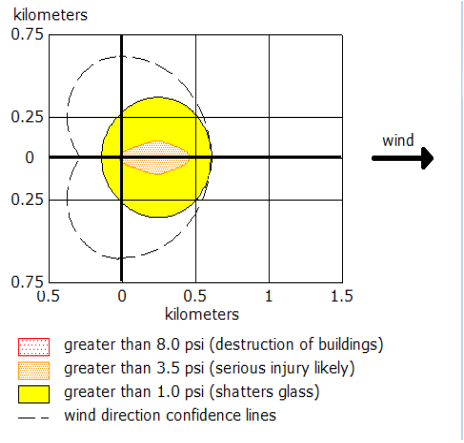
Fig 3, 4 Propane Concentrations at different Locations at 1800 hrs and 00:00 hrs
Fig 3 narrates that the highest release of propane i.e. (>12600 ppm) occurs at a distance of 365 mts from the source and release of propane around 2100 ppm occurs at a distance of 942 mts from the source.

We can observe from Fig 4 that the highest release of propane i.e. (>12600 ppm) occurs at a distance of 887 mts from the source and release of propane around 2100 ppm occurs at a distance of 2100 mts from the source.

CALCULATING OVER PRESSURE
Fig 5 shows that the pressure of magnitude > 3.5 psi is observed at a distance of 463 mts and pressure of magnitude > 1.0 psi is observed at a distance of 612 mts.

Fig 6 indicates that the pressure of magnitude > 3.5 psi is observed at a distance of 176 mts and pressure of magnitude > 1.0 psi is observed at a distance of 300 mts.

Case 1 : 06 00 Hours



Case 2 : 12 00 Hours

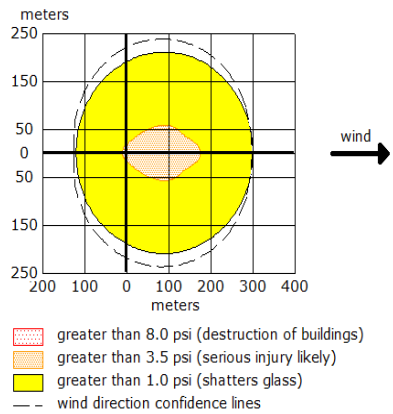


Fig 5, 6 Over-pressure due to Propane Explosion at different Locations at 0600 hrs and 12:00 hrs

Case 3 : 18 00 Hours

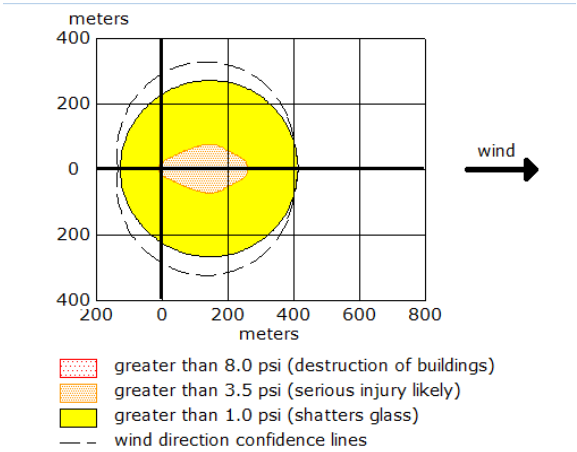
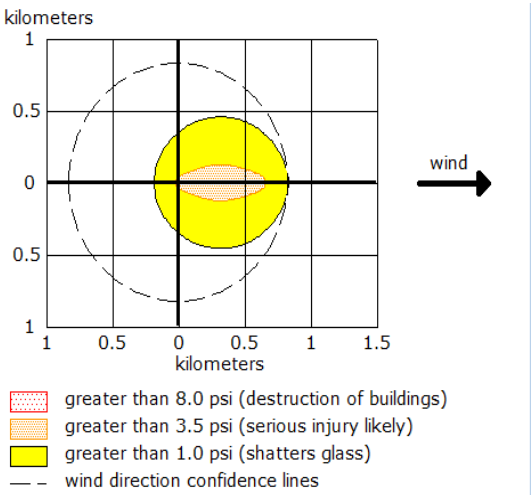


Fig 7- Over-pressure due to Propane Explosion at different Locations at 1800hrs

In Fig 7 ,it is observed that the pressure of magnitude > 3.5 psi is observed at a distance of 265 mts and pressure of magnitude > 1.0 psi is observed at a distance of 416 mts

Case 4 : 00 00 Hours



Case 1 : 06 00 Hours

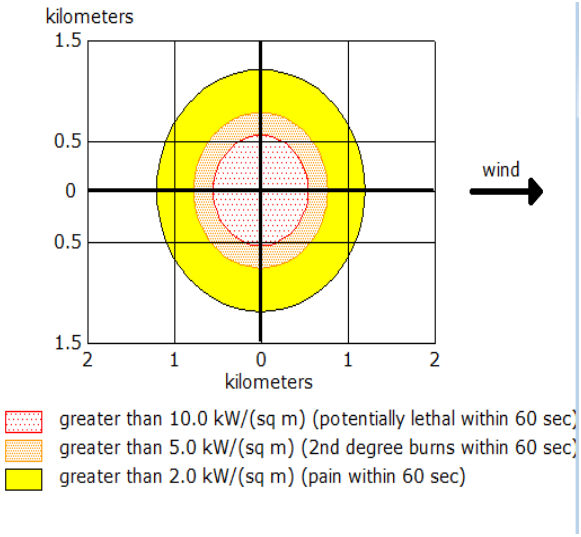


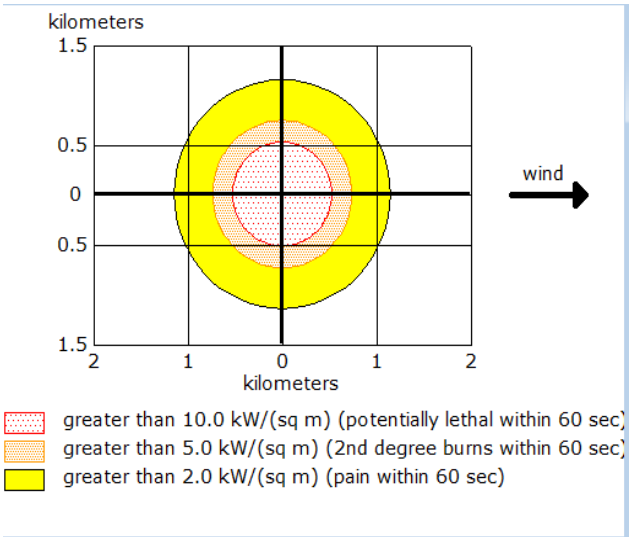
Fig 8 Over-pressure due to Propane Explosion at different Locations at 0000hrs **Fig 9** Thermal Flux due to BLEVE at different Locations at 0600hrs

In Fig 8 ,the pressure of magnitude > 3.5 psi is observed at a distance of 665 mts and pressure of magnitude > 1.0 psi is observed at a distance of 833 mts.

BLEVE (Boiling Liquid Expanding Vapor Explosion)

A BLEVE occurs when a vessel containing a pressurized liquid above its boiling point ruptures. If a vessel partly filled with liquid with vapor above filling the remainder of the container, is ruptured—for example, due to corrosion, or failure under pressure—the vapor portion may rapidly leak, lowering the pressure inside the container. This sudden drop in pressure inside the container causes violent boiling of the liquid, which rapidly liberates large amounts of vapor. The pressure of this vapor can be extremely high, causing a significant wave of overpressure (an explosion) which may completely destroy the storage vessel and project fragments over the surrounding area. While the term BLEVE is most often used to describe the results of a container of flammable liquid rupturing due to fire, a BLEVE can occur even with a non-flammable substance such as water liquid nitrogen liquid helium or other refrigerants or cryogens, and therefore is not usually considered a type of chemical explosion. In Fig 9, the maximum heat (>10 kW/Sq. m) is radiated at a distance of 544mts, heat >. 5kW/Sq m is radiated at a distance of 768 mts and heat greater than 2 kW/Sq m is radiated at a distance of 1200 mts.

Case 2 : 12 00 Hours



Case 3 : 18 00 Hours

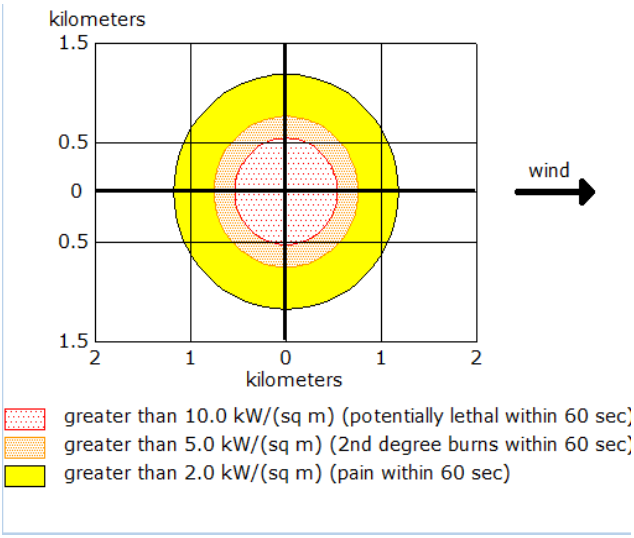


Fig 10, 11 - Thermal Flux due to BLEVE at different Locations at 1200hrs and 1800hrs

In Fig 10, the maximum heat (>10 kW/Sq. m) is radiated at a distance of 522mts, heat >. 5kW/Sq m is radiated at a distance of 737 mts and heat greater than 2 kW/Sq m is radiated at a distance of 1100 mts. In Fig 11, the maximum heat (>10 kW/Sq. m) is radiated at a distance of 537mts, heat >. 5kW/Sq m is radiated at a distance of 758 mts and heat greater than 2 kW/Sq m is radiated at a distance of 1200 mts.

Case 4 : 00 00 Hours

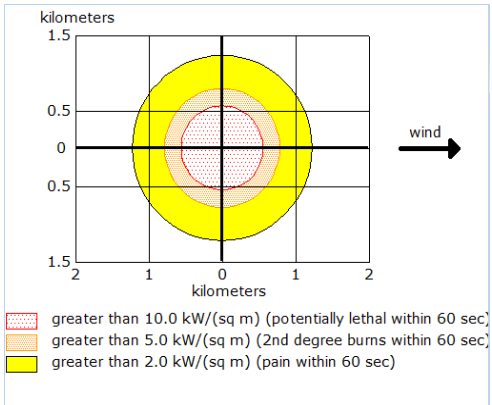


Fig 12 Thermal Flux due to BLEVE at different Locations at 0000hrs

In Fig12, the maximum heat (>10 kW/Sq. m) is radiated at a distance of 555mts, heat >. 5kW/Sq m is radiated at a distance of 784 mts and heat greater than 2 kW/Sq m is radiated at a distance of 1200 mts.

Conclusions

Simulations were performed for the chemical propane release under the selected scenarios at different times. ALOHA heavy gas model is used to determine various threat zones were obtained for different types of release. From the results it can be concluded that the climatic conditions, elevation, speed of wind, humidity in atmosphere, etc. play an important role for deciding the area that will be more prone to threat due to propane release. In the first case it is considered that a BLEVE would occur in which the thermal radiation threat zone was calculated. In the second case it is considered that Vapour Cloud Explosion (VCE) takes place because of release of propane from a rectangular hole in a storage tank. The flammable area for all 4 time zones was plotted and secondly the overpressure threat area was also plotted. From all these simulations we conclude that be it VCE or BLEVE maximum destruction occurs if accident occurs at mid-night 0000hrs and minimum destruction occurs at 12 noon. Thus it can be concluded that as temperature and wind speed decrease at night threat zone increases. Thus threat area increases with decrease in temperature and wind speed. Thus, ALOHA model can be instantly used to model threat zones, flammable areas, overpressures, thermal radiation zones and also the source strength of various chemicals depending on their ERPG values of propane at different time-scales by only specifying the conditions under which the chemical is stored. In this way we can predict any accidental releases and their consequences like over-pressurisation and heat flux across different locations at different time- scale.

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LANDSLIDE SUSCEPTIBILITY ZONATION MAP OF UPPER CATCHMENT OF MANIMALA RIVER OF WESTERN GHATS AREA, KERALA, INDIA USING GIS-TECHNIQUES AND FREQUENCY RATIO METHOD

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DRVC2014
2nd Disaster Risk & Vulnerability Coference

Abstract

The main intension of the present study is to prepare a land slide susceptibility zonation map of the study area using GIS – techniques and frequency ratio method in which each theme and their classes are given with number of pixels of class and percentage of class. This will give an estimation of percent of area under each class. By using the GIS techniques, calculate the number of lad slides in each of the class within each theme. A total of 38 landslides were coming within the study area. Percentage of landslide within each class is calculated by dividing the number of landslide within each class by the total number of landslides. Frequency ratio or the favorability value is obtained by dividing the percent of landslide by the percent of class. The different classes within each theme have particular frequency ratio. The sum of frequency ratios of all the selected themes at a particular zone gives the Landslide Susceptibility Index (LSI) of that zone.LSI is the value which says how much a region is susceptible to the occurrence of landslide. Based on the cumulative LSI values we have prepared four zones as stable, low susceptible, moderately susceptible and highly susceptible.

Keywords

GIS, Frequency ratio method, Landslide susceptibility index, Manimala River, Pixels.

Introduction

Natural hazards are events that occur suddenly and swiftly causing extensive damage to life and property. Floods, earthquakes, cyclones, volcanic eruptions, droughts, wild fires and landslides are some of the common natural hazards. Their characteristics are difficult to be determined and prediction of their recurrence and behavior is a delicate task. Landslides have become more severe especially with increase of human intervention on unstable hill slopes. Landslides belong to that family of short lived and suddenly occurring natural phenomenon that can cause extraordinary landscape changes and destruction of life and property. In the strict sense, landslides are relatively rapid down slope movement of soil and rock which takes place characteristically on one or more discrete bounding slip surfaces which define the moving mass (Hutchison, 1988).The term landslide has now come to include a broad range of different types of motion whereby earth material is dislodged by falling, sliding and flowing under the influence of gravity (Coates, 1981).These events are recorded in different terrains with varying geological assemblages and different climatic zones. Changes in the slope gradient both natural and man-made, changes in antecedent moisture content, vegetation, lithological assemblage etc. are some of the factors that have a direct bearing on the stability of a region. Normally the calamity is triggered by a sufficiently strong mechanism which overcomes the natural stability of a segment i.e.; the shear resistance threshold is exceeded. Seismic events and excessive precipitation are considered to be common triggering mechanism. Therefore, the determination of the relative importance of various categories of causative factors, using different types of analytical and assessment techniques, is the basic pre-requisite for landslide susceptibility modeling (V.Prassannakumar and H.Vijith 2012).

The term Landslide Hazard Zonation applies in a general sense to divide the land surface into discrete zones and rank them according to degrees of actual or potential hazard from landslides or slope instability (Varnes,1984).All zonation studies carried out till date relies on three fundamental assumptions.

(1).The slope failures in future will most likely be in similar terrain conditions that have led to past and present failures.

(2).In a given area the main environmental conditions which causes land sliding can be identified.

(3).A summary of the degree of potential hazard in specified areas can be built up, depending on the number of failure inducing factors, their severity and their interaction. However, the overall accuracy of Landslide Hazard Zonation mapping for discrete areas still remains unevaluated and it is only rarely possible to predict the exact location and time of a probable landslide

Study area

The areas selected for the study comprise 43.5sq.km falling within Lat.76°51′40″ and 76°57′10″ and Long.9°34′37″ and 9°39′48″ in Survey of India toposheet No.58C/11. Administratively the area falls within Idukki and Kottayam district of Kerala and forms part of the highland region of Kerala encompassing within the entire upper catchments of the Manimala River. The area reflects all the physiographic components of a typical vulnerable zone of Western Ghats has experienced multiple slides in the recent past which attracted considerable attention from governmental agencies. The Eastern part is occupied by the Peerumed plateau which has all characteristics of a natural plantation surface. The Manimala River originates from this plateau edge and its first, second and third order tributaries flow down through the steep plateau margin. Generally the elevation difference averages to about 1000m from the origin of first order stream to the confluence with the main Manimala river which is 6th order stream. Thus the central part of the area has the active youthful upper catchments of two streams, the westerly oriented Meenachil River and southerly oriented Manimala River. These two upper attachments are typical zones upon which the river is engaged active head ward erosion. The plateau margin presents youthful topography where denudational landforms are prevalent which constantly pushes the drainage divide towards east. Further the same drainage divide separate some parts of the upper catchment of Manimala and Meenachil rivers which were constantly head ward cutting both the sides of a divide. Thus the central part of the study area hosts a plateau margin which has all pre-requisites of an active erosion zone where the natural terrain set up is conductive to slope failure/mass movements. Towards west of this zone the area has dissected topography where the elevation difference is hardly more than 100m falling in the highland region. The area covers the foothill region presents a composite denudational and depositional topography. The relative relief is low with very little mass movement history within this zone. Thus the area selected for the present study has all the three physiographic zones: the plateau landform, plateau margin with the source region of rivers and the lower midland plains facilitating their evaluation in terms of landslide potential.

As far as the vegetation cover is concerned the major portion of the area encompassing the plateau margin and the midland region is occupied by rubber plantations. However the area has strips of natural vegetation in the form of natural degraded natural forest and grasslands in addition to seasonal cultivation adopted by local settlers. The plateau region consists of extensive tea and cardamom plantation which is typical of Western Ghats. The area presents a typical example of conversion of natural vegetation to monoculture plantations mainly rubber and tea in private lands. The vegetation in the area is also typical of Western Ghats region in that all the variants available for a land cover assessment which can be regionally applied. Thus the study area is an ideal sector where all the relevant terrain set up and socio-ecological features are represented so that it can form a model or rather a sample of the entire Western Ghats region of Kerala.

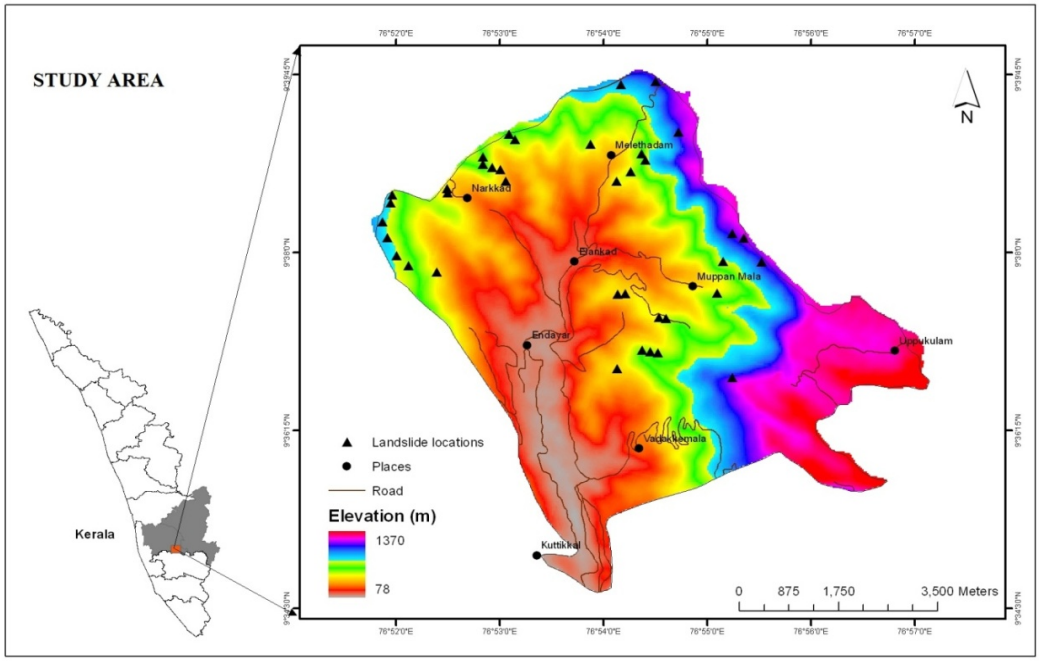

Fig.1 Location map of the study area with landslide points by digital elevation model.

Methodology

The methodology adopted here essentially is to work out the geologic, geomorphologic, hydrologic, climatic and anthropogenic factors which are responsible for past occurrences of landslides. The causes of landslides can be worked out based on available case studies from the region by taking nature of rock or soil, slope, hydrologic variables and imposed human intervention like construction; cultivation etc. These could be correlated with past failures thus permitting extrapolation of site information to regional areas. For a given area, depending upon the prevalent failure inducing factors along with their severity and interaction potential, the degree of potential/hazard can be worked out. The success of such assessment depends on the accuracy and volume of data used for the subjective evaluation. Various thematic maps were prepared using remote sensed data along with extracted data from available topographic maps of Survey of India (SoI) and structural and geologic maps of Geological survey of India(1:250,000). Data enhancement and field truth verification was conducted by regular systematic field work for the collection of landslide locations verification of land cover, geology and geomorphologic features. The spatial database constructed using Arc GIS 8.3 includes ten layers of information are geomorphology, land use, soil type, slope, aspect, relative relief, lineament density, drainage distance, drainage density. A pixel size of 20 x 20 m was adopted for all the themes. Therefore, the study area covers a digital image of 48,388 pixels. The digital elevation model (DEM) portraits accurate representation of land surface which was suitable for medium scale mapping (Tomlin1990; Nagarajan et al.1998)The DEM has been prepared by digitizing contours at 20 m interval and the elevation points from the SoI topographic map interpolated and resembled to the desired pixel. By using DEM very significant derivative layers such as slope angle, slope aspects etc. were produced.

The next stage in the study is the comparison of landslide inventory/ landslide population map with individual thematic and interpretive maps in order to identify the units/ parameters/ zones in which past failures have taken place. By this comparison it is possible to identify the degree of importance of individual parameters as causative factors so that a rating could be made among the individual themes. A simple integration of these themes and their comparison with the landslide population map can yield a qualitative assessment so that area could be divided into units depicting different degrees of stability,

1. Stable zone -A very stable setting and no action by man possibly threaten the balance

2. Low susceptible zone – Dissected slopes of hills characterized by stable geologic setting that can be destabilized by erosion/improper developmental activities.

3. Moderately susceptible zone – The terrain setting is same as in the above and landslides have occurred in the past but conditions prevailing do not favor instability. However, if natural drainage is disrupted/ slope modified, landslides could be triggered.

4. Highly susceptible zone- where landslides are likely to occur in view of the prominent factors contributing to landslide being present.

The numerical methods of landslide hazard zonation using index values are the usage of Landslide Susceptibility Index (LSI). This procedure of zonation involves identification of elements having role in causing landslides such as slope, soil type, drainage, land use etc. This number is designated as LSI for a given area, the LSI of the categories if added together gives the total LSI. This value is used for zonation of the area into different zones of landslide susceptibility. An integration of all factors will lead to the allotment of LSI for the terrain to culminate in zonation based on LSI. In the present study as the first stage of zonation individual factor maps are superimposed on landslide population map to assess the influence of each factor to attempt zonation based on that particular causative factor. In the second stage all such individual factor based zonation integrated cartographically to arrive at a qualitative zonation of the area. In the second stage based on the importance of factors zonation is attempted using LSI.It may be summarized that the concept employed both in qualitative and numerical system used here is the preparation of landslide hazard zonation map by evaluation and synthesis of various geo-environmental factor maps in terms of frequency of landslide occurrence in the region. Such zonation map depicts different regions of relative instability and identifies zones having equal degree of susceptibility.

Total area of study is 43.55km^2 and for the convenience of study this value has been converting into number of pixels. The total number of pixels of our study area is 48388. Different themes such as geomorphology, land use etc contains different classes. The area contain each class is given in number of pixels and their percentage is calculated. The total number of slides observed in the area is 38. The classes such as slope, aspect, relative relief, lineament buffer, lineament density, distance from the drainage, drainage density are given certain identities. In the thematic map instead of the class these identities are shown.

Frequency ratio model

Frequency ratio model used in this study for the landslide susceptibility is on the concept of the favorability function (Chung and Fabbri 1999, 2005). The likelihood of landslide occurrence can be measured by statistical relationships between past landslides of a given type and specified spatial data sets. It is assumed that any landslide occurs under particular conditions can be characterized by these spatial data sets, which are considered as independent conditioning factors. Thus, the prediction of landslide susceptibility is considered as the joint conditional probability that a given small area will be affected by a future landslide condition by the physical characteristic of the area.

The calculation of prior and conditional probabilities is compulsive condition for the development of the remaining procedure, and represents the first step of the cartographic data integration (H.Vijith, G.Madhu 2007) The calculated probabilities ,based on the correlation between landslide map with several independent data layers and on the relationship between affected areas and total areas, are the following: In the case of landslide, if we set the landslide occurrence event to be represented by a factor , "A", and this factor's attributes are denoted by, "B", then the frequency ratio of B is the conditional probability ratio. If this ratio is >1, then the relationship between a landslide and the factor's class or type is strong. If the ratio is <1, then the relationship between a landslide and the factor's class or type is weak (Zezere *et al*.2004; Lee and Sambath 2006).The spatial relationship between a landslide occurrence location and each landslide- related factor was derived using frequency ratio model. For calculating the frequency ratio, a contingency table was made for each of land slide-related factors. Then the area ratio for landslide occurrence and non-occurrence was calculated for the class or type of each factor, and the area ratio for class or type of each factor to total area was calculated. Finally, frequency ratio for the class or type of each factor was calculated by dividing the land slide occurrence ratio by the area ratio.

Relationship between terrain factors and landslides

Identification and mapping of a suitable set of instability factors bearing a relationship to slope failures requires a prior knowledge of the main causes of landslides (Guzzetti *et al*.1999; Lee *et al* 2004b). Relationship between landslides driven areas and terrain factors controlling landslides can be distinguished from the relationship between areas without any past history of landslide and landslide related terrain factors. Frequency ratio was used to represent the distinction quantitatively. The terrain factors such as geomorphology, land use, soil type, slope, aspect, relative relief, lineament buffer, lineament density, distance from drainage and drainage density were evaluated using frequency ratio method to determine the level of correlation between the locations of the landslide in the study area. These terrain factors and results are given in the table (1).

Geomorphology of the area is the one of the prime factor controlling the occurrence of landslides. Landform represents the shape of the ground surface i.e. the shape of the hills and valleys. In other words landform is the feature of the earth's surface with distinctive form characteristics which can be attributed to the dominance of particular processes or the structures in the course of its development and to which the features can be clearly related. The present day landform depends very much on the history of weathering and rejuvenation of the area. A detailed landform map depicts the relative disposition of each land facet formed as a result of multi cyclic surfacial processes acted upon it over a period of time. While considering the geomorphology the area is divided into six classes, namely plateau, structural hill, escarpment, denudation hill, denudation slope, valley fill. Among these the analysis shows that, the structural hill is having frequency ratio >2, indicating very high possibility of landslide occurrence. Next to structural hill the frequency ratio of escarpment is above 1 indicating high probability of landslides. As structural hill and escarpments are structurally controlled, they are highly sensitive to earth movements and mere tremor may trigger the landslide here. The denudation hill and valley fill have frequency ratio less than 1 where they are less susceptible to landslides.

When considering the land use of the study area the main determinant factor that comes up is the vegetation cover of the area. The major portion of the area is covered by the plantation and natural vegetation. The impacts of deforestation connected with hydro electric or irrigation projects through soil erosion and siltation are the main problems of slope stability. The protective role of vegetation in mass stability of slopes has gained increasing recognition. The beneficial effects of vegetation on Slope stability are, root reinforcement, soil moisture depletion, buttressing, arching and surcharge. The area under study falls within the high land region comprising within it the plateau region, its steep plateau edges, highly dissected slopes and part of midland. A few decades ago the major part of the area was covered by natural vegetation that is prevalent in the tropical high land region. However the last few decades witnessed severe human migration into this region resulting in the conversion of this natural vegetation into plantations and seasonal crops. This process of conversion has changed the land cover characteristics leading to a stage by which the long term stages have gradually become critical at many locations. Based on the land use; the area is divided into the following classes. They are, Cleared area, Dense mix jungle, Grass land, Open scrub, Rocky knob, Rubber, Tea, Teak, Urban area. The frequency ratio derived from the analysis observed for open scrubs with a value of 2.63 followed by the classes rocky knob, grass land and cleared area with values 2.43, 2.16 and 1 respectively. The most susceptible class is the open scrub followed by rocky knob, grass land, cleared area, rubber and tea. The classes teak and urban area are characterized by the absence of landslides, means they are stable areas within the 9 classes with frequency ratio of zero however their percentage of area is less. Soil type is the other factor which influences the distribution of landslides in various regions. The study area is characterized by the distribution of three types of soil viz. Gravelly clay loam. The frequency ratio of gravelly clay loam is 1.39 and that of gravelly clay is 3.24 which is more susceptible to the landslides. The gravelly sandy clay loam is characterized by the absence of landslides where they accounts for about 43.39% of the area i.e.; no landslides were reported the study area coming under the class gravelly sandy clay loam.

The land surface from the summit of the hill to the base of the valleys is bounded by a sloping surface or the slope. The configuration of the slope has a vital part to play in the planning of the use and conservation of earth's resources for present and future. Their complexity of form and multivariate nature of processes that act on it make the study of slopes rather difficult. In any land use planning, whether for agriculture, transport or other anthropogenic activities slope stability is a determining factor. To evaluate the slope in its term of stability ;slope angle ,slope form and the material of which it is formed has to be evaluated properly assuming that the processes that act on it continues to act

everywhere. Slope angle within a given area is estimated by ground measurements of true slope at selected individual points. One convenient method to represent slope is in the form of isoclinal maps show the areas of equal inclination in terms of degrees.

Table 1.Frequency ratio of factors to landslides occurrences

Thematic layer	Class	Number of pixels in the class	Class %	Number of Land Slide pixels with in the class	Slide %	Frequency ratio
Geomorphology	Plateau	4665	9.64	1	2.63	0.23
	Structural hill	10454	21.6	17	44.7	2.1
	Escarpment	1810	3.74	2	5.26	1.4
	Denudation hill	15685	32.41	11	28.94	0.89
	Denudation slope	4758	9.83	0	0	0
	Valley fill	11016	22.76	7	18.42	0.8
Land use	Cleared area	1276	2.63	1	2.63	1
	Dense mixed jungle	1677	3.46	0	0	0
	Grassland	1180	2.43	2	5.26	2.16
	Open scrub	9202	19.01	19	50	2.63
	Rocky knob	2092	4.32	4	10.52	2.43
	Rubber	24433	50.49	10	26.31	0.52
	Tea	7805	16.13	2	5.26	0.32
	Teak	597	1.23	0	0	0
	Urban	126	0.26	0	0	0
Soil type	Gravelly clay loam	21900	45025	24	63.15	1.39
	Gravelly clay	5489	11.34	14	36.84	3.24
	Gr. Sandy clay loam	20999	43.39	0	0	0
Slope	0 to 5	3328	6.87	0	0	0
	5 to 10	5670	11.71	0	0	0
	10 to 15	6455	13.34	4	10.52	0.78
	15 to 25	16805	34.72	11	28.94	0.83
	25 to 35	12639	26.12	18	47.36	1.81
	35 to 45	2990	6.17	4	10.52	1.7
	>45	501	1.03	1	2.63	2.55
Aspect	Flat	14	0.02	0	0	0
	North	4460	9.21	5	13.15	1.42
	North-East	4016	8.29	3	7.89	0.95
	East	5846	12.08	11	28.94	2.9
	South-East	3183	6.57	3	7.89	1.2
	South	5981	12.36	5	13.15	1.06
	South-West	11378	23.51	5	13.15	0.55
	West	8923	18.44	5	13.15	0.71
	North-West	4587	9.47	1	2.63	0.23
Relative relief	<150	3927	8.11	0	0	0
	150 - 250	12049	24.9	2	5.26	0.21
	250 - 350	11099	22.93	5	13.15	0.57
	350 - 500	12866	26.58	25	65.78	2.47
	>500	135	0.27	0	0	0
Lineament buffer	<50	5376	11.11	3	7.89	0.71
	50 - 100	5063	10.46	0	0	0
	100 -150	5336	11.02	3	7.89	0.71
	150 - 200	4052	8.3	6	15.78	1.88
	200 - 250	4850	10.02	5	13.15	1.31
	250 - 500	17219	35.58	13	34.21	0.96
	500 - 700	5164	10.54	4	10.52	0.99
	>750	1328	2.74	4	10.52	3.83
Lineament Density	<1000	12578	25.99	20	52.63	2.02
	1000 - 2500	23587	48.74	12	31.57	0.64
	>2500	12233	25.26	6	15.78	0.62
Distance from Drainage	<50	17065	35.26	10	26.31	0.74
	50 - 100	12921	26.7	8	21.01	0.78
	100 - 200	13515	27.93	15	39.47	1.41
	200 - 500	4752	9.82	5	13.15	1.33
Drainage Density	<1000	7326	15.14	17	44.73	2.95
	1000 - 2500	37071	76.61	20	52.63	0.63
	>2500	3991	8.24	1	2.63	0.31

Selection of suitable classes of angles takes into account; the short term and long term stability of slopes and geomorphologic set up. In many tropical landscapes especially in humid conditions, slopes develop with usually distinct characteristic angles. In the higher slope category certain types of landforms are delimited again by slope angles called limiting angles. Taking into consideration both characteristic angles and limiting angles of slope, suitable classes of angles are selected. In the area slope ranging between 0^0-64^0 classify it in to seven as 0-5, 5-10,10-15, 15-25, 25-35, 35-45, >45. The region with greater than 45^0 is having one landslide. On looking at the frequency ratio this class attains maximum frequency ratio value of 2.55. It is followed by just upper class with a 35^0 - 45^0 range with a frequency value of 1.70.In the first two classes with slope angles low, there is no landslides occurred. It is observed that as the slope angle increases the frequency ratio is also increasing, that means if the slope of the terrain increases then it is more susceptible to landslides whereas a flat terrain is not susceptible to the landslides. Ultimately the hilly regions are susceptible to landslides and with increasing slope angle they become more susceptible.

Aspect of the area is related to the direction of slope. *ie:* the different parts of the area are having the slope towards different directions such as north, south, N-E etc. There are positive and negative values for slope. The negative values are indicated by the flat area i.e.; without slope. Aspect is classified as Flat, North, North- East, East, South-East, South, South-West, West, and North-West. The frequency ratio in the area towards East is highest and is 2.9 and the probability is also high. However the class S-W is wide but their frequency ratio is less. Frequency ratio of above one is observed in classes N, S-E, and S slopping terrains .The remaining 4 classes have frequency ratio less than one and flat area is characterized by absence of landslides means they are stable.

The earth surface to a large degree, possesses relief because the geomorphic processes operate at differential rates in different regions for which the main reason being the difference in lithology and structure of crustal rocks. The local intensity of particular processes may change notably in response to differences in such features as temperature, moisture, altitude exposure, topographic configuration and the amount and type of vegetal cover. Hence many complex factors are influencing the regional geomorphic processes. The rate of all weathering, all mass wasting, all erosion and all deposition varies appreciably within narrow limits in relation to the influence of local conditioning factors. Thus the relative relief /topography of an area are the reflection of sum total of all these attributes. The relative relief represents actual variation of altitude in a unit area with respect to its local base level. While making the analysis of relief it is often important to relate the altitude of the highest and lowest points in any particular area that is to ascertain the amplitude of available relief. The relative relief does not take into account the dynamic potential of the terrain but is closely linked with slopes and hence is useful in understanding morphogenesis. The relative relief classes with their identity are <150, 150-250, 250-350, 350-500, >500.The high frequency value is observed in the class (350-500) and indicating high susceptibility.

A lineament is a linear feature in a landscape which is an expression of an underlying geological structure such as a fault. These are often apparent in geological or topographical maps and can appear obvious on aerial or satellite photographs. A lineament buffer is the distance from a lineament. The lineament is also divided into different classes and each class is given an identity as <50, 50-100, 100-150, 150-200, 200-250, 250-500, 500-750, >750.The maximum number of landslides observed in the class (250-500) with frequency ratio 0.96 while for the class >750 the frequency ratio is 3.83, means as the distance from the lineament increases there is a tendency to more susceptibility to landslides. Lineament density is the number of lineament within specifically designated areas. Lineament density is divided into three classes and the identity is given to each class as Low- <1000, Medium-1000-2500, High- >2500. While considering the 3 classes, maximum number of landslides occurred in area with low lineament density. 20 landslides occurred in this class with frequency ratio of 2.02. The medium and high lineament density class has frequency ratios of 0.64 and 0.62 respectively. The observation is that as the lineament density decreases the region is highly susceptible. The distance from lineament increases it is highly susceptible i.e., the presence of lineament decreases the possibility of landslides.

Among the different deciding criteria in the physical landscape of the earth's surface, drainage system has significant role. The drainage network is the focus for the interacting processes which carry water and sediments out of a drainage basin aiding ultimately to shape the landscape. Hill slope evolution in an area is controlled by the sediment transport processes which changes in response to the evolving topography and by their interaction with stream processes at the slope base. On the surface of the earth running water is by far the most important agency in affecting transportation of weathering products from highland to lowland areas and further from the land to the sea. Further a vast majority of valley owe their origin lateral and vertical erosion by streams. In order to understand something of the complex process of fluvial transport and erosion, it is necessary to evaluate the drainage characteristics of the terrain. One of the important drainage characteristic is how much a region is distant from the drainage. For example the region near to the drainage have a less infiltration of water whereas the region away from drainage have a higher infiltration rate of water which controls the stability of soil and the factors such as vegetation etc which depend upon the distance from the drainage. According to the distance from the drainage, the area is classified into five classes and they are <50, 50-100, 100-200, 200-500, >500. In the class <50 the number of landslides occurred is 10 and the frequency ratio is 0.74. As the distance from the drainage increases it is observed that the susceptibility to landslide is increasing. The classes 100-200 and 200-500 has frequency ratio of above 1 which is higher value. Hence it is observed that the distance from the drainage increases the chance of landslides is also increasing. Near to drainage the surface run off reaches the channel and less infiltration occurs where the distance from the drainage increases the infiltration rate increases and changes the soil stability. As a result slope stability decreases and the area become more prone to landslides.

Drainage density is the total length of all the streams and rivers in a drainage basin divided by the total area of the drainage basin. It is a measure of how effectively or how poorly a watershed is drained by stream channels. Permeability and underlying rock type affect the runoff in a watershed; impermeable ground or exposed bedrock will lead to an increase in surface runoff. Rugged regions or those with higher relief will have the higher drainage density which in turn affects the occurrence of landslides. In a region with high drainage density the infiltration of water is low, because the surface runoff enters into the channels and no downward movement of water takes place. But in a region with low drainage density instead of surface run off percolation of water into the ground takes place. These two processes have a control on the stability on soil. In region with less drainage density the region may be more prone to landslides.Drainage density can be classified into three classes and their identity is High- <1000, Moderate-1000-2500, Low- >2500. In the class <1000 the number of landslides occurred is 17 with a frequency ratio o 2.95. In the upcoming two classes the frequency ratio value is decreasing. In the second class (1000-2500) the number of landslides is greater than the first class with a percent value of 52.63 (20 out of 38). But the frequency ratio is low (0.68), means the first class is more susceptible to landslides. The third class is least susceptible to landslides with a frequency ratio of 0.31.The observation is that as the drainage density decreases the region become more susceptible to landslides.

Landslide susceptibility index

Landslide Susceptibility Index (LSI) of a zone is the value which says how much a region is susceptible to the occurrence of landslide. To achieve this existing landslide distribution data layer has been compared with various thematic layers separately. The frequency ratios of each factor's class or type were assigned to the themes to produce weighted thematic map. All the factors were taken to the spatial analyst extension of the ArcGIS software for the integration. The landslide susceptibility index (LSI) is calculated by summation of each factor's ratio value using the raster calculator option of the software by the equation.

$$LSI = Gm_{pr} + Land_{pr} + So_{pr} + Sl_{pr} + As_{pr} + {}_{Rrpr} + Lb_{pr} + Ld_{pr} + Disdr_{pr} + Drd_{pr}$$

Where Gmpr is the frequency ratio of geomorphology, $Land_{pr}$ is the frequency ratio of land use, So_{pr} is the frequency ratio of soil type, Sl_{pr} is the frequency ratio of slope, As_{pr} is the frequency ratio of aspect, ${}_{Rrpr}$ is the frequency ratio of relative relief, Lb_{pr} is the frequency ratio of lineament buffer, Ld_{pr} is the frequency ratio of lineament density, $Disdr_{pr}$ is the frequency ratio of distance from drainage, Ld_{pr} is the frequency ratio of drainage density respectively. The higher LSI value indicating high susceptibility to landslides and lower value for low susceptibility to landslides. By considering the factors used, LSI values has been divided in to four classes to yield four landslide susceptibility zones *viz*. stable, low susceptibility zone, moderately susceptibility zone, highly susceptibility zone (fig-2).The four susceptibility zone are given in the table (2).

Landslide hazard zonation

The term zonation applies in a general sense to categories the land surface into areas and arranges them according to degrees of actual or potential hazard from landslides or other mass movements on slopes. The fundamental assumption is that used in the zonation studies are: the past and present are keys to the future, the main causative factors of land sliding can be identified and degrees of hazard can be estimated. Hazard zone mapping involves a detailed assessment and analysis of the past occurrences of landslides in terms of their location, magnitude and frequency with respect to various geo environmental factors that influence landslides and mass movements. The factors that affect slope instability are varied and their interaction processes are complex depending on terrain set up and climatic characteristics. The most important terrain evaluation factor in hazard zone mapping is the recording of the landslides that occurred in the area. The spatial distribution of old and presently active landslides when compared with different terrain factors reveal the importance of each causative factor. The various individual factor maps such as land use, soil type, relative relief etc have been prepared.

The parameters generated through terrain evaluation gives the necessary clues for identifying potential sites of landslide hazard. For example an area 300 meters away from drainage with 400 meter relative relief and if the area is having degraded natural vegetation it is characterized by very high LSI value and the area is most susceptible. This susceptibility may be enhanced if the slope of the region is above 45˚. Normally the incidence happens during high intensity rain during the middle phase of south-west monsoon or if the pre-monsoon is usually heavy, during the initial phase of south-west monsoon. If there is no dry phase between south-west and north-east monsoons a high intensity rain due to the effect of cyclonic storms in the eastern coast during north-east monsoon is a favorable time for occurrence of landslides. A two day rain in excess of 30cm during a rainy season may generate slope movement in critical zones.

Landslide hazard zonation

Based on the cumulative LSI values obtained, the area was classified into 4 zones of relative instability viz. stable, low susceptible, moderately susceptible and highly susceptible depending upon the range of cumulative LSI values (table2)

- Stable zone- A very stable zone where no restrictions are warranted as reasonable human activity of any form does not possibly threaten the balance.

- Low susceptible zone - For all practical purposes these areas are safe from mass movements by virtue of its present geo-environmental set up. However many slopes falling within this zone could be destabilized by uncontrolled erosion, improper land use practices and development activities.

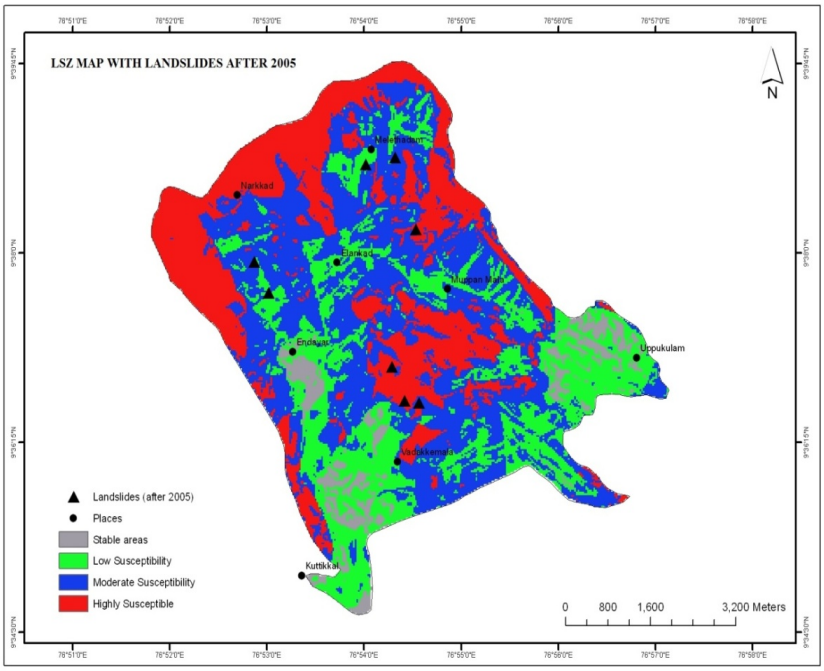

Fig.2 Landslide susceptibility zonation map

- Moderately susceptible zone – These areas are prone to land sliding. Terrain setting is comparable to the last category and in many cases the landslide initiated in the last category will have its impact on this zone also. The area needs urgent attention in the form of mitigatory measures like regeneration of natural vegetation, reforestation, drainage correction etc. Unless immediate action plans are implemented this zone will soon deteriorate to the highly susceptible category.

- Highly susceptible zone – This is very unstable zone where landslides are likely to occur in view of the prominent causative factor present. The area is almost degraded to such a state that it is practically impossible to evolve economically and socially acceptable remedial measures which can positively prevent recurrence of hazard. The area has to be entirely avoided for settlement or other developmental purposes and preferably left out for regeneration of natural vegetation and attainment of natural stability in course of time through the physical process active in the area.

Table 2. Landslide Susceptibility Zones and corresponding LSI values.

Zones	Cumulative LSI
Stable	2.39-6
Low susceptible	6-9
Moderately susceptible	9-11
Highly susceptible	11-23

Conclusion

The area under study was characterized by 38 landslides occurred before 2005 and prepared the thematic maps of each. There are 8 landslides which were occurred after 2005 up to present. During the field work the GPS reading of each of these 8 landslides were taken. The Landslide Hazard Zonation map was prepared using the data of the previous (before 2005) landslides. The GPS reading of these 8 landslides (recent) are applied and their location in the landslide hazard zonation map is marked. In the validity test it is observed that no landslides occurred in the stable zone while in low susceptible only one is occurred. Three landslides were occurred in the highly susceptible and four in moderately susceptible zone, highlighting the region is more prone to landslides. From the above observation it can be concluded that the Landslide Susceptibility Zonation (LSZ) map prepared is precise since the high and moderate zones cover about **87.5%** among the total observed landslides(8). The LSZ map with landslides after 2005 is given in the figure (2) clarifies our result.

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MULTI INFLUENCING FACTOR TECHNIQUE FOR IDENTIFYING GROUNDWATER VULNERABLE ZONE IN PAMBAR RIVER BASIN, DEVIKULAM TALUK USING GEOSPATIAL TECHNOLOGY

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Abstract

Groundwater is a dynamic and replenishable natural resource. And groundwater being more dependable source of sustained water supplies, especially during drought and in hard rock areas, its assessment, development and rational utilization should be given more importance. Groundwater prospects in a basin depend on lithology, geological structures, geomorphology, hydrology, meteorological conditions and quality of water, which is useful in predictive groundwater resource management. In the present paper, various groundwater vulnerable zones for the assessment of groundwater availability in the Pambar sub basin of Devikulam Taluk have been delineated using remote sensing and GIS techniques. Survey of India toposheets, Idukki district Geological Map (GSI) Google satellite imageries, SRTM DEM, Lnadsat ETM+ datas were used to prepare various thematic layers viz. lithology, geomorphology, slope, landuse/landcover, lineament, lineament density, drainage, drainage density, soil etc. The raster & vector maps of these factors are allocated a fixed score and weight computed from multi influencing factor (MIF) technique. Moreover, each weighted thematic layers is statistically computed using ArcGIS 9.3 software to get the groundwater vulnerable zones. The groundwater vulnerable zones thus obtained were divided into five categories, viz., very low, low, moderate, high and very high zones. The final output depicts the groundwater vulnerable zones in the study area and found to be helpful in better planning and management of groundwater resources.

Keywords

Groundwater resource; Groundwater Vulnerability; Weighted Thematic Layer; GIS; Remote Sensing

1. Introduction

Water vulnerability is one of the major water related issues that most countries are facing or will face in the near future due to increased water demand resulting from rapid population growth, urbanization, deforestation, industrialization and economic development activities. Utilize the effectiveness of a GIS-based Water Infrastructure Inventory in the assessment of water resources on district scale in a mountainous basin is achieved by establishing an inventory of existing water infrastructures using GIS to assess water withdrawals; by estimating water availability and water demand of different water user sectors; and by analyzing and mapping the spatial distribution of water situation, water vulnerability indicators and proposed future water development in the study area (Tran Van Ty, et. Al., 2009) Water crisis is caused and increased by various factors which some of the most important ones are: land use change, analyses of water needs of the past and future, review of water balance and its quality (Anonymous, 2000). Therefore, water crisis has been considered from different perspectives. (Biswas, 2005) believed that major crises are unlikely to come from water vulnerability, even if some countries will find it difficult to manage such problems. Ajali and William (2004) studied the water crisis in the Spanish Guadalquiviv River basin and proposed that the main solution lies in the preparation of integrated management policies for water resources at basin scale. Variability of water resources has also been studied in terms of climatic changes such as precipitation, temperature, evaporation etc. The interpretation of satellite data in conjunction with sufficient ground truth information makes it possible to identify and outline various ground features such as geology, structure, geomorphic features and their hydraulic characteristics (Das, et.al.,1997) Geology, geomorphology, structure and climatic condition are the controlling factors of ground water storage, occurrence and movement in hard rock terrain (Sooraj Kannan. P.V, et.al., 2008)

2.Study Area

The present study has been conducted in Pambar River Basin situated in Devikulam Taluk, Idukki district of Kerala. Among the three east flowing rivers in Kerala, Pambar River is one which drains the eastern slopes of Western Ghats covering Anamalai – Cardamom hill ranges. The study area stretched between the latitudes of $10^0 8' 0''$ to $10^0 2' 0''$ N and longitudes of $77^0 3' 0''$ to $77^0 16' 0''$ E covers an area of about 289 Sq.Km. Pambar river basin is a 6th order basin developed in a part of the Proterozoic, high-grade, Southern Granulite Terrain of the Peninsular India are carved out of a terrain dominantly made of granite- and hornblende-biotite gneisses (K. P. Thrivikramji 2012). The study area has been divided

into different geomorphic units, such as escarpments, valley fill, Highly dissected denudational slopes, valleys, denudational slope etc. It covers Keezhanthoor, Kanthalloor and parts of marayoor and Kannan Devan Hills Villages. Pambar River is one of the main tributaries of Chinnar River flowing from west to east confluence near Chinnar chauki settlement.

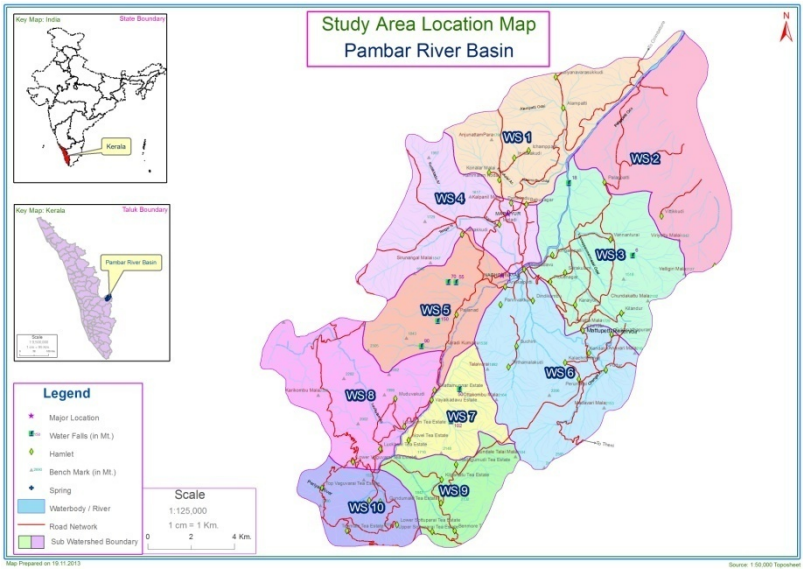

Fig.1. Study Area Map

3. Aim and Objectives

This paper mainly emphasizes on identification of groundwater vulnerability area of Pambar river basin by introducing multi influencing factor techniques in geospatial technology platform.

4. Methodology

To identify groundwater vulnerability area in Pambar river basin the following methodology (Fig:2) have been employed. The major meterials are Survey of India (1:50,000) 58F03 & 58F04 Topographical Maps, Idukki District Geological Map (GSI), SRTM (DEM) with 90 m spatial resolution and Google satellite Map, Terrain map downloaded from Google Map were involved in these analysis. From the scanned toposheets all tributaries of different extents and patterns were digitized. The slope map was prepared from SRTM DEM data in ArcGIS Spatial Analyst module. The drainage density and lineament density maps were prepared by incorporate 1 sq. km grid using the spatial analysis-Inverse Distance Weighted analysis tool in ArcGIS 9.3.

Satellite images from Google maps and LANDSAT-ETM+ Imageries (geo-coded, with UTM projection, spheroid and datum WGS 84, Zone 44 North) have been used for delineation of thematic layers such as lineament, lithology, geomorphology and land-use/land-cover. These thematic layers were converted into a raster format before they were brought into GIS environment. The groundwater vulnerability zones were obtained by overlaying all the thematic maps in terms of weighted overlay methods using the spatial analysis tool in ArcGIS 9.3. The final output has been converted from raster to vector and the vulnerable area was calculated in sq.km.

4.1 Multi Influencing Factor (MIF) of ground water vulnerable zones

To calculate the groundwater vulnerability zone in Pambar river basin, the ranking was given for each individual parameter of each thematic map, and weights were assigned according to the multi influencing factor (MIF) (Shaban et al., 2006) of that particular feature on the hydro-geological environment. Seven influencing factors, such as lithology, lineament, dranage, geomorphology, slope, land-use/land-cover and soil have been identified to delineate the groundwater vulnerable zones. Interrelationship between these factors and their effect is shown in Fig. 3.

Each relationship is weighted according to its strength. The representative weight of a factor of the potential zone is the sum of all weights from each factor. A factor with a higher weight value shows a larger impact and a factor with a lower weight value shows a smaller impact on groundwater vulnerable zones. Integration of these factors with their vulnerable weights is computed through weighted overlay analysis in ArcGIS 9.3 software.

5. Result and Discussion

5.1 Data analysis and thematic map preparation

5.1.1 Drainage Density. Horton (1932), introduced the drainage density is an important indicator of the linear scale of landform elements in stream eroded topography. Low drainage density leads to coarse drainage texture while high

drainage density leads to fine drainage texture (Strahler, 1964). The less permeable a rock is, the less the infiltration of rainfall, which conversely tends to be concentrated in surface runoff. Drainage density of the study area is calculated using spatial analysis-IDW technique tool in ArcGIS software. The study area has been grouped into five classes. These classes have been assigned to very good, good, moderate, poor, and very poor respectively. High drainage density is recorded in the central parts of the basin (Fig. 4). The suitability of groundwater potential zones is indirectly related to drainage density because of its relation with surface runoff and permeability.

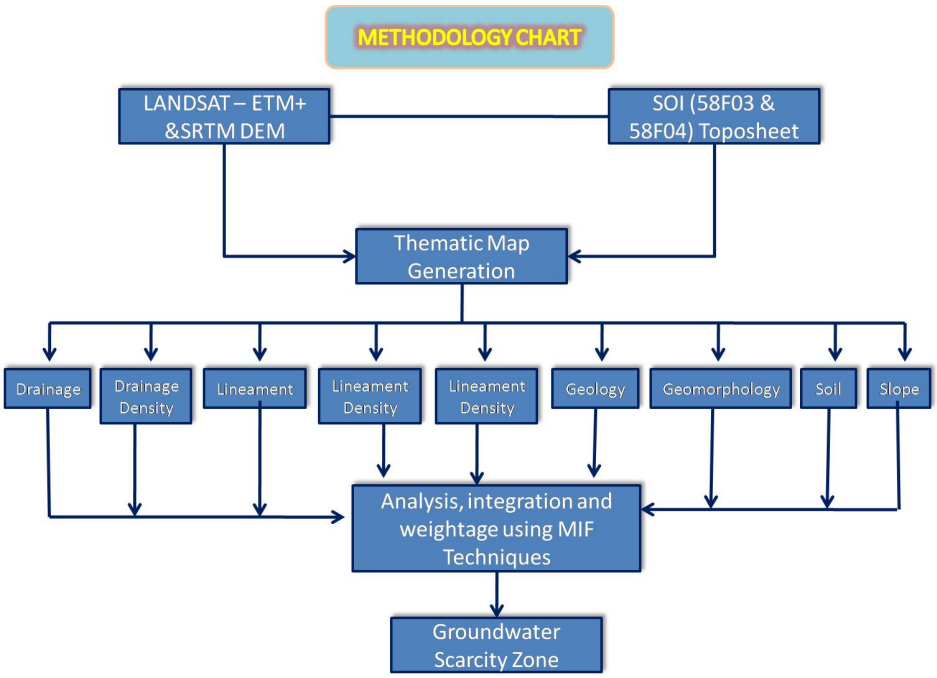

Fig 2. Flow chart showing the methodology adopted for assessment of groundwater vulnerable zone.

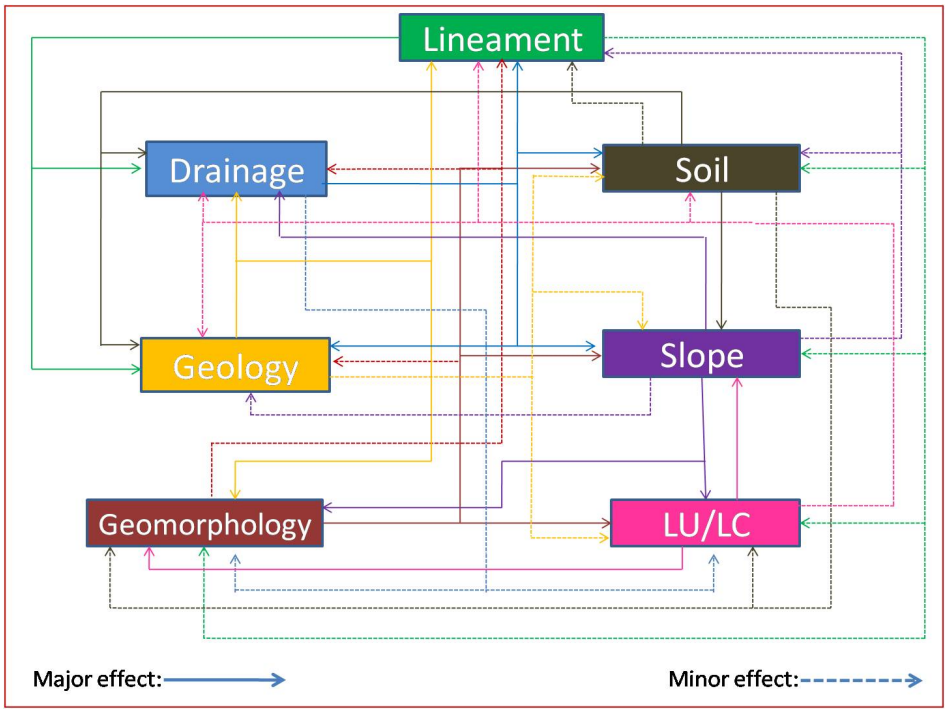

Fig 3. Interrelationship between the multi influencing factors concerning the groundwater potential zone.

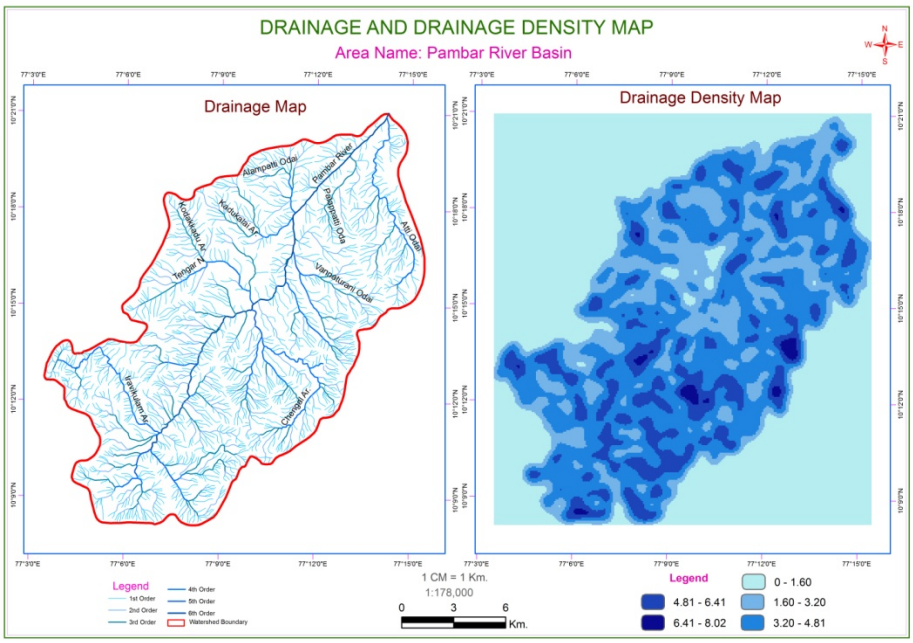

Fig. 4 Drainage Density

5.1.2 Lineament Density. A lineament is defined as a large-scale linear feature, which expresses the topography of underlying structural features and relatively straight tonal alignments visible in satellite images. In general lineament density is considered as good potential zones for groundwater targeting as they reflect high porosity and hydraulic conductivity of the underlying materials (Subagunasekar M, et.al. 2012). The lineament density map of the study area is shown in Fig. 5.

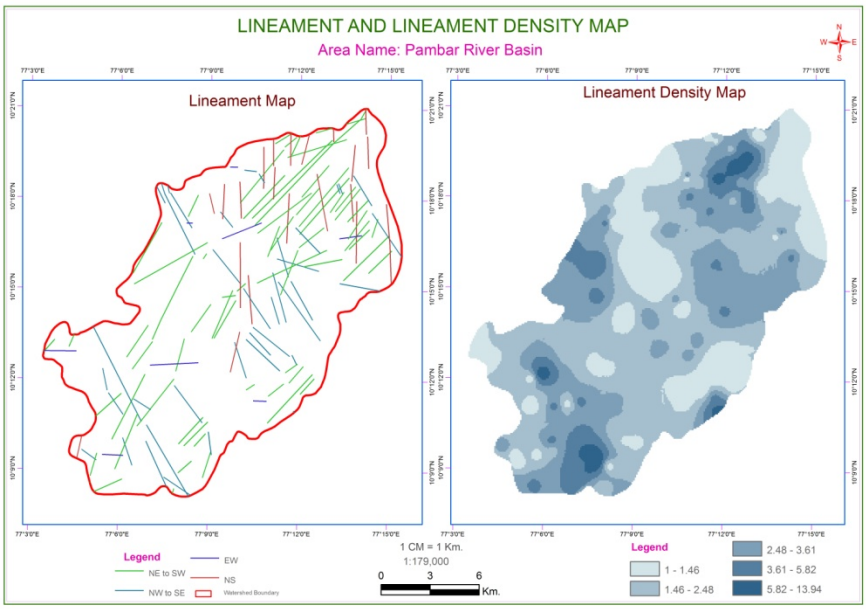

Fig. 5: Lineament density map of the study area

5.1.3 Geomorphology. The geomorphology of the area is highly influenced by lithology and structure of the underlying formations. The hydro geomorphological unit such as flood plain, valley fill, buried pediment is good sources of groundwater whereas structural hills, pediment zone and gullied land are poor recharge zones. The study area consists of Escarpment, Highly dissected denudational hill, Piedmont zone, Plateau, Rock exposure, Valley fill, Valley, Waterbody are shown in Fig.6

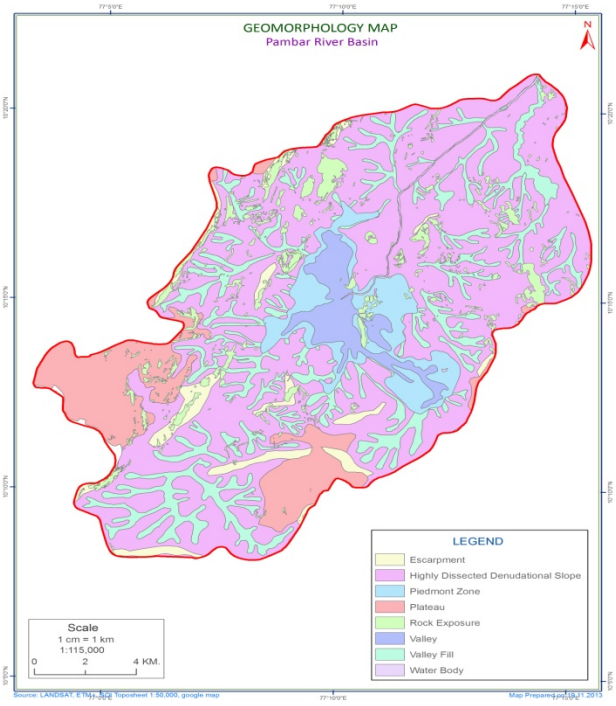

Fig.6: Geomorphology map of Pambar River Basin

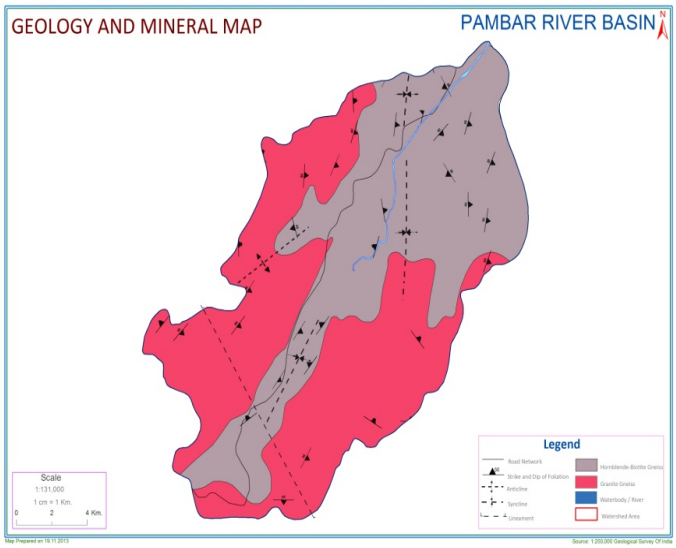

Fig.7: Geological map of study area

5.1.4 Geology. Geology plays an important role in the distribution and occurrence of groundwater. In the present study geological mapping is done using Idukki District Geological Map (GSI) with scale 1:250,000. The study area is underlain by Hornblende-biotite gneiss, Granite gneiss, Anticline, syncline, strike and dip of foliation. The geological map of study area is shown in Fig. 7

5.1.5 Slope Slope of a surface refers to change in height across a region of surface. Slope is an important factor since it affects land stability. Slope map was prepared from SRTM data as shown in Fig. 8 the study area covered by undulating topography with varies elevation structural hills. A high sloping region causes more runoff and less infiltration and thus has poor groundwater prospects compared to the low slope region.

5.1.6 Landuse/ Landcover This map was prepared by the analysis of Landsat ETM+ images of 2004 and Google Map images 2013. Based on the prepared map, 10% area is come under agricultural land followed by 39.18% forest land, 34.70% Grass land, 9.15% Plantation, 5.42% Rock outcrop, 1.05% settlement and 1% waterbody respectively. The landuse/landcover map has been shown in fig.9 Considering the areas under irrigation, they constitute about 10% of the study area indicating a strong reliance of the agricultural activities on irrigation which due to low precipitation in the region is supplied by groundwater resources.

5.1.7 Soil. Soil types of the study area are largely depending on lithology characters. There are two main soil group of this area (Fig.10). The first one is Hill soil (Chinnar Series) well drained with depth more than 150 cm developed from gneissic parent material, strongly acid. Soils dark yellowish brown to red with clay loam to clay texture and the second one is Forest soil (Anaimudi Series) well drained with depth more than 150 cm. developed from gneissic parent material,very strongly acid and soils dark reddish brown to reddish yellow with silty loam to clay texture.

5.2 Weightage Calculation

The multi influencing factors are independent. Each influencing factors have major and minor effects are given in the Table 1. The effect of each major and minor factor is assigned a weightage of 1.0 and 0.5 respectively. The cumulative weightage of both major and minor effects are considered for calculating the relative rates (Table 2). This rate is further used to calculate the score of each influencing factor. The proposed score for each influencing factor is calculated by using the formula.

$$\left[\frac{(A+B)}{\sum(A+B)}\right] \times 100$$

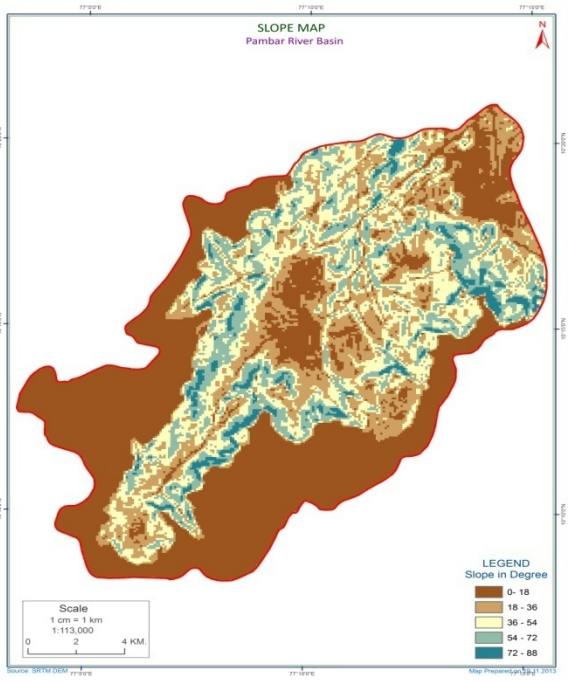

Fig.8: Slope Map of Pambar River Basin

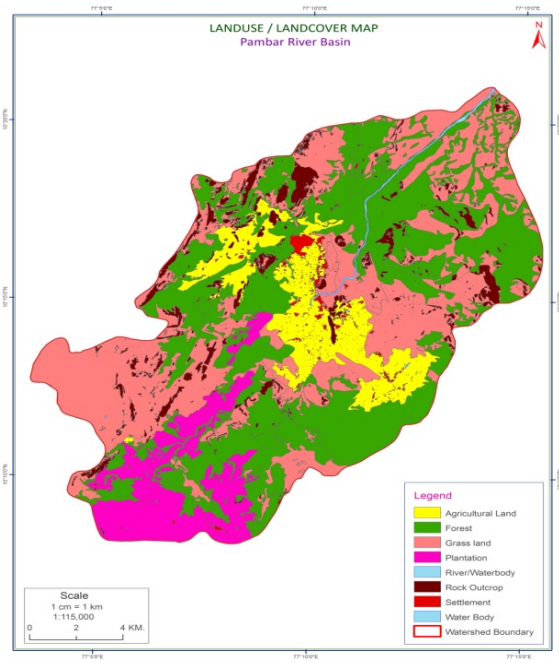

Fig.9: Land use and Land cover of Pambar River Basin

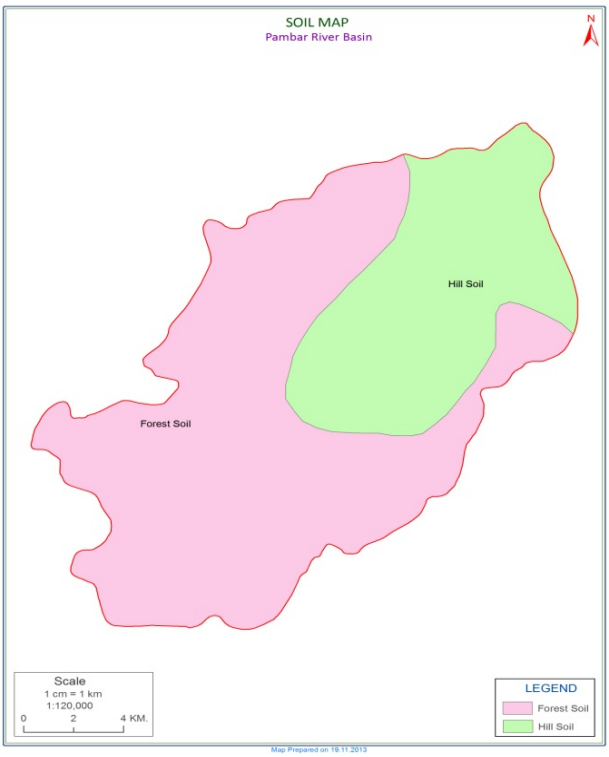

Fig.10: Soil Map of Pambar River Basin

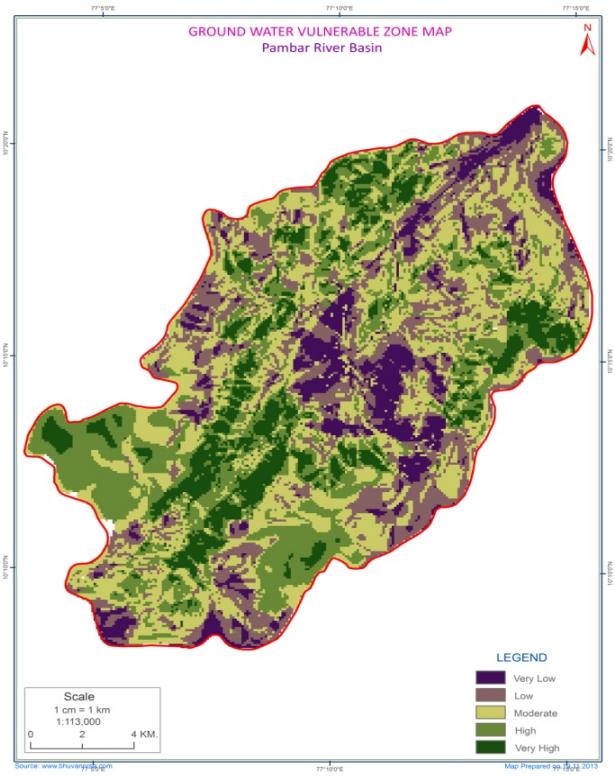

Fig.11 Ground water Vulnerable Zone Map of Pambar River Basin.

Table 1. Major and minor effects of multi influencing factor.

Influencing factors	Major effect A	Minor effect B
Lineaments	Drainage, Lithology	Land use /Land cover, Slope, Geomorphology, Soil
Geomorphology	Land use /Land cover, Lithology, Slope, Soil	Lineaments, Drainage
Lithology	Geomorphology, Drainage, Lineaments	Slope, Land use /Land cover, Soil
Slope	Geomorphology, Drainage, Land use /Land cover	Lineaments, Lithology, Soil
Drainage	Slope, Lineaments, Lithology, Soil	Land use /Land cover, Geomorphology
Land use /Land cover	Geomorphology, slope	Lineament, Lithology, Drainage, Soil
Soil	Geology, Drainage, slope	Geomorphology, Land use /Land cover, lineament

Table 2. Effect of influencing factor, relative rates and score for each potential factor.

Factor	Major A	Minor B	Proposed relative rates (A+B)	Proposed score for each influencing factor
Lineament	1+1	0.5+0.5+0.5+0.5	4	13
Geomorphology	1+1+1+1	0.5+0.5	5	16
Geology	1+1+1	0.5+0.5+0.5	4.5	14
Slope	1+1+1	0.5+0.5+0.5	4.5	14
Drainage	1+1+1+1	0.5+0.5	5	16
Land use /Land cover	1+1	0.5+0.5+0.5+0.5	4	13
Soil	1+1+1	0.5+0.5+0.5	4.5	14
Sum			32	100

5.3 Mapping of groundwater Vulnerability zone using hydrologic parameters and MIF techniques

The groundwater prospect map of the basin is established through investigation of hydrologic factors (geomorphology, lithology, slope, landuse/landcover, lineament drainage and soil) which control the occurrence of groundwater. The influencing factors on groundwater vulnerable were digitally mapped and their relative importance is examined in the present study. Thematic layers of geomorphology, lithology, lineament density, drainage density, landuse/landcover, soil and slope were used to demarcate and map the zones of groundwater vulnerability in the basin. The extent of influence of each factor on groundwater vulnerability was assessed from interrelationships among the factors (Table 2). Each unit of geomorphology, slope, lithology, lineament density, drainage density, soil and landuse/landcover is categorized as very good, good, moderate, poor and very poor on the basis of groundwater holding capacity (Table 3). Weightages of every individual themes and features were assigned depending on the suitability of groundwater vulnerability and on the basis of MIF techniques. The maximum weightages value was given to the triggering feature of groundwater vulnerability (eg. Rock outcrop) and the minimum weightages to the lowest triggering feature (eg. Very high lineament density) of groundwater vulnerability (Table 3).

Table 3. Classification of weighted factors influencing the potential zones

Hydrological Parameters	Features	Ground Water Vulnerability	Weightage
Drainage Density	Very Low	Very low	1
	Low	low	5
	Moderate	Moderate	9
	High	high	12
	Very High	Very high	16
Lineament Density	Very Low	Very high	13
	Low	high	9
	Moderate	Moderate	6
	High	low	3
	Very High	Very low	1
Geology	Granite	Very low	7
	HBG	Very High	14
Geomorphology	Plateau, Escarpment, Rock Exposure	High	16
	Valley, Denudational slope	Moderate	10
	Valley fill, piedmont zone, water body	Low	5
Slope	0-22	low	4
	22-45	Moderate	9
	45-89.9	high	14
Lineament Interaction	Very Low	Very High	13
	Low	High	9
	Moderate	Moderate	6
	High	Low	3
	Very High	Very Low	1
LU/LC	Settlement	Very High	13
	Rock area, Grass land	High	9
	Forest	Moderate	6
	Agricultural Land, plantation	Low	3
	Water Bodies, river	Very Low	1
Soil	Forest soil(Clayey)	Very High	14
	Hill Soil (Loamy)	Very Low	7

After assigning the weightages to all the themes and features, the thematic layers were converted to raster format using the spatial analyst tool. Finally, an integrated groundwater vulnerability zone map was prepared using spatial analysis-Raster Calculator tool in ArcGIS software (Fig 11). From the result, high water vulnerability zones almost 85 sq.km area are identified on North West and Southern part of the area which is a hilly terrain with steep to moderate slope and hard rock areas in nature. Morethan 104 sq.km area is yet to meet groundwater vulnerability. In contrast that low vulnerability zones comprises about 90 sq.km are marked on Piedmont zones of the agricultural land (Sugarcane, Paddy, Tapioca etc) of Marayoor and Kandalloor village and along the course of Pambar river bed region and southern part of Nemakkad, Lower Sottuparai estate.

Water Conservation Techniques. Sand dam, Sub-surface dam, Percolation ponds, Percolation ponds, Contour trenching, Teras, Tube recharge of groundwater are some of the groundwater conservation measures insisted by Janette Worm, et.al

2007. Half moon trenches, Staggered contour trenches, Semi elliptical trenches, Graded trench, Continuous contour trenches etc are suggested by S.Maniuannan, et.al 2007. Check dams should be build thereupon to block & store water after certain gaps. This help water to percolate to the water table and also provide small water stores at regular intervals (Wiki.answers.com)

Conclusion

Delineating the groundwater vulnerable zones in Pambar basin, Devikulam taluk, Idukki district using remote sensing, GIS, and MIF techniques is found efficient to minimize the time, labor and money and thereby enables quick decision-making for sustainable water resources management. Satellite imageries, topographic maps and conventional data were used to prepare the thematic layers based on hydrological parameters such as lithology, lineament density, drainage density, slope, soil, Geomorphology and land-use/ Land-cover. The various thematic layers are assigned proper weightage through MIF technique and then integrated in the GIS environment to prepare the groundwater vulnerable zone map of the study area. According to the groundwater vulnerable zone map, the study area is categorized into five different zones, namely very high, high , moderate, low, and very low. The result of the present study can provide as guidelines for planning future artificial and natural recharge projects in the study area in order to ensure sustainable groundwater utilization.

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A STUDY ON THE SCOPE AND IMPORTANCE OF TUBER CROPS, A BETTER RESILIENT TOWARDS THE IMPACT OF CLIMATE CHANGE

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Abstract

Climate change impact at the global level has become a major concern today. Climate change has significant threats to agricultural sector. The agricultural production and productivity declining year by year, but the number of feeding mouth increasing day by day. This paper reviews the possibility and potentiality of tuber crops in the study area, the resilience towards climate change and it related catastrophes and aware the farmers the importance and economic feasibility of tuber crops as a better alternative and industrial welcoming crops. The study found out that majority of the tuber cultivating farmers in the study area falls into low landholding status whereas majority of the farmers engaged in cassava cultivation. The farmers reported that the famers who cultivating tuber are completely satisfied with the resilience of crops against various change in climatic variable.

Keywords

Climate change, Cassava, tuber crops

Introduction

Climate change is real. Weather and climate having profound impacts on living and non-living components on the globe. According to Intergovernmental Panel on Climate Change (IPCC), climate change refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (IPCC, 2007). Climate change may be due to natural internal processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. Anthropogenic activities over the last century have contributed towards increase of atmospheric concentration of the greenhouse gases (GHGs) and thereby led to an enhancement of natural greenhouse effect. Increase in concentration of the greenhouse gases in the atmosphere has led to the warming of the earth's system. IPCC special report on Emission Scenario project an increase of global GHGs emission by 25 to 90% (CO_2-eq) between 2000 and 2030, with fossil fuels maintaining their dominant position in the global energy mix to 2030 beyond (SRES, 2000).The evidences of global climate changes are sea level rise, global temperature increases, warming oceans, shrinking ice sheets, declining Arctic sea ice, glaciers, ocean acidification, emergence of pest and insect attacks. Increased level of greenhouse gases beyond their natural levels due to uncontrolled human activities such as burning of fossil fuels, increased use of refrigerants and enhanced agricultural activities caused climate to change to the present form.

India is an agricultural country, majority of the population (65%-70%) engaged in farming. Climate change also affects this agricultural country. The past data shows that average surface air temperature over the Indian subcontinent show a slight warming trend by 0.2˚to 0.4˚C per 100 years in the mean annual temperatures (Srivasthava *et al.,* 1998). The country's agricultural sector are under vulnerable to climate change, climate change related extreme weather events and other catastrophes. Studies show that every 2˚C may decrease rice yield by about 0.75 t ha^{-} and also affects other important crops like wheat, chickpea, soyabean, sorghum. Reduction in production of staple food crops like wheat and rice will lead to boost the price of these materials. Price peak will mostly affects the marginalized poor backwards peoples of the country. To find out an alternative food source which provide sufficient calorie to maintain the normal diet? It is very much necessary to introduce the importance of tropical root and tubers in our country.

Tropical Root and Tuber crops are known as the energy bank of nature serving either as primary or secondary staple to meet the calorie needs of about one fifth of world's population. They have the highest rate of dry matter production per day and act as a chief calorie contributors. Root crops are the edible energy-rich underground plant structures developed from modified root while tuber crops are those crops in which the edible energy- rich storage organs develop wholly or partly from underground stem (Okigbo, 1989). These crops have numerous and complex roles to play in the food security and reduction of hunger and elimination of poverty in small and marginal farmers and tribal population. Under angiosperms there are 18 families which have more than 30 genera producing edible root and tubers. Among more than 25 species of root and tuber crops, cassava, sweet potato, aroids (taro, swamp taro, elephant foot yam, yam and tannia), yams (lesser yam, greater yam and aerial yam) are commonly cultivated. Economically important tropical root and tuber producing species commonly used for food, feed medicine and industrial purposes.

Countries like Africa, Latin America, and Asia extensively consumed root and tuber as the major source calorie providing food material in order to defend against hunger and malnutrition. In country like Africa highly prone to drought condition will not allow rice and wheat production. So the tuber crop like cassava plays an important role in their dietary. Kerala the "God's own country" now faces the staple crop production decline and the price peak of the staple food crop rice. The state was prone to all natural hazards and also experience extreme weather events. Climate change and it related catastrophes make the agriculture sector more miserable. The increase in population will make the situation more dejected. So under such circumstance to aware the people the importance of tuber crops and its economical feasibility are very much necessary for a sustainable future. The major objectives of the study is to understand the production potential of tuber crop in the study area, to evaluate climate change influence the growth and production of tuber crops, to under the resilience tuber crops by means of farmers opinion and the importance, possibility and potentiality of the tuber crops in industrial uses.

Materials and Methods

The study was undertaken in Kottayam district of Kerala state, lies between 9˚23'-9˚52'N latitude and 76˚21'-77 E longitude. The district has Western Ghats on the east and Vemband Lake and paddy field of Kuttanad on the west. From the 5 taluks 130 tuber cultivating farmers especially cassava were selected using simple random sampling procedure and structure questionnaires was employed for the collection of the primary data used for the analysis. The secondary data mostly from the government revenue departments, government agriculture offices, reports and articles collected from journals. The collected data were analyzed using descriptive statics such as frequency table, mean and percentage analysis. The study area location map given below Figure: 1

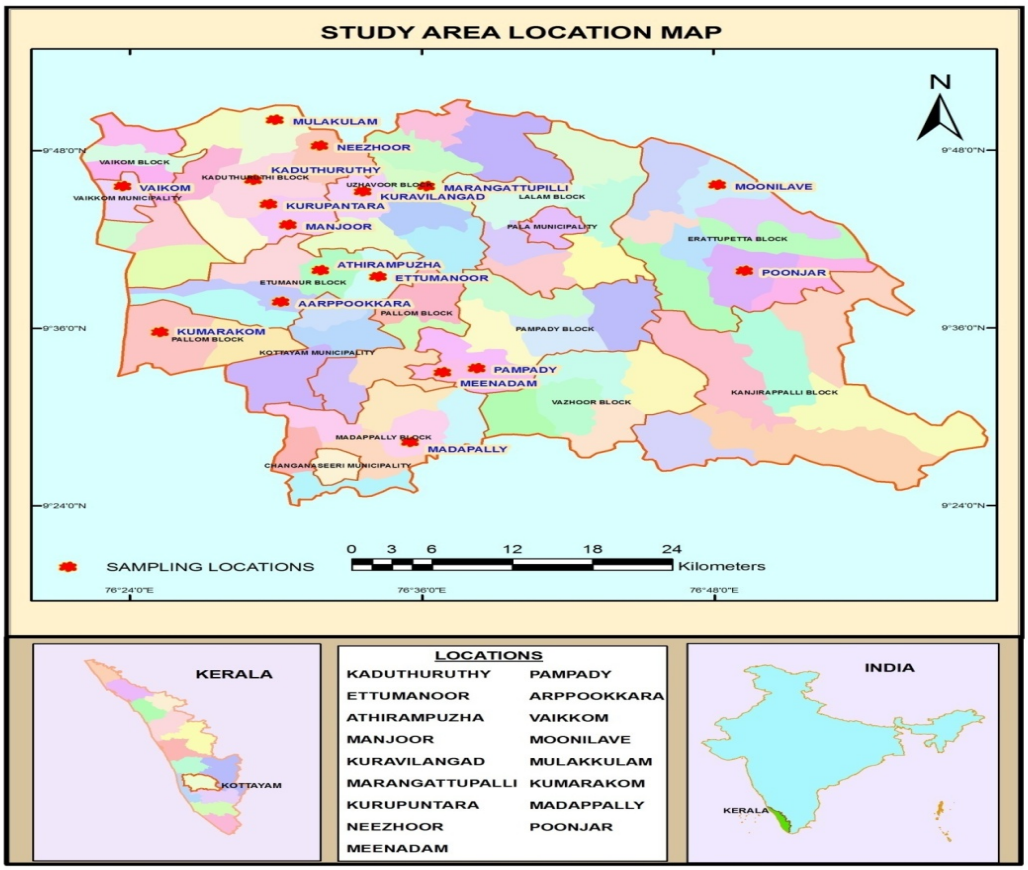

Figure: 1 Study area location map

Result and Discussion

Result of Market survey and Field selection

Market survey conducted mainly in two districts namely, Ernakulam and Kottayam district of 13 major loci listed in the Table 1. From the market survey it's clear that Kottayam district is the major provider or source of tuber crops mainly cassava. Majority of the vendors reported that cassava from various cultivating zones of Kottayam was noted for its quality and quantity and also the availability in off seasons. Other easily available tubers are elephant foot yam, colocasia. Hence for an in depth study Kottayam district was selected.

Result of Production potentiality of tuber crops in the study area

Result of status of Tuber crops. From the survey, the farmers reported that the tuber and root crops mainly cultivated in Kottayam districts are cassava, yam, elephant foot yam, colocasia, lesser yam and sweet potato. Out of the total 130 farmers 96% of the farmers are cultivating cassava in their field whereas 73% farmers produce elephant foot yam. Only 19% of the farmers are reported to cultivate sweet potato in their land. The farmer's status of growing tuber in their fields was listed in table 2.

Table: 1 Distribution by the list of Markets

Sl no	Markets	Source of tubers	Sl no	Market	Source of tuber
1	Ernakulam	EKM,KTM, TN	8	Kodimatha	Ktm, TN
2	Pachalam	Ekm, TN	9	Kottyam	Ktm, TN
3	Kaloor	EKM,KTM, TN	10	Ettumanoor	Ktm, TN
4	Vaduthala	Ekm, TN	11	Athirampuzha	Ktm, TN
5	Cheranalloor	EKM,KTM, TN	12	Kuruppanthara	Ktm, TN
6	Fort-Cochi	EKM,KTM, TN	13	Kodimatha	Ktm, TN
7	Chambakara	EKM,KTM, TN			

Source: Field Survey 2013 EKM- Ernakulam, KTM- Kottaym, TN- Tamil Nadu

Table: 2 Distribution by the status of tuber crops

Characteristics	Frequency	Percentage (%)
Tapioca	125	96
Yam	88	68
Elephant foot yam	95	73
Colocasia	50	38
Lesser yam	38	29
Sweet potato	25	19

Source: Field Survey, 2013

Result of tuber cultivation status. In this study the landholding of farmers mainly categoried into three. Category 1 is low (5 cent- 50 cent), category 2 medium (above 50 cent- 1acre) and category 3 high (above 1 acre-1 hectare and above). The graph 1 shows that 66% of the farmers having low (5 cent- 50 cent) landholding status while 10 % have high (above 1 acre-1 hectare and above) landholding status. This results that majority of the farmers engaged in tuber cultivation having low cultivating land and are poor marginalized farmers.

Result of cost of production and output. The cost of production of tuber crops per hectare comes nearly 5800/- rupees given in Table 3. Out of the total cost of production, hired labour cost constituted 64% where as farmyards manure and chemical fertilizers shares 14% of the cost. When compared to the production cost of paddy, tuber demands less cost per hectare.

Table: 3 Cost of production

	Tuber name	No. of plants in 1 cent land	Output(Kg)	Income generated
Production of tuber from 1 cent land	Cassava	10-12	90-120	2000-3000
	Elephant foot yam	8-10	40-70	1000-1500
	Yam	10-12	36-40	1800-2200
	Colocasia	10-15	25-30	1500-1800
	Lesser yam	10-12	35-40	1600-1800

Compared to rice the tubers are profitable because it demands less cost. The yield productions of tuber crops are given in the table 4 shows that from 1 cent of land 90-120 kg of cassava obtained after a successful growth cycle. The income generated nearly 2000-3000. The other tubers like yam, elephant foot yam, colocasia also generating a better income from completing a successful growth cycle.

Growth condition and Resilience of tuber crop. The tuber crops are not only good calorie provider but also they are able to tide over the unfavourable conditions caused by the climate change and the occurrence extreme weather events. The

table: 5 shows the growth period, optimal rainfall, temperature, fertility requirement, planting materials and storage time in ground of cassava, sweet potato, potato, tannia, colocasia, yam.

Table: 4 Distributions by the production and output generated

Sl.no	Components	Rupees
1	Hired human labour	1800
2	Planting material	1500
3	Manure and fertilizer	2000
4	Planting protection	0
5	Irrigation	0
6	Maintenance	500
	Total	**5800**

Source: Economic review, 2013, Field survey, 2013

Table: 5 Main characters of tuber crops

Characterstics	Cassava	Sweet potato	Colocasia	Yam
Growth period(month)	9-24	3-7	6-18	8-11
Annual or Perennial	Perennial	Annual	Perennial	Annual
Optimal rainfall	100-150	50-75	250	115
Optimal temperature	25-29	15-18	21-27	30
Drought resistant	Yes	No	No	Yes
Optimal pH	5-6	5.5-6	5.5-6.5	Na
Fertility requirmnet	Low	High	High	High
Organic matter requirement	Low	High	High	High
Planting material	Stem	Tuber cutting	Corms, cormels	Tubers
Storage time in ground	Long	Short	Moderate	Long
Post harvest storage life	Medium	Long	Long	Long

na – data not available Source: FAO report 2012

These tuber crops are very rustic and grow well under marginal environment where most other animal crops would not survive. Tubers especially tapioca is found to thrive under almost all weather and climatic conditions. It has several defenses mechanisms that help it to conserve water, its roots can grow to great depths to access subsoil moisture reserve. By this mechanism tapioca can withstand prolonged period of drought. Once the plant established, tapioca can grow in very dry areas; the crop's water requirement is put at form 400-750 mm for a 300 day production and have the ability to withstand a temperature peak of about 38-40˚C. The other tuber crops include Elephant foot yam, yam, and lesser yam also shows resilience to drought condition. These crops overcome the unfavourable temperature stress condition by shedding leaves to reduce its number. For reducing the rate of transpiration it reduce the leaf stomata by curling the leaf. The colocasia are highly resilient to flooded and heavy rainfall condition. The plant petiole and roots are composed of arenchyma cells. The peculiar feature of arenchyma cells was the presence of air channels, which allows exchange of gases between the shoot and the root. Table 6 shows the opinion of the farmers regarding the resilience of tuber crops in the study area.

Table 6. Opinion of farmers towards the resilience of tuber crops

Natural Hazards	Cassava	Elephant foot yam	Yam	Colocasia	Sweet potato
	yes/no	yes/no	yes/no	yes/no	yes/no
Floods	slightly	slightly	yes	no	Slightly
Drought	no	no	no	yes	Slightly
Cyclone	no	no	no	no	Na
Landslide	na	na	na	no	Na

Source: Field survey 2013

The old meterological data shows that climate change happing on regional basis. The temperature shows an up shooting trends whereas the amount of rainy days declining. The future projection shows the warming environment with high temperature and chance of occurrence of severe drought events. The Kottayam district experience summer rain in the year

2007 which highly damaged the paddy cultivation and other crops. The natural hazards experienced by the study area were flood, drought, cyclone and landslide. The farmers (93%) in the study area reported that the cassava was highly profitable and easily cultivated. 85% of the farmers reported that cassava shows high resilience under high drought condition and also79% were reported that under water logged condition also they were surviving. Table 6 shows the opinion of the farmers regarding the resilience of tuber crops in the study area. While the elephant foot yam, yam, lesser yam in the study are also shows it ability to survive in the extreme drought condition, and if the harvesting may delays it will safely buried in the soil and preserve themselves.

Importance of tuber crops as alternative & other sectors

Tuber crops not only enrich the diet of the people but also possess medicinal properties to cure many ailments or check the incidence. Different part of the now choose these tuber crops as the future food crops, because its resilience and also its low production investment. The study also conducts survey in the bakeries of Kottayam district. Out of 50 bakeries owners 72% reported that the tuber like cassava flour used in bread making and also in cake stuff and other bakery purposes. Mainly in Kottaym cooked cassava with fish curry are tourist attracting menu and got high popularity. Fried cassava slices are highly selling product of cassava in Kottayam district.

They are not only used as a food material, but also it has medicinal properties and other industrial uses. In California, after harvesting the crop residues are used as cattle feeders. The whole plant body is utilized for cattle feed. In other countries cassava used by different industries for starch making, alcohol production, glucose, acetone, dextrins, glue and pastes, used as binder and so on. By understanding its economic feasibility the counties like America, California, and Nigeria are conducting a number of research work on tuber crops as a better future food and industrial crops. Elephant foot yams are medicinally important tuber crops treat against piles, dysentery, asthma, swelling of lungs and tumors. In Kerala these tuber crops medicinal uses are broadly applied in Ayurvedic treatments.

Conclusion

The study mainly focused the possibility and potentiality of tuber crops in the study area, does the tubers in the study area are resilient towards climate change and related catastrophes and to aware the people the importance of tuber crops as an alternative food stuff and the industrial applications providing a better income. 130 respondents were randomly selected and interviewed with the aid of well structured questionnaires to gather all the necessary information for this research. The major findings of the study are the districts also affected by climate change and related natural hazards. But the farmers reported that the tubers especially cassava, elephant foot yam, yam are resilient under drought condition and successfully completing their growth cycle. 65% of the farmers having low landholding status and majority of the farmers reported that they cultivating cassava in their field. The bakeries survey also shows the use of cassava in bakery industry was noted. The staple foods vulnerability towards the climate change and related catastrophes the tuber crops will remains as the viable and cheap calorie provider.

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EMERGENCY RESPONSE PLANNING & MITIGATION STRATEGIES FOR TERRORISM EVENTS INVOLVING RADIOACTIVE SOURCES

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Abstract

The radioactive sources play a crucial role in the public domain including medical & health care sectors, research and industrial applications. Though most of these sources are regulated; chances of the deliberate use of such sources as a terrorism vector or an accidental dispersion in ambient air is expected to cause unprecedented consequences in public domain. Out of the total reported radiological accidents worldwide, it is observed that more than 40 accidents are of terrorism activities and/or radiological homicide natures as per international statistics. In order to protect the public from the detrimental effects of radiological exposures of this kind, a well designed emergency response planning aided by an Early Warning System (EWS) with real time sampling capabilities is to be implemented. The requirement of such system is evaluated through a case studies conducted in the context of a Mayapuri radiological accident reported in 2010 and a comparative study conducted to identify the background radiation level of Delhi. A graded approach in accordance with national and international protocols on radiological protection and emergency management is utilized for the development of a Consolidated Emergency Management plan for terrorism events involving radiological sources. Study concludes with the recommendation for developing a national level Mobile/Standalone Environmental Radiation Monitoring Network at Metro Cities, and the implementation of mitigation strategies for the protection of general public from the effects of radiological accidents.

Key Words

Radiological Terrorism, Threat perception, Orphan Sources, EWS, Mayapuri, First Responder, Response Measures, Mitigation.

1. Introduction

Since the discovery in 19th century, the radioactivity have brought an exponential change to the humankind through its application in hospital & health care sectors, food irradiation, power sector, industrial application and for many other uses. Subsequently over a short span of time, a chain of events pertaining to leakage of hazardous radioactive material reveal that the radioactive materials in the form of radioactive powder or pellets have moved out from security cordons to public domain. The horrendous radiological accident during April at the Mayapuri scrap metal bazaar in New Delhi, which caused radiation poisoning to seven persons, one of whom has since died, due to the result of abandoned radiation sources mixed with scrap metal originating from various places both from India and abroad. The experts have identified the material as Cobalt-60. The scrap industry recycles such scrap metal; largely iron, into low-grade steel, which is then converted into various other products. Such events can take a more dreadful face as in the case that came up in Goiania, Brazil 1987 where a radioactive source abandoned from a medical installation was unintentionally led to widespread contamination which required a screening of 1,12,800 people for assessing the contamination. The statistics of orphan and stolen radioactive sources and the incidence reported shows that these sources are at an arms length of public and any terrorist group.

Continuous monitoring of background radiation level plays a vital role in obtaining information about radiological contamination. These real-time monitoring becomes the deciding factor for the declaration of a radiological emergency and initiation of response procedures. A properly designed emergency response plan backed with an Early Warning Systems and dedicated first responder teams becomes the backbone for the protection of public from the dangers of radiological events.

2. Threat Perception

The availability of radioactive sources in the public arena through its various applications and the inherent disruptive power associated with it increases the chances of these sources being stolen. The medical facilities and industrial sources become the soft target for terrorist groups, and they have the potential of using such materials for creating a RDD attack or a homicide attack for social/political gains. The intention of these groups may not be the development of a “Weapon of Mass Destruction” like nuclear bomb; rather these can be converted as a “Weapon of Mass Disruption”. The terrorist groups may select crowded locations like a public gathering or places of strategical importance for such attacks resulting in dispersion of radioactive material into the environment causing widespread contamination. The major aim of such

attack is to engage the Governmental machineries to necessitate a mass clean up/decontamination of the affected area and create large scale panic among the general public. The threat of terrorist groups planning and executing such radiological attacks in India cannot be ignored. Considering the actual and implied consequences of such phenomenon, the threat associated can be categorized in two different groups viz. Radiological Threat and Security Threat.

2.1 Radiological Threat: The radiation sources used normally remain in sealed containments. Such equipments are the most significant in the context of terrorism; because they contain large amounts of radioactive material such as cobalt-60, strontium-90, caesium-137, and iridium-192. Out of these Cs-137 is identified as one isotope which can be used for incidents of terrorism nature. This particular isotope is extremely dangerous if ingested or inhaled accidentally even in small quantities. It's ability to get bound to the building materials makes it extremely difficult to decontaminate also. The commonly available sources in the public domain can be classified into different categories as given below;

Table 1: Categorization Table

Category	Categorization of common Practices	Activity ratio (A/D)
1	• Radioisotope thermoelectric generators (RTGs) • Irradiators • Teletherapy, multi-beam teletherapy (gamma knife)	A/D≥1000
2	• Industrial gamma radiography • High/medium dose rate brachytherapy	1000>A/D≥10
3	• Fixed industrial gauges • Level gauges, dredger gauges • Conveyor gauges containing high activity sources • Spinning pipe gauges,Well logging gauges	10>A/D≥1
4	• Low dose rate brachytherapy (except eye plaques and permanent implant sources) • Thickness/fill-level gauges, Static eliminators • Portable gauges (e.g. moisture/density gauges) • Bone densitometers	1>A/D≥0.01
5	• Low dose rate brachytherapy eye plaques and permanent implant sources • X ray fluorescence devices • Electron capture devices • Mossbauer spectrometry • Positron Emission Tomography (PET) checking	0.01>A/D>Exemption Level

Health Effect: Radiological dispersion devices are typically designed to spread radioactive material over wide areas. The health effect associated with radiation exposure are of two kinds Stochastic and Deterministic. The stochastic effects which are of probabilistic nature ranges from hereditary effects to cancer. whereas deterministic effects are based on threshold limits and includes radiation burns, Acute Radiation Syndrome etc. These effects depend on various factors like intensity, duration, type of the radiation and the chemical & physical characteristics of the material involved. The detectable effects according to the exposure criteria is given below in table;

Table 2: Effect from Radiological Exposure

Health Effects	Acute Dose (Gy)
Blood count changes	0.50
Vomiting (threshold)	1.00
Mortality (threshold)	1.50
$LD_{50/60}$ (minimal supportive care)	3.2-3.6
$LD_{50/60}$ (supportive medical treatment)	4.8-5.4
$LD_{50/60}$ (autologous bone marrow or stem cell transplant)	>5.4

2.2 Security Threat: Radioactive sources are widely used in various sectors like industry (calibration, material testing, product irradiation and sterilisation, fill level and density measurement), medicine (radiation therapy for cancer treatment, medical diagnostics, and blood irradiation), agriculture (seeds irradiation) and research. The details of registered sealed sources available in India are given in Table 3.

The increase in the terrorist activities post 9/11 attack and the sporadic instances of smuggling of radioactive materials have forced the security analyst to correlate the capabilities of known terrorist groups spreading its fangs towards unconventional radiological attack mode. The recent incidence of cases of radiological thefts and homicide attacks using radiological sources support the claim. According to Incident and Trafficking Database (ITDB) 2013 fact sheet, between January 1993 to December 2012, the ITDB contained a total of 2331 confirmed incidents, out of which 419 incidents reported involved unauthorized possession and related criminal activities, 615 incidents reported involved reported theft or loss and 1244 incidents involved other unauthorized activities. Terrorists might choose to use such smuggled sources as a radiological weapon for one or more purposes with potential consequences of serious health effects, psychological effects and widespread contamination through;

- The deliberate placement of a breached or unshielded source in a public area(Radiation Emission Device)
- The deliberate dispersion of radioactive material with the help of explosive attack. (RDD)
- Use of radioactive material to cause homicide attack.
- Dispersion through air-conditioning systems or transportation tunnels or water supply system.

Table 3: Sealed sources in use in India

Devices	Sources	Numbers
Telegamma Units	Co – 60 (plus depleted uranium used as shielded materials in some cases)	283
Branchytherapy Units	Co – 60, Ir – 192, Cs -137, SR -90	229
Gamma Irradiators	Co – 60	12
Gamma Chambers	Co – 60	110
Industrial Gamma Exposure Devices	Ir – 192, Co – 60 (plus depleted uranium used as shielded materials in some cases)	1507
Nucleonic Gauges including well-logging sources	Am – 241, Am241- Be, Cs – 137 , Co – 60	7850
Medical and Industrial Linacs	Depleted Uranium used as shielding materials	143
Consumer Products		
Gas mantle	Ce – 58, Th – 90	62
Lamp Starters	I -131, Tc -99	20
Smoke Detectors	Am – 241	102
Electron Computer Detectors	Co -60	667

Case History in INDIA: Number of cases has also been reported from India about the unauthorized access, theft or loss of radiological sources and equipment containing various radioactive isotopes. Some major cases include; the Recovery of Uranium 235 weapons grade material from criminals in Tamil Nadu in 1998; theft of more than 8 kg of natural uranium from the IGCAR, Chennai (later seized by the Central Bureau of Investigation in 1999); recovery of 26 kg of uranium from illicit traffickers in Hyderabad in 2000; theft of a gamma radiography camera containing Iridium 192 with an activity of 729 GBq during transportation in Assam in July 2002; theft of industrial ionizing radiation-gauging device containing about 9.25 GBq Cs-137 source in November 2006; seizure of around 4 kg of low quality uranium from a group of smugglers from the Nepal border in 2008; theft of Cobalt-60 isotopes from the Steel Authority of India Limited (SAIL) Durgapur plant in January 2011.

Most of these incidents have been reported from areas having known record of terrorist activities, some of them were even from cross border terrorism belts. In the context of such incidents and, the security threats to the country from terrorists operating inside the country, State sponsored terrorism from across the border, terrorist groups with international presence like Al Qaeda, LTTE, etc, extremist religious groups with specific political/religious aim, Nationalist/separatist groups like naxalites, Naga insurgents etc. need to be re-ascertained.

3. Materials and Methods

The implementation requirements of this study are satisfied firstly by applying a graded approach to assess the background activity level and to identify the radiation isotopes in the public reach. This is done through a dedicated sampling and counting procedure and literature review. Secondly, to formulate protective action guidelines for the mitigation of radiation emergencies accomplished through the first responder deployment and real time analysis using software model and GPS system. Finally, enhancing the capabilities of the system required administrative controls and protective guidelines were suggested. Sequential steps of the study methodologies were divided by the following way:

3.1 Background Radiation Survey- Gamma

The natural radioactivity in the environment comes from the primordial radio-nuclides which are present in the earth's crust, cosmic radiation and manmade radio-nuclides. To find out the radiation events, it becomes necessary to assess the background radiation level in the area. The gross alpha/beta counting and gamma mapping have been performed in Delhi for a span of two years. The purpose of such measurement was to provide adequate information concerning to the background radiation level in the particular area and to develop a radiation mapping of Delhi area.

The background gamma radiation levels have been measured using a gas filled GM tube detector, commonly known as environmental radiation monitor. This instrument was kept on the ground with sensor at a height of 1 meter for a period of 5 minutes. Three readings were taken for each location to determine the background radiation level. The study reveals that the background gamma level varies from 4 μR/hr to 17 μR/hr with an average of 9.6 μR/hr. All the measured values were found to be well below the permissible level of 50 μR/hr. The residual readings are tabulated to map the gamma activity in the area. Sample data are given below.

Table 4: Gamma Radiation Level in Air at Selected Locations

Ser No	Place/Location	Gamma Exposure (μR/hr)
01	Palam area	12
02	Chanakya Puri	9
03	Old delhi	10
04	Dwaraka	11

3.2 Air Activity Monitoring - α and β

Gross Alpha/Beta activities were determined using filter paper method. The samples should be collected in a Glass fiber Filter paper of recommended size with a high volume air sampling pump. Sample collection time should be 10 minutes and flow rate should be 500lpm. The samples were analyzed using a Gross Alpha counter and Gross Beta counter.

The gross α and β activity in air has been determined at various identified locations (20 numbers) of Delhi area. The α activity was found to be ranging from 0.25 Bq/m^3 to 0.82 Bq/m^3 and the β activity were 0.16 Bq/m^3 to 0.48 Bq/m^3. The average values of α and β were 0.54 Bq/m^3 and 0.29 Bq/m^3 respectively. These levels resembles to the natural background levels reported by international agencies. The values were also added to the background data base with location tag. Sample reading were given in the table below.

Table 5: Radioactivity in air using filter paper method

Ser. No	Location/Zone	Activity (Bq/m^3)	
Gross Alpha		Gross Beta	
1		Palam area	0.40 ± 0.01
2	Chanakya Puri	0.76 ± 0.02	0.47± 0.01
3	Old delhi	0.47 ± 0.02	0.26± 0.02
4	Dwaraka	0.60 ± 0.01	0.23± 0.02

3.3 Case study & Simulation

For the purpose of the case study the data obtained from Mayapuri Accident., New Delhi 2010 and Goiania Orphaned Source Event, Brazil 1987 is used for a terrorist event simulation. The simulation studies are performed at Sarojini Nagar Market (Terrorist Bomb blast site in 2006), in South West Delhi area.

Table 6: District Wise Population, Density Data of Delhi, 2011

Sl. No.	District / State	Total population	Density (per sq. Km)
1	North	883418	14973
2	South	2733752	10935
3	East	1707725	26683
4	West	2531583	19625
5	New Delhi	133713	3820
6	Central	578671	23147
7	South-West	2292363	5445

Case I: The radiological event in the study is simulated for Co -60 with source strength of 20Ci (equivalent to Mayapuri Source). The reported event caused by a radioactive material originated from a Gamma Chamber belonging to an academic institution. The Co – 60 seized from Mayapuri area was from the Gammacell 220 Research Irradiator, originated from CANADIAN IRRADIATION CENTER in 1969. The said source has completed its 8 half life by the time it was recovered during the accident, the source strength being 18.61 Ci. Authorities recovered eight sources at the original shop, two at a nearby shop, and one from the dealer's wallet. The consequence of this accident was reported as 1 fatality and 7 injuries with a widespread contamination requiring an exhaustive clean up action. As per the DAE reports and Supplier data the initial activity of the source was over 3978 Ci (4000Ci aprox.).

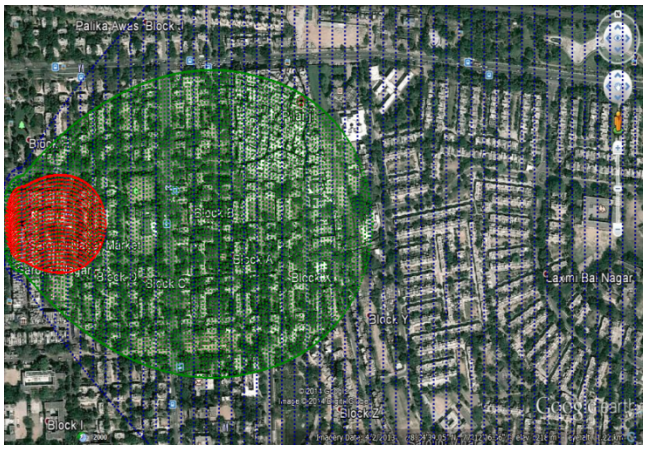
Source terms		**Meteorological Parameters**	
Source Material	: Co-60	Wind Speed	: 10m/s
Source Term	: 20 Ci	Wind Direction	: 270° W
Airborne Fraction	: 1.000	Atmospheric Stability	
Respirable Fraction	: 0.200	Solar Information	: Sun high in the sky
Respirable Release Fraction	: 0.200	Stability Class	: C – Slightly unstable

The simulation is performed using General Plume dispersion method for particulate matter dispersion. The Total Effective Dose Equivalent contour plot is placed in Fig.1.

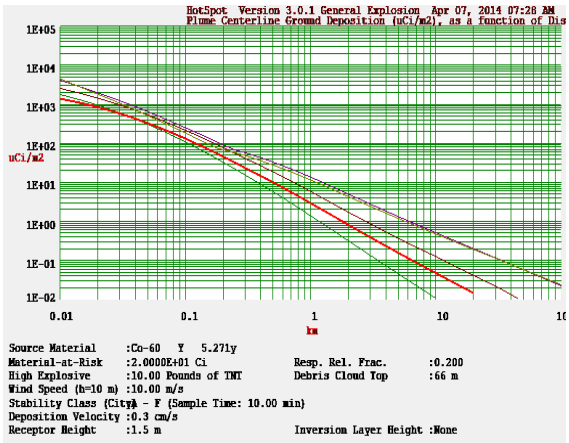
Case II: The radiological event in the study is simulated for Cs – 137 with source strength of 1300Ci (Goiania orphaned source event, 1987). The accident scenario of Goiania, Brazil 1987 was related to the radiotherapy unit of a private medical facility. The 50 TBq (1350Ci) ^{137}Cs tele-therapy unit was left abandoned in the partially demolished building. After two years some local people dismantled the source from its housing and removed it for scrap metal value. The ruptured cesium chloride source, which is highly soluble and readily dispersible was spread over parts of the city by contact contamination and resuspension.

Source terms		**Meteorological Parameters**	
Source Material	: Cs- 137	Wind Speed	: 10m/s
Source Term	: 1300 Ci	Wind Direction	: 270° W
Airborne Fraction	: 1.000	Atmospheric Stability	
Respirable Fraction	: 0.200	Solar Information	: Sun high in the sky
Explosive Charge	: 10 lb	Stability Class	: C – Slightly unstable

The simulation is performed using General Explosion method for particulate matter dispersion. The Total Effective Dose Equivalent contour plot is placed in Fig.2.

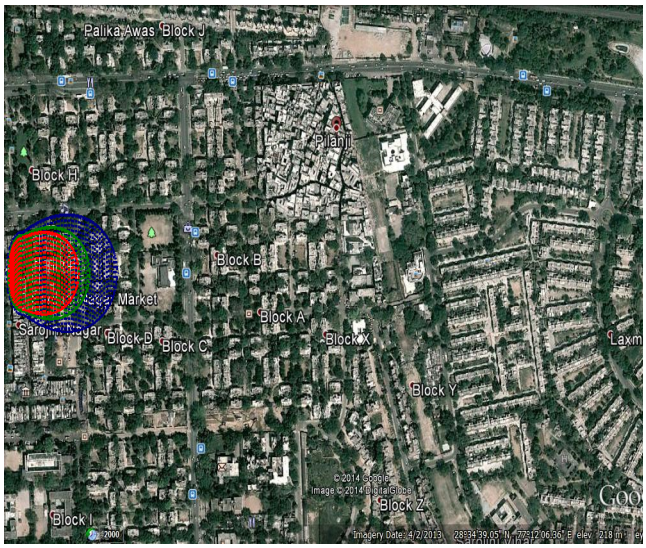


Ground Deposition Plot

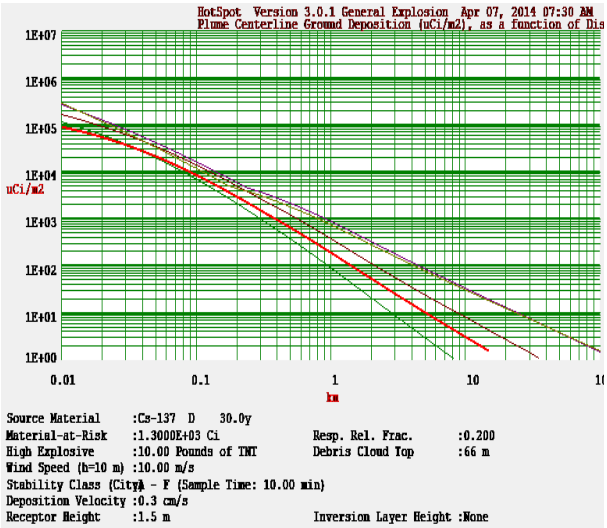


Ground Deposition Contour

Fig 1: Simulation Contour Plot



Dose Contour Plot



Ground Deposition Plot

Fig 2: Simulation Contour Plot

The simulation output for Dose conversion and ground deposition for both the cases in tabulated form is given below. The analysis shows that an RDD attack will have both blast casualties and contaminated (radiological) casualties. The blast effects of such an attack scenario depend mainly on the explosive charge used in the device. The contamination level depends on various parameters like type of the source material, particle diameter, metrological parameters and explosive charge/means of dispersion. The study reveals that the ground deposition of the radioactive materials in both the cases reached upto a distance of 1km with 4kg explosive charge, which can be a cause for widespread contamination requiring mass mobilisation of clean up and medical assistance after the attack.

Table 7: Dose Conversion Data - Total Effective Dose Equivalent (TEDE)

DISTANCE km	Case I T E D E (rem)	Case II GROUND SURFACE DEPOSITION (uCi/m2)	T E D E (rem)	GROUND SURFACE DEPOSITION (uCi/m2)
0.030	2.7E-02	5.8E+02	2.6E-01	3.8E+04
0.100	6.8E-03	1.3E+02	6.5E-02	8.6E+03
0.200	2.4E-03	4.6E+01	2.4E-02	3.0E+03
0.300	1.3E-03	2.3E+01	1.2E-02	1.5E+03
0.400	8.1E-04	1.5E+01	7.8E-03	9.5E+02
0.500	5.7E-04	1.0E+01	5.5E-03	6.5E+02
0.700	3.3E-04	5.6E+00	3.1E-03	3.6E+02
1.000	1.8E-04	2.9E+00	1.7E-03	1.9E+02

4. Early Waning and Monitoring Network

Detection is the vital in obtaining the real time information about any suspicious increase in the background radiation level. A dedicated radiation monitoring network supplemented with the database of background radiation level of each location becomes the deciding factor for executing mitigation procedures and emergency response planning at the attack zone.

The concept is designed based on a remotely controlled two –tier detection and monitoring network. The strategy followed includes early detection and warning system, confirmation and reporting system. The configuration of the proposed network is as follows.

a) First Tier detection consist of a wide area gamma monitor and continuous air monitor (α and β). The Gamma monitors functions based on the GM (Geiger Muller) tube principle. The Continuous Air monitor consists of an End window type pan cake probe for β and Mylar Scintillator based PMT method for α counting. One complete unit having both type of detectors will be considered as a single node.

b) The Second Tier consists of a Mobile Detection Laboratory Units containing gamma spectrometry units and Gross alpha and beta counting stations with human intervention for confirmatory purpose.

c) Each detection nodes should be networked with the Emergency Control Center (ECC). The real time data should be recorded and analyzed at ECC.

d) A dedicated continuous monitoring system should be installed for buildings of strategic importance and public transportation systems by means of high volume air samplers and area gamma monitors at the entry and exit point and air-conditioning ducts.

5. Emergency Management

In order to attain an effective and timely control over radiological emergencies arising out of terrorism events, an integrated planning and multi- level co-ordination of all the stake holders is required for an early detection and response on ground. The effective mitigation of radiological emergencies depends on the action taken by First Responders at scene. The initial response activities include; Rescue & Medical activities, controlling the spread of contamination, establishment of protective action guideline, Command Control and Coordination, Site remediation and Clean up measures. These functions/activities may be overlapping and to be performed simultaneously with a dedicated team work. Prior to commencement of response measures report the accident to existing national/state Emergency Management Agency (NDMA) as soon as possible.

The following steps are to be followed at the earliest possible time by the first responders. These steps are given as guidelines for trained responders only. The exposure pathways and means of contamination after an attack is given below;

Table 8: Exposure Distribution over phases

Exposure		Early	Immediate	Late
Direct Plume	Radiological Release Event			
Inhalation Plume material				
Absorption through wounds				
Contamination of skin and clothes				
Ground Shine (deposition)				
Inhalation of re-suspended material				

The first responders equipped with personal dosimeter, portable dose rate meter with beta and gamma capability, personal protective equipment, full body over garments, SCBA/full face piece respirators, decontamination solution and water. The action sequence should be as follows,

a) Rescue & Medical operation: The evacuation and treatment of casualties should be given highest priority. The main concerns for first responders to a radiological contaminated site are:

- The casualties must be handled based on the Medical Triage. Early triage and stabilization will help in the medical management of radiological event and reducing the deterministic effects.
- The sequence of action includes the immediate removal of contaminated clothing, decontamination of skin and wounds, transferring to the nearest medical facilities.
- Casualty transfer can be done with isolated casualty bag. The casualty bag should be marked with Triage Tag for easy medical attention and isolated treatment in the hospitals. This may also help in controlling the spread of contamination to other public. This Tag system also helps to keep the accountability on the casualties.
- In case of traumatic injuries the casualties need not be decontaminated prior to administration of lifesaving or other significant medical procedures, nor should evacuation or transport to medical facilities be delayed.
- Care must still be taken to minimize the spread of contamination. Decontamination (DECON) will be done once casualties are medically stabilized.

b) Monitoring and Hazard Control: When responding to such emergencies as a First Responder, the accuracy of the radiation measurement is not as critical as verifying whether radiation is present or not. Even if the initial reading is not precise, possibly make a quick determination of where the high and low radiation areas are, and determine which

areas are most contaminated. The main charter of duties include the Continuous monitoring of radiation levels, cordoning off the contaminated area, decontamination of the personnel and equipment, planning and implementation of hazard control procedures like work planning, evacuation etc. The details are;

➢ **Source Searching:** The source searching is the First stage of Contamination Control and Recovery operations. The main responsibilities of the search team are, Isolate the area. Assess the contamination level in the area. Locate the debris, and identify the source

➢ **Search Techniques:** Depending on the accident criteria, radioactive sources may be scattered over a large area. A systematic search over a large area must be conducted until accountability of all source material is completed. Search techniques followed include;

➢ **Visual Search**: The effects of RDD will normally be accompanied with explosion, visual fumes, smokes coming from the burning parts due to the high explosive part associated in it. This particular kind of search is meant to mark the unusual metallic objects and debris fall area in the particular attack case.

➢ **Instrument Search**: The team uses radiation monitoring equipments for the searching purpose. This will help to locate accurately the radioactive isotope in the emergency zone. The devices used for this type of searching include Telescopic Gama radiation monitor (TELETECTOR), Field Gamma Spectrometers, and Contamination Monitors etc. This type of instrument search is conducted in a highly contaminated area after the initial hours of accident. This will help to assess the contamination levels at the accident zone.

c) Access Control: The contaminated area must be cordoned off from the reach of general public. The cordoning distance must be based on the exposure limit values for alpha, beta and gamma radiations. The cordoning depends on the metrological parameters also. The frequent wind shifts can alter the radii of cordoning.

➢ If the radiation levels exceed 0.1mR/h or 1Bq/cm^2 for beta/gamma and 0.1Bq/cm^2 for alpha the accident location must be cordoned off to avoid public involvement. Establish a Contamination Control Line (CCL) by marking and separating the contamination hazard zone.

➢ Establish a Hot Line (HL) for high contamination area if the background radiation level crosses 2mR/hr or 1000Bq/cm^2 for beta/gamma and 100Bq/cm^2 for alpha the area must be considered as contaminated. Establish a Contamination Control Station (CCS) to exercise a proper contamination control strategy for personnel entering in to HL.

➢ After establishing the CCL, HL and CCS, a team should be deputed to collect the ground and air samples from the contaminated area. These samples should be analyzed using recommended monitors to assess the level of ground and air contamination.

➢ A periodic monitoring of the parameters such as weather conditions, wind speed, wind direction and localized radiations levels around the cordoning must be carried out in every 60 minutes.

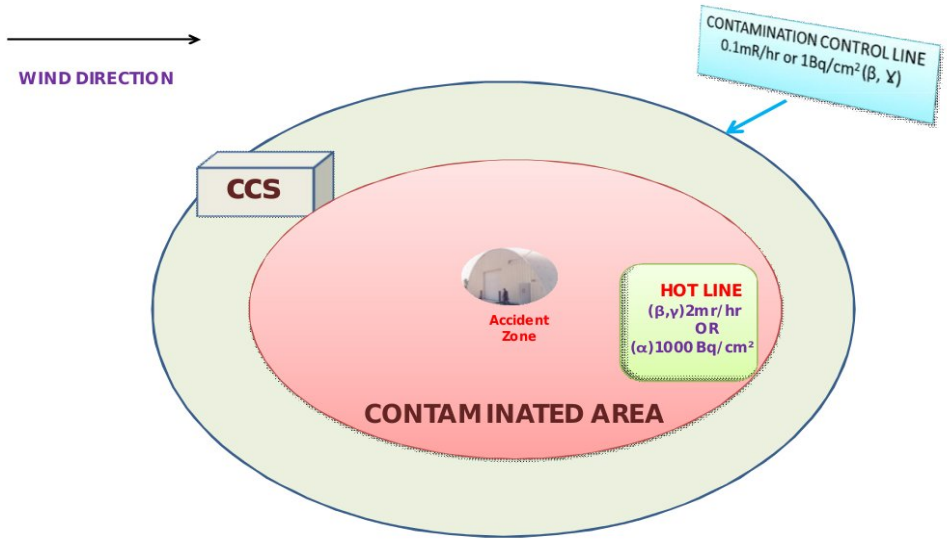


Fig 3: Cordoning Details

d) Risk Reduction: The mitigation strategies on ground are to be planned and executed on a time-bound scale to reduce the long term radiation exposure and related effects on health and environment. The basic principle for reducing the effects from such an accident is divided in to three.

➢ Prevent serious deterministic health effects. The level of effective dose must be reduced below the threshold for deterministic effects. Measures have to be taken to reduce the effective doses below 10 mSv or less.

➢ Intervention should be justified in the sense that the protective measure should do more good than harm.

➢ Levels at which an intervention is introduced and levels at which it is later withdrawn should be optimized. After an intervention is applied (e.g., evacuation or sheltering of a population), there needs to be optimization of the action to determine the scale and duration.

The evacuation of the buildings in the contaminated area must be undertaken based on the radiation level and meteorological parameters. The maximum evacuation must be carried out in the downwind side. If this is not possible public must be informed to stay inside a protective shelters. The specific procedures to be followed for such conditions are given below:

Table 9: Protection Action guideline phase wise – Time Scale

Protective Measures	Radiation release event occurs	Early	Intermediate	Late
Evacuation, Sheltering				
Control of Access to Public				
Administration of Prophylactic				
Personal Decontamination				
Decontamination of Land				
Relocation				
Food & Drinking Water Controls				
Release of personal property				
Rehabilitation of the victims				

6. Post Disaster Management

Special program must be undertaken for the mental and social rehabilitation of affected individuals. The Post Traumatic Stress Disorder (PTSD) has to be treated with affective awareness techniques. Following factors must be complied to meet with the rehab.

1) Reduce physiological activities – encourage rest, sleep, normalization of eat/sleep/work cycles
2) Provide food and shelter in a safe environment
3) Facilitate communication with family, friends, and community
4) Make them literate in the radiological safety.
5) Decrease exposure to reminders of the traumatic event, advise decreasing watching/listening to media coverage of overly traumatic images.

7. Conclusion

Any amount of Control measure cannot eliminate the risk of any accident and the same principle applies for the radioactive material too. However, such measures help to minimize the risk/aftermath of such incidents. Since universally the stocks of radiological material exist, therefore, the risk persists too. To reduce these risks, some stringent control measures have to be implemented for the possession and use of radioactive sources either industrial or medical. International laws/agencies should be promulgated to keep the radioactive access under check. The sources available for industrial, medical and commercial purposes should be accounted for and strength of such sources should be recorded. Frequent inspection should be carried out for all high activity sources deployed at various installations, like irradiation sources in research centers, medical instruments and food processing units. There should be adequate security deployment at the radioactive waste disposal site and spent fuel complexes.

The simulation of different dispersion scenarios have to be formulated for various metrological and occupancy conditions. The Geographic Information System (GIS) application in-line with a continuous Environment Radiation Monitoring stations have to be implemented for potent countervalue targets. The continuous monitoring of natural background level in the environment, water, air and consumables is the simplest way to get early warning of any type of radiological releases. The fire and rescue services, police forces and identified medical installations have to be given adequate training for radiological protection and handling of emergencies of radiological nature.

8. Recommendations

➢ Environmental Monitoring is the only method which can help to find out the increase in the background level radioactivity. The back ground radiation level for prime cities has to be recorded and a database should be prepared. This may include the background gamma radiation level in air, soil, food and ground water. The residual activity must be sampled and added to the database. The sampling must be conducted for alpha, beta and gamma activity. The work can be outsourced to academic institutions.

➢ The routine sampling result must be analysed with the background data base. Any suspicious increase from the background activity will help to warn any type of radiation leak. A separate mobile radiation-monitoring unit must be provided at identified locations. Moreover there must be a national level monitoring network to collect these data and to provide information on a national scale.

➢ Major hospitals must be equipped with facilities to treat radiologically contaminated casualties. Radionuclide specific prophylaxis measures must be made available at major hospitals along with medical response teams for treatment.

➢ A nationwide awareness program must be conducted through educational institutions, work centers, offices, hospitals etc. All the police, fire services and other emergency response agencies must be trained in handling radioactive accidents. They should be provided with proper protective and monitoring materials.

- A dedicated team must be formed to respond to the radiation accidents and such team should be located in prime locations. These teams must be provided with adequate protective and monitoring kit.
- Measures to be taken for accountability and tracking of all radioactive sources deployed for civil applications prior to the constitution of AERB.
- The radioactive waste management in health care sectors and academic institution should be strengthened by periodic monitoring and adapting structured and safe methods for handling, storage and disposal in order to prevent threats of radiological attacks.

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CULTURING DISASTER RESILIENCE IN RURAL KERALA: POTENTIAL PROGRAMMES AND CHALLENGES WITH GENDER-BASED ADVANCEMENT

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Introduction

Still life is on the Earth, after uncountable disasters. And we are always in search of better options for life saving tools and skills; because the demands are continuously changing in the developmental scenario of the world. When initiating disaster resilience to grow up in Kerala, we were thinking about a management framework for communities, it influenced to wait until Asian tsunami 2004. And it is being as the milestone for DRR in Kerala also, the logics were not enough to empower the communities at their own resources and development or it tried to put them forcefully energizing into a DRR. The communities were not able to accept and utilize the community based programs designed for, struggled at its initials figuring out the resilience building inclusive of the responsibility sharing pattern and literacy in DM. The channeling of development and information management mechanism when manufacturing miracles in the survival nature against the time; to level the knowledge and know- how -uniformity at different levels of requirements at local levels were not started to move in a risk reduction theme. And still advancement of movements for the stability of life situations instead of succumb them need to be put under examinations, because there where exactly we lost our resilience capability towards disasters in the transition between the major emotions to survive or to succumb. After 2004 Asian tsunami, several changes were happened in Kerala, most attractive achievement is the community mind set developed to support the government by sharing the response towards the disastrous situations and its aftermaths. Sometimes the uncertainty about poverty was harder than a tsunami regarding the varied economical vulnerabilities of some communities. The elasticity of a mixed economy sounding state like Kerala towards hazards, the resilience is all about stabilizing its own economy, sometimes an additional or alternative income generation is prime than of building up the DRR/DM literacy in place are not negligible. The foundation of searches for an adequate intervention in livelihood alternation was triggered by these uncertainties. As a result almost of the affected coastal communities were strengthened to DRR at their various components. The Asian tsunami of 2004- being as the milestone which drastically changed the total traditional/ communal set up with gender approaches and acceptance of alternative livelihood options in Kerala coastal. At the same time its wind never showered its ideal benefits to the other vulnerable- high risk areas of Kerala against holistically its non- addressed variety of natural hazards along with its socio- economic vulnerability. The integrated approach of DM became inadequate to feel the community to its own realities and circumstances. Everything runs in a practical way of practice of years, and we don't have a periodic check measure mechanism to ensure its adequacies against time and development.

Focus: *to find out the potentials and challenges of DRR in Kerala coastal and rural developmental context*
Observations: *1) Impactful advancement of women in developmental activities and in resilience building in rural, coastal Kerala 2) Gaps and failures of DRR at various social and economic backgrounds of rural, coastal Kerala 3) Spaces and potentials of PRI in building up resilience through institutionalization of DRR programmes at local level*
Methodology: A) Non- structured interviews with persons under 3 Categories.
1) NGO persons working in DRR 2) The PRI Board members who have experience in DRR 3) Beneficiary individuals and common public
B) Analysis of informations with experts

Major points of discussions and suggestions

- Vulnerability heads on the scenario of Kerala
- Experiments in Alternative livelihood options and resource management supports at local level
- Potentials and possibilities of MNREGS- employees to contribute impacts to DRR setting up at local place
- Positive signs of women advancement and acceptance in communities
- Ownership shared implementation projects
- Recommendations and guidelines for HRV assessment methods for local PRI to do their own

Disastrous vulnerabilities and challenges against DRR in Kerala

The coastal tapering narrow strip of India, Kerala stands for more proud specialties regarding its geography, geology, and climatology which are severely grabbing the state into their own risks and calamities also. Because of that exactly, when addressing the natural and man-made calamities of Kerala, still we are unfortunately not in a position to enable to implement a system or procedure which prioritized to consider the above mentioned centricities. The hilly/high ranges getting victimized every year by landslides, the low lying areas get flooded during Mon -soons, most of the interiors are vulnerable for droughts and unexpected seismic lethal possibilities all over the state are risking the normal life of the whole vulnerable population of Kerala. Here is the clear line of marginalization positioned. Such kinds of lands are occupied by economically marginalized also with social marginalization criteria among major expressed reasons. The social vulnerabilities due to economic and marginalization also remarks that the people are belonging to such geographical areas. The DRR programmes were conducted and implemented had priority criteria in locational vulnerabilities, which were exclusive of other location specific hazards and their impacts; even within the same political boundaries the concentrations, were set under them as on which areas the most are vulnerably exposed to risks.

The loss of income generation while attending such knowledge creation programmes holds back the men group who are dominant group in generating supportive income to the family. That tends the common women group to attend such meetings. There also the search of an additional financial development space was a factor. The gender discrimination and customs of caste and creed was a challenge which is slowly getting wash away; because of the cause-effective advancement of women for financial independence and finding out a source of additional income generation to support the family from their own surrounding and resources. Lack of acceptance of public to DM advocacies and developmental advocacy is still a barrier; a governing system which can afford the remedies or prevention against emerging threats is to be implementing at local level with peoples participation. In this regard the PRI is not much exposed to implement adequate measures to DRR. The lack of ownership approaches to programmes installed and at the same time the unemployment prevalence and unawareness at rural/ remote Kerala challenges DRR.

Gender equity and advancement of women in DRR processing

The remarks of a terminologically marginalized group for vulnerability- women; became the major power of advancement in setting up the resilience at local level their role is imperative in the root fixing of DRR in Kerala. It also dissects solutions so far indicating the economical empowerment of vulnerable Kerala regions with DM literacy and practical capabilities. As an analytical overview on the difference between the circumstances before and after the implementation of DRR it is crystal clear that the advancement of women for the search of survival and additional income generation skills flourished DM among them as representing the community for men. The basic needs which had re-built the customs and traditional restrictions against the leadership of women in community are good signs of development at grass root level. The transition of function the home kitchen to steering the economic balancing of the community through the developmental programmes of government focused on women empowerment as Ayalkkootam, and later Kudumbasree. A number of prominent social welfare societies/ organizations had played their role meaningfully in the initiatives of DRR and virtually gradually successfully mainstreamed women calibers into the process of development at bottom level. Small scale industries are getting track in most devastated coastal Panchayath of Kerala, Alappadu of Kollam district. The fishermen community women getting well exposures in rural entrepreneur development as they running tailoring centers, food processing units etc. They could recover the past failures of accessibility of market the products and curios items are designing by the local natural resources from coconut tree parts etc. And when connecting the disclosed power until then, in culturing disaster resilience was about both their social and economic set ups the advancement can be depicted as revolutionary with examples of Ernakulam and Kollam districts which bearing historic wounds of a disaster.

The coastal community of Kerala also very reserved for its customs and traditions. The family management is their responsibility and supporting the earning members of the family also, those are always the men. And the marketing of caught fishes were up to the women group. By these differences of field of interactions, the communication was at different extensions of poles. The other locations also this same is the situation. Men are going out for work and women are concentrated their jobs almost at their intimate surroundings. This could help the evolution of identifying, bringing out and resolve the issues within the area with women, and lacking these activities to reach most of the men belonging to that area; and exactly this mainstreamed potentials and advantages of women being major involved group in DRR.

Resilience building and power support of PRI and developmental programs

Potential DRR programmes on women empowerment in Kerala. Most of the NGO's were worked hard in DRR programmes across Kerala coastal Panchayaths. Followed by the basic awareness creation and community based disaster risk reduction measures, it found that such programmes cannot engage people for DRR throughout an year, because those were all not aim at financial support to those who act, they are all forced to find a stable income, and it was much better idea to introduce small scale industries/rural entrepreneur development programs at place to control the economic cycling out of seasonal establishment. The advancement of women to build resilience at various sectors in rural Kerala with power support of PRI could revitalize the community which reached almost up to devastation followed by 2004 tsunami in the rehabilitation reconstruction time in Ernakulam, Alappuzha and Kollam districts. By the concentration at Panchayath level programmes it could brought an enhancement of DM at places by several government projects implemented through the potentials of NGO's. The programmes designs were introduced by UNDP; through which they have conducted several programmes. Due to the short term tenure allotted to complete the project, in some places the NGO's forced to stay there itself to achieve the actual results of DRR. And they had taken almost seven years at the same place; and as a result they could reach the meaningfulness of empowerment and resilience. The theme of task forces and

the leadership developed through this then selected them up to control the steering wheel of the PRI; is a typical example from Ernakulam. The PRI in identifying, discussing the issues and seeking for solutions which setting trends in implementing adequate infrastructural and non structural measures seen as the most supportive sign boards to DRR at local level with women and un skilled individuals. Current status of DRR in Kerala, raising demands for more suitable education and refreshments of DRR and traditional practices/knowledge are need to be discovered from local level through PRI to plant a disaster proofing development strategy; and to find out the applicable spots to link them to embrace innovations and technologies to improve sustainability.

The experimental spaces of MNREGS providing to environmental protection activities and watershed management programmes despite of '100 days employment', the programmes can be established with its own local human resources is a challenge at local governing level. During the previous years at several Panchayath, they didn't have better ideas about utilizing the funds with the Panchayaths own human resources. But the vagueness become melting when they started to identify issues emerging over, and are able to shoot the troubles with accuracy. Still the demand remains unfilled as it lacks proper guiding and guidelines which found as the major underlined problem ; and also there is no clarity about whoever can help into this considering all the legal complexities is a challenge. And how about use the people recognized as NREGS employees based on their physical abilities to train them to skilled workers who can support the PRI as a force throughout the year. They will be able to act in both the structural and non structural components of DRR and developmental programmes in peace time as well as in emergencies.

Knowledge management/ information sharing technologies and technology literacy in rural Kerala. The challenges of Knowledge management mechanism in DRR at local level the issue which had put struggles over the complete reachability of the community was about the partial absence of men in the case of they do not have much better social gathering and activities out of their occupational environment at place as to discuss the vulnerabilities of them. The Kudumbasree, and MNREGS like ones helping women as similar to their social gathering, there a knowledge management system runs through it. While they are able to convey this to home a track to converse between community and service providers opens through women. In general at local level a portion of women are active in such programmes; though the problem is how to get involved the middle class people into it as they do not participating in such social activities directly. The above mentioned unavailability of job opportunities and conventional job specialties draw back affects some systems implemented as for DRR. The prime examples are task forces and EWS. The information's and information (EWS) systems are installed in coastal areas, unfortunately they are almost abandoned. The reasons are two:- one is the lack of adequate knowledge in its maintenance and alternative uses and second the lack of clarity in its ownership sharing and maintenance responsibility both at technical and financial aspects. This also raising the necessaries of empowering women in technical aspects, especially in the background of they are literates and familiar with mobile phone operations regardless of ages.

Sustainability of programmes and creating ownership sharing with community. For the further inspirations and project implementations there are potential programmes installed by the state government itself inclusive of micro financing and rural entrepreneurship development for 'prevention of hazards'. Kerala Water Supply and Sanitation Agencies Jalanidhi Project which is one of the major draught management programmes along with ground water recharge suitable for the location specialties, also lime lighted for an outstanding example for PRI and common public participation and ownership sharing with financial, social and physical cooperation along with Government. When defining structural and non structural DRR measures setting up; as there is no involvement of money, the acceptance of community declines, which stands for more impactful and need based interventions. To meet this demand, the local government bodies need more attention to them to help locate the issues and find adequate remedies. About the involvement of women in developmental activates and major implementation projects including government ones in Kerala, which directly demanding peoples participation and ownership sharing. One of the accountable achievement of this project is the thorough awareness creation on the vulnerability and its remedial measures among the common public is getting high and incredible through they are conversing directly to the service providers about their circumstances gradually. And it can be further recommend for HRV assessment of local PRI with their own and then to reach the stage of implementing remedies on their solution seeking. Other hand it is the only way to address the basic vulnerabilities can be handling within the political boundaries by the power supervision of PRI, which needs to be an institutionalized way of functioning inclusive of government and common public.

Conclusion

The demand and the service need to be reached at the same focus, and then only the culturing of need based programmes and sector wise rectification of vulnerabilities and risks will take place at applicable mode of action. At the local level practice of it can attain the 100% coverage by implementation of ownership sharing projects. Though, what was the driven factor of participation of women in DRR as economic resilience building which is the same threatening the participation and impacts of other gender component and economic classes from DRR activities. The women empowerment and initiatives for economic balancing are categorized under this. And the real challenges are here as the participation of the community may be contract to small portion of women population and a few geographical high risk areas. The waiting for the windows to be widely open at all primary local communication are the gaps to resilience. The institutionalized operation mechanism with the responsibility sharing of government, PRI and the common public is the only remedial practical strategy for resilience building.

CRITICAL ROLE OF CROSS SECTOR COLLABORATIONS IN DISASTER MANAGEMENT

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Abstract

Disasters are harbingers of human fatalities and crippling economic loss, the effects of which can be stymied, only by effective plans based on analyzing and evaluating risks, as well as planning and implementing risk reduction and mitigation action plans. Vulnerability is the susceptibility of being harmed, which can be due to natural or man-made factors. Hazard mitigation efforts for facing vulnerabilities are having effective disaster management plans, enacted mock drills, which become the core strength in a situation of chaos. A Plan-Do-Check-Act cycle, approach & emphasis can only meet the challenges in the Disaster Management knowledge domain improvement. Effectiveness of a disaster management plan has a straight correlation in ensuring coordination between various elements in the area of Infrastructure, Information availability, Logistics, Human resources for risk mitigation, field operations, finance mobilization, communication, governmental agencies etc. In disaster management, "successful response" term has no validity, but the aptness can be only attributed as, having an ability to enact, a more effective response with agility and quickness. Diversity in understanding the vulnerability and the gravity of risk issues by various agencies involved in mitigation processes, also pose a challenge to effectiveness of planned strategic approaches to hazards. The various systems in the society are independent in role play but in times of disasters they have a hybrid role to infuse robustness in lacking infrastructure systems, by sourcing from their core competencies, a helping hand for a common social cause. Utilization of technology of the various sectors, during chaos phases of a disaster, by coordinating and building up the disaster management grid, can help in boosting the core strengths of chain of dependencies of various links of disaster mitigation. Exposure of various agencies, to each other's strengths and capabilities to foster cross sector collaborations in the various sectors of society, industry, academia and government can only chalk out effective and tangible results in integrating effective disaster management plans. Estimating in advance the critical factors in play, quantitative estimates of urgently needed goods, prior agreements of support connectivity of various sectors would be handy in response situations of disaster management. Division of roles, work flow modules, command center clarity, information management and networks developments are needed in logistics flow during disaster mitigation plan implementation. The purpose of this paper is to explore the benefits, challenges & risks in cross-sector collaborations and opportunities in disaster management scenarios. It is also is an effort to analyze; the major critical success factors needed in the disaster plans based on an extensive literature review. Attempt is also made to find the possibility of establishing the Disaster Management partnerships within the framework of corporate social responsibility (CSR).

Key words
Disaster Management, coordination, CSR, cross sector collaborations

1. Background : Disasters and Vulnerability

Etymology says that the word disaster is derived from Middle French *désastre* and from Old Italian disastro, and from the Greek pejorative *dus* meaning bad & *star* from Latin *astrum*, from Greek *astron*. The root of the word disaster ("bad star" in Greek) comes from an astrological sense of a calamity blamed on an unfavorable position of a planet. In earlier days natural catastrophes were attributed to the wrath of unknown powers of planets, stars, divine interventions etc.. The word vulnerability origin is from early 17th century: from the Latin term *vulnerabilis*; from Latin *vulnerare* 'to wound'; from *vulnus* 'wound'. In the new world disaster is used as synonyms to calamity, catastrophe, and cataclysm all referring refer to adverse happenings usually occurring suddenly and unexpectedly with loss. History of mankind is woven with many events of disasters since time immemorial. Earlier it was always the natural forces that caused disasters. But with industrial revolution and as man stepped into new frontiers of technology, the cause of disasters is not limited to only natural causes but by manmade causes too.

Disaster may be caused by negligence, ignorance, bad judgment, bad decisions of man or by natural forces, viz. hurricane, flood, earthquakes, soil erosion etc. Disasters are now categorized into sudden or unexpected natural disasters like earthquakes, floods, avalanches etc, and sudden or unexpected human caused disasters like chemical disasters, explosions, accidents etc. and slow onset or long lasting disasters like famines, epidemics, desertification etc and slow onset or long lasting human made disasters like long wars, displacements, national and international disputes etc. (Beristain 1999, Van WassenHove 2006, Maon, Lindgreen & Vanhamme 2009). With science and technology, the research & understandings of all types of disasters and their causes all have grown leaps and bounds. The root causes of disasters were probed by all scientific tools and today the domain of knowledge is vast and growing fast day by day too. Still every now and then, somewhere a disaster strikes. The vulnerability to disasters, the hazards and risks involved makes this

domain of knowledge to probe and assess the limitations in disaster mitigation steps. Every now and then new steps are planned and documented every passing hour the world over by various agencies and governments to tackle disasters.

2. Disaster mitigation steps

Disaster mitigation and disaster management knowledge domains have emerged as vital scientific pursuits to reduce the threats; harm posed by disasters and alleviates the suffering that disasters can cause to their victims. The growing impact of natural disasters has triggered a need to enhance the understanding of human and social vulnerability to disasters (Pielke et. al, 2005; Cutter, 2003; Peacock et. al, 1997; Alexander, 1997) and to improve both the quality of data and management of information that guides the humanitarian response following disasters (Cross, 1997). Now the significant task of planners involved in emergency disaster management is identifying vulnerabilities and planning for effective disaster management collaborations to satisfy the vital need of minimizing loss both human and economic. The "vulnerability" perspective in disasters, which is rapidly emerging as a dominant view in the field, identifies the sources of vulnerability are multiple and quite diverse. Some of the most important factors that affect vulnerability in modern world include increased population density, population growth and distribution, social diversity.

Congestion, limited escape routes, dense infrastructure, and poverty add to the vulnerability matrix. Decision makers have to develop and implement policy that moves from a reactive response to a more proactive approach focusing on emergency preparedness (Jayachandran, 2011). These and other questions have now become the central focus for scholars and emergency planning. Disasters wipe out economic gains and development. Natural disasters have profound social, economic, and environmental impacts (Benson and Clay, 2000, NRC, 1999; Morduch, 1994; Sapir, 1993). Scientific and statistical tools are used to plan disaster management studies. Modeling population vulnerability and risk in natural disasters and post-disaster assessments of surviving populations enable governments and humanitarian organizations to make rapid, informed decisions under conditions of great uncertainty (McEntire, 2001; Kunreuther, 2002). The advantage of using modeling before or immediately after a disaster is that it can help to target and guide post-disaster activities, including surveys, to obtain higher quality data for subsequent analysis and decision making. The research literature in the area of disaster management is on a rapid surge.

2.1 Disaster Management Planning

One of the most challenging steps for planner in disaster management is defining the design criteria which should be used to anticipate a system's response during a natural disaster, because the situation at that time is characterized by a high degree of variability and uncertainty, unlike the normal situation. Design load input from a natural disaster is difficult to predict and select properly. An examination or research illustrates vulnerability scales to natural disasters and man-made disasters and the colossal loss they inflict on mankind and economies. Every year 500 disasters affect around 200 million people and kill 75.000 people (van Wassenhove, 2006). It is estimated that both natural and man-made disasters will increase five-fold over the next 50 years. This forecast implies the disaster relief operations market will expand (Thomas & Kopczak, 2005).

The research into literature on disaster management planning highlights , various facets that have emerged as critical aspects like logistics, planning coordination, use of varied agencies, funds paucity etc. etc. According to Kovács and Spens (2007), logistics have always been an important factor in humanitarian aid operations, for they account for 80 percent of disaster relief operations. These logistic efforts have to be carried out under special circumstances, in an environment with destabilized infrastructures and security issues (Overstreet, Hall, Hanna, & Rainer, 2011). Therefore, humanitarian logistics during disasters have different characteristics than business logistics (Kovács & Spens, 2007; Oloruntoba & Gray, 2006). The main aim of humanitarian logistics is to ease suffering of vulnerable people and to respond in a speedy manner to save lives. To reach this goal as effective as possible, the logistical efforts of both military and non-military organizations need to be aligned (Fernandez & Suthikarnnarunai, 2011). In order to mitigate the impact of a natural disaster, an effective and efficient logistics preparation and response is needed (Tatham & Houghton, 2011). The response will increasingly require collaboration and specialization of tasks between humanitarian organizations, as well as increased collaboration with the military, governments and private business" (van Wassenhove, 2006, p. 483). The difference in origin, cultural and political nature of the actors poses potential problems in collaboration (van Wassenhove, 2006). The coordination of local and regional actors, suppliers and many various aid agencies can be extremely challenging (Kovács & Spens, 2007). Humanitarian supply chains tend to be inefficient due to lack of inter-organizational planning (Chandraprakaikul, 2011). When providing relief for the same disaster, it is important to look at where and how to separate their logistics-related tasks (Fernandez & Suthikarnnarunai, 2011). Movements of relief workers in the early stage of the response were restricted and therefore valuable time was lost (Bhattacharjee & Lossio, 2011).

2.2 Present Disaster Management Challenges

The Emergency situations demand fast decision-making and reliable communication with emergency personnel and rescuers. Despite having experienced and equipped to handle disasters, new challenges are found cropping up during many natural and industrial emergency situations.

In disaster management, "successful response" term has no validity, but the aptness can be only attributed as, having an ability to enact, a more effective response with agility and quickness. On analysis, every disaster points out the shortcomings or the things to be improved during next such occurrence. Disaster response systems seems adequate in small-scale disasters when hazard matrix is low and a limited agencies are involved in mitigation, but in the case of major incidents, there are gaps in the coordination and execution part of disaster management plans. Disaster management coordination poses significant challenges as it represents many unrelated groups and agencies with different aims of existence. These require a great deal of coordination between agencies, most of which may be having little

exposure and co relationship to each other in the past. When the disaster management paradigm of various near and far away experiences are analyzed, it is found that we need to evaluate the major issues which precipitate in the disaster management exercises. It can be seen that, most of these issues bloom during emergency and wither out after it. These issues are to be addressed to make the emergency management exercise effective to meet all challenges. Some of the major issue that has come up while analyzing the disaster mitigation steps is:

- Lack of clarity in defining the goal, scope & magnitude of assistance, during a disaster by various agencies involved in it.
- Lack of technical and domain knowledge of the involved personnel in dealing with the chemical contingency.
- Lack of accident or disaster reporting formats and methodology & rushing in to the incident site without adequate briefing or caution of situation
- Lack of clarity in defining and listing the expected roles and responsibilities and pre-agreeing on it by the various stakeholders in disaster management.
- Lack of meaningful correlations and collaborations between the various governmental semi-governmental & private agencies to work in unison based on a pre-decided code of conduct.
- Lack of clarity in agreement to the financial practices of disaster management expenses.
- Lack of coordination of logistics mobilization and deployment in risk mitigation, relief and rescue work
- Lack of coordination in sharing of the best practices and knowledge domains by the various agencies involved in pre & post disaster scenarios.
- Lack of establishment of an effective command tree, structure & system of a meaningful command and leadership structure.
- Lack in correlated working relationship and meaningful partnerships in deterrence of risk evaluation & risks handling, leading to slowness in response coordination
- Issues of facing wrath of public or community which demodulates for a coordinated response
- Lack of community capacity building, training and awareness buildup
- Lack of coordinated private resource & expertise mobilization for emergency management
- Lack of resources to contain the damage to environment in chemical disasters.
- Lack of dedicated communication networks to mobilize a network during disaster.
- Lack of industrial & chemical emergencies inflicted injuries treatment knowledge, in general doctors available during disasters & absence of networked knowledge database to assess and ascertain treatment & containment measures.
- Lack of community radio or channel collaborations to stop spread of rumor.
- Lack of management experts to synchronize the various disaster management activities.

3. Chemical Disaster Management in India

Disasters wipe out the economic gains made by nations. Manmade disasters are more intriguing since they are engineering challenges of contains energy from going out of control to disruption mode energy. Industrialization has made mankind prone to manmade disasters too. As chemical and petrochemical facilities sized up with growth to built large capacity manufacturing plants, chemical storages and chemical transit vehicles to accommodate huge steps of growth, the risk associated also has magnified significantly. Disasters like Bhopal tragedy has changed the way the world looks at threats from Chemical disasters With rapid growth in populace around the chemical and petrochemical industries, gradually enveloping them to be specifically in canopy of densely populated areas the Frequency and severity of chemical disasters has magnified in last few years. There are over 1724 Major Accident Hazards (MAH) units across the country. India's earlier policy on disaster management was focusing on relief and rehabilitation efforts. The new policy approach of government is aiming on a holistic management of disasters, incorporating pre-disaster issues of prevention, mitigation, and preparedness, as well as post-disaster issues of response, recovery, and reconstruction.

In India various Ministries, institutions are involved in chemical disaster management. At the national level National Disaster Management Authority, Ministry of Environment and Forest, Ministry of Home Affairs, Ministry of Labour & Employment, Ministry of Agriculture, Ministry of Petroleum, Ministry of Industry, etc. are involved with the process. At the State level - State Disaster Management Authority, Department of Factories & Boilers, Pollution Control Board, Department of Health, Police, Fire, Industry & Commerce, etc. are directly responsible for industrial accident related issues. As multiple sections are involved in execution of DM plan the need to work out better and effective institutional mechanism, coordination and strategies for ensuring synergy in the various activities of different Ministries and organization is absolutely necessary. A strategic framework is needed especially towards capacity building and integration with holistic environmental risk management within the framework of a multi-hazard risk reduction strategy. Disaster Management gained legal and institutional mechanism set up by the Environmental Protection Act (EPA), 1986, shall be dovetailed with the Disaster Management Act (DM Act), 2005.Total prevention of natural disasters is inevitable and methodology to cope with such disasters are to live with some level of impending risk scenarios. But analysis of most chemical disasters indicates a total prevention of chemical disasters is possible. Cooperation, Convergence of institutional mechanisms for chemical disaster with the holistic disaster management framework is essential for achieving the goal of total prevention of chemical crisis or disasters. Based under the ambit of EPA 1986, Crisis Groups were formed at National, State, District and Local levels whereas under the DM Act, 2005 Disaster Management Authorities has been set-up.

3.1 Disaster management plans refinement by PDCA

Countries differ in culture, value systems, legal and regulatory requirements, community infrastructure and response capabilities and resources. However, it is recognized that national governments and the chief executive officers of industries have a fundamental role in promoting and supporting these local efforts. Industry associations also have an important part to play in encouraging industry participation.

In India too after the Bhopal tragedy, the government, the industry and the awareness created on chemical disasters has formulated many statutory enactments and hence most of the hazardous units have disaster mitigation plans within purview of their handled chemicals and their chemical transportation needs. The disaster mitigation plans, onsite and offsite emergency plans are now defined and documented by the industry. Mock drills are also conducted as per requirements of statutes.

Disaster Management Scheme can be expressed as a cycle of Evaluation of all potential risk scenarios -> Formulation of disaster management plan -> Enactment of the plan during mock drills->Audit of the shortcomings -> Refinement of the plan -> State of preparedness-> Unexpected occurrence of a disaster-> Execution of disaster management plan -> review of the success of plan-> Refinement of plan.

Some of the disaster mitigation plans have never been enacted due to non-occurrence of disasters in the areas. Complacency also creeps in with good safety records which make the effectiveness of disaster management plans low during actual incidents. Hence mock drills are play a vital part in refining the disaster management plan. Every disaster management plan is made with a scenario kept in focus based on one or multiples variables of risk. But the vulnerability matrix of disaster is changing in its shape so fast that some new limitations can be observed during enactment of the plan. Hence the success of disaster mitigation plan can be assessed after the effectiveness of response and mitigation plan, in an actual disaster occurrence. Till then adding steps to address all plausible vulnerability matrix occurrences can refine the plan. The lacunae of the plan are exposed during the enactment, which needs to be acted on for correction in plan. Hence a Plan-Do-Check-Act (PDCA) cycle based analysis of the disaster management plan ensures constant refinement and improvisation in effectiveness of the mitigation plan.

3.2 Role of Government and Policy in Disaster Management

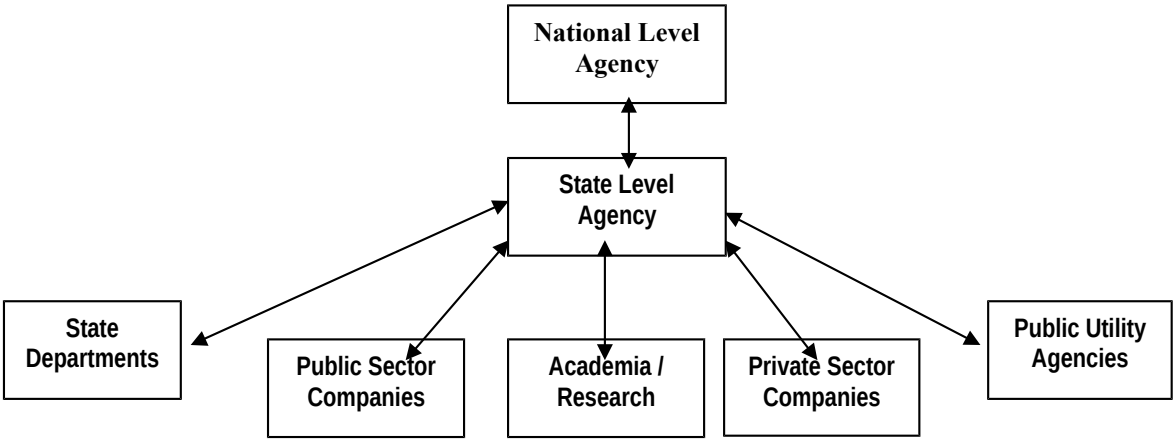


Fig.1 Various stakeholders in the disaster management plans

In the fig. 1 the various stakeholders in the disaster management plans is listed. The various sectors role-play has to merge into an effective synchronized and harmonic relationship for effective execution of a disaster management plan. On an analysis of the variance in core competencies of stakeholders, it can be seen that there are divergence in core mottos of different stakeholders which can result in diverting the focus in diverse directions. Government has the most important role-play in making effective collaborations amongst various agencies and stakeholders in face of a disaster. Due to varied reasons of existence and different aims of organizations the government has to mediate the role of leadership during crisis to minimize economic and human loss. Ahrens and Rudolph (2006) describe the interdependence between institutional failure and susceptibility to disaster. They assert that accountability; popular participation, predictability, and transparency of the administration are key factors in the promotion of sustainable development and disaster reduction.

This "new understanding of disaster also called into question earlier, ill-conceived ideas of "normality" and "abnormality" that pervaded much thinking about disaster. Disaster often used to be seen as an abnormality or an aberration from a linear path of progress rather than perhaps a chronic condition as much caused by development as impinging on it. Wisner et al (2004: 20) therefore argued that the phenomenon of disaster should be placed in the mainstream of policy and practice.

During disasters however, it is not sufficient to focus only on the capacities of the disaster affected groups and communities themselves. The role of the public sector and of public policies is crucial in attempts to prevent, mitigate, and respond to disasters. Regardless of whatever aid can be offered, the responsibility to help people in need resides squarely

with their own government. It is here that an analysis of the government institutions, the political culture and the functioning of the public sector can provide insight into the history of a disaster and the disaster response.

4. Building up an Effective Disaster Management plan

Based on the variables of risks involved, the multiplicity of agencies with different structures involved, the different fields of expertise required, the quantum of logistics involved, the management expertise and technical know-how involved in a major disaster, it mandates that the government agency dealing with disaster management to step in at time of disaster to buildup the correlations and collaborations between various stakeholders involved. Such an effective and timely involvement in the response structure of a disaster management plan would only help to bring down the casualty rate and economic loss in the case of manmade disasters especially involving chemical disasters. Based on the analysis of various disaster management scenarios shortcomings in industry in the past the following suggestions are also put forward as steps to built-up an effective disaster management plan.

4.1 Community Awareness & Capacity building exercise

Disasters take their toll on the community where it effects. Hence the community should be made aware of probable disaster scenarios and should be trained constantly to face any disastrous occurrences. This knowledge transfer will help in reduction of casualties during disasters and will help reinforce community resilience to disasters. Training and effort to increase awareness levels of community to disasters lurking them should be a part of the community awareness exercises. This helps building up communities with more resilience to disasters, which can help in a positive way in rescue and relief missions during disaster. Community awareness built-up will also enable casualties caused by ignorance during disasters.

4.2 Net based mandatory Disaster management website accessed by only stakeholders

The possibilities of information networks and technology development in connectivity without geographical limitations should be used. A dedicated web-site for area wise stakeholders vulnerable to disasters can be developed and assessed by stakeholders only, by administrative control of access. It should contain methods of mitigation of chemicals; properties of chemicals, personal protective equipments required, risk area assessment, etc and should be able to address all issues needed to be known by stakeholders during disasters. With help of such a website the disaster management role-play by experts from other facility, also, can have an effective role and contribution in understanding the risks involved. Such a knowledge domain can encapsulate the best practices in effective disaster mitigation.

4.3 Dedicated Disaster Management frequency with dedicated wireless /mobile sets to all stakeholders

Communication is vital in face of any disaster. Normal networks of communication become loaded while dealing with disasters due to rise in communication and also because of rumors too. Hence a wireless/mobile set based dedicated frequency is required in a perimeter of a district or a cluster of districts as the case seems fit, so that all the disaster management experts, stakeholders can be alerted and coordinated immediately. Various establishments with the communication flow in the dedicated frequency can aware of the disaster already leashed in their area and can help in the disaster mitigation by pooling in their Disaster Management experts, resources, and logistics for the social cause.

4.4 Statutory Disaster Management Manager designate in stakeholders establishment

Every MAH units, establishments handling or storing hazardous chemicals or departments with potential of origin of disaster should have a designated Disaster Management manager and a team of experts from various faculties, to pool in for disaster mitigation, rescue and relief works in their organization as well as others during disasters. This will help mitigate shortage of manpower and expertise in handling disaster management plans at time of occurrence.

4.5 Role-play defining in exigencies of various stakeholders

At times of disasters it is seen that many agencies from statutory, organizations, government and semi government organizations rush to the situation only to find that coordination and defined role-play is absent. This causes avoidable coordination and command issues amongst various agencies and industries. For example law-enforcing agencies won't be ready to take and follow opinion of an industry expert handling chemical emergency. Protocol issue develops when many statutory departments work in coordination with each other based on their command structure and their role-play in the new management paradigm is not clearly defined. Hence the role-play of agencies in disaster management should be clearly defined in the website as proposed above and agreed to in prior for effectiveness of written procedures.

4.6 Disaster Management Experts directory on web as well as in print

As disasters strike at the least expected time, a scramble for expert at time of disasters to work as disaster management coordinators is difficult. Hence a directory with the name, location, designation, land & mobile number of designated experts and team members is to be prepared and should be made available in print and on web ,so that at time of difficult situations, the services of the expert can be summoned in short notice..

4.7 Technical data base development and up-dating on website by academia, research institutions

Academic research into physical and chemical properties of substances, risks, hazards, safety measures, mitigation and prevention steps in case of spillage, environmental data, disasters database, root cause analysis etc. needs to be researched, updated and shared in the website dedicated for disaster management. Close interaction with the academia, research institutions, industry etc in updating the latest developments in the field can be of help in prevention steps.

4.8 Medical fraternity to be made aware of Disaster Management type injuries

Many a times the normal hospitals lack in the expertise to handle chemical disaster victims as their expertise and experience in the injuries caused by chemical spills, burns damages etc is minimal. This causes delay in the effective and timely response in meting treatment to victims by the suitable antidotes, medicines etc. Medical fraternity should be trained in the industrial medicine, treatment for injuries that can be caused by chemical disasters. Hospitals in the industrial vicinity should have disaster management awareness and training modules for it's personnel.

4.9 Disaster Management capacity built up for treatment in hospitals

At time of disaster management hospital resources gets squeezed for want of personnel, expertise, medicines and utilities. Hence disaster management capacity built up focus based on hospital and clinics will be resourceful during handling of disasters and relief work.

4.10 Private companies' logistics use in Disaster Management scenarios.

At time of disasters resources mobilization becomes a critical criteria. As private industry has grown resourceful in certain sectors than government departments the use of private sector resources like cranes, buses by the disaster management team for effective mitigation would increase the speed and quality of rescue services and can reduce impact of disasters. Private sector can help in improving the relief operations by contributing technology, logistics in their possession along with their experts in different fields like logistics handling etc.

4.11 Private-public partnerships and participation in Disaster Management activities

With the growth of big industrial houses and groups in the country it would be resourceful if the private sector resources can be mopped under public-private –partnerships in face of disaster management scenarios. This will strengthen the fundamentals of the disaster management capabilities and also open doors to a large store of resources and expertise. The work related partnerships should be worked out during planning to encode those dormant resources into disaster management.

4.12 Fund mapping for Disaster Management in CSR activities of companies

Many of the public and private companies are now willing and ready to do CSR activities in fields of environment, energy etc. If the CSR activities of the companies are also made mandatory to allocate resources for DM activities, the fund paucity in the cash paucity disaster management scenario can be alleviated. It also becomes the social responsibility of the companies to ensure that business practices are safe and do not cause disastrous circumstances and it mandates that firms allocate an amount to Disaster management activities too like the insurance part which most of the firms take for safeguarding their business.

4.13 Tax rebates on Disaster Management funds to built up infrastructure

In a competitive environment of business as margins are meager the funding for risks and budgetary allocations for disaster management and safety, at times takes a backseat. Considering the huge economic loss in case of disasters, the government can think of tax rebates on funds allocated for disaster management capacity built up.

4.14 Tie up with media to help not spread rumors

At times of disasters the news that spreads fast is rumors caused by inaccurate official account of news regarding the disaster. This leads to people resorting to misguided doings. A disaster management communication protocol is necessary to be developed and pact with media streams like mobile, visual, print, net portals is required to give correct and accurate news and information regarding the news on disasters. This enables in lessening the panic and havoc situations in aftermath of disaster are also helpful in proper disaster relief.

4.15 Set up infrastructure and designate to pass correct info to avoid panic

We live in a world of breaking news. It is seen that at times of disasters the persons on the reporting media on the front does not get the officially designate disaster management spokesperson which leads to varied accounts of the disasters. This also led to unpleasant and sometimes difficult situation .Even in mock drills the person exist but is difficult to be located. A disaster management color coded vest based information personnel should be mandated as part of disaster management to perform the function, which would be a relief to the people awaiting news from the disaster scenario.

4.16 Disaster Management –Law enforcers networking to barricading to clear roads

Police, Para military forces, law enforcers in industry are to be mandated clearly on requirements during disaster management. They are to clear roads for emergency vehicles, ambulances and vehicles that are required in disaster management. However most of the times the public rush to places of disaster for firsthand account leads to crowd management difficulties Probable casualties can be increased as people may not be aware of the inherent vulnerability into which they have moved in. This requires a clear mandated approach in schemes as at times the visit by politicians and others to spots puts the disaster management machinery task and gear out of order.

4.17 Satellite launch for Disaster Management communication and GRPS purposes

Now a day's macro approaches to problems of scale of disasters makes the scenario of opportunities clear during relief and rescue work. In a world lurked with disasters it would be required that exclusive DM satellites are launched for

monitoring, coordinating disasters on large and small scale. Coordination of GRPS enabled disaster management teams connected with satellite phones would all become need of the days as the complexity in situations increases.

4.18 Mandate GRPS for hazardous chemical transfer

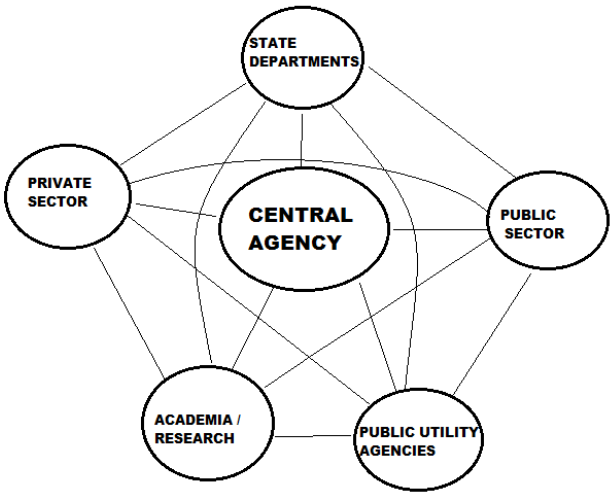
All hazardous goods chemical transport on road by vehicles in quantities, which can cause disaster scenarios, should be in vehicles with GPRS facilities. This will enable effective monitoring of hazardous chemical movement. Also satellite tracking can be enabled for safety of these consignments.

4.19 Building special lanes for Chemicals Movement

In areas where new infrastructure build up is in progress, chemical movement infrastructure should be planned. Along with it transport by waterways etc needs to be focused based on disaster potential mapping of chemical transport.

4.20 Centralized Governmental agency with more executive powers.

The Disaster management centralized agency should be made to be developed as an agency or department with additional powers during the time of disasters. Pre disaster role of the department should be, the job of training, collecting database of resources, building resilience in community and industry etc. Like the Election commission in India, which develops more power by the purview of law during election time, national disaster management agencies should be empowered with more statutory administrative control powers to use the varied stakeholders resources and expertise at time of disaster management. This will help them to be effective at times of disaster.



5. Conclusion

When a disaster strikes, it is already too late to develop solutions. The better prepared we are the more effective the response would be. It is necessary to plan and ensure coordination and cooperation between different elements involved in the disaster management plan. Inter- agency collaborations when success fully established, provides all stakeholders with mutual benefit such as best practices knowledge, resource sharing and transfer of expertise. Disasters are events when there should be close coordination of various governmental and non-governmental bodies, departments, public and private sectors etc. Bringing all of them together at times of disasters need organizational arrangement under a powerful departmental set up on National and state level, , which should be activated at time, only when disasters are officially declared. The disaster management agency should be attending to mundane activities of risk mitigation, capacity & resilience building, till the stipulated role of it precipitates, like the Election commission which surfaces during elections with special powers and roles. Such an organizational and statutory setup given to Disaster management parent body will be help function the role of effective coordination of various stakeholders in the face of a disaster.

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MAKING A CASE FOR PRIVATE OIL SPILL RESPONSE ORGANISATIONS

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Abstract

For decades, policy planners, regulators and disaster contingency planners in India have engaged with the industry stakeholders to arrive at an equitable model for establishment of a national stockpile of oil spill response resources. Establishing inventories is a complex governance issue. While on the one hand, responsibility for clean-up vests with the polluter and expending taxpayers' money for establishing inventories could lead to un-internalized externalities, on the other hand, even the bare minimum stipulation in the national plan for the industry has perpetually been contested, possibly guided by a view that oil spill response inventories are public goods. This paper examines the State vis-à-vis stakeholder debate for establishing inventories of response equipment, reviews policy elements and facilitating provisions under national law fostering private oil spill response organisations (OSRO) in select countries, and argues on the unsuitability of direct response action by government agencies such as Coast Guards while making a case for private OSRO.

Key words
Disaster preparedness, environmental governance, externalities, tiered approach, OSRO

Introduction

Risks are an incidental problem of modernization which must be either eliminated, or denied, or reinterpreted (Beck 1992, pp. 25-27). With an estimated population of 1.26 billion people (populationofindia.info, n.d.) and economy growing at 5% annually, India has a phenomenal demand for energy. 76% of the demand for crude oil is met through import (MoPNG 2010), by tank vessels, which presently stands at 3.86 million barrels per day (Business Standard 2014). Another million tons of crude transiting from the Persian Gulf to North America, Europe and Asia, passes near or through the coastal waters of India. Besides, numerous exploration and production activities abound in the offshore development areas (Project Review and Monitoring Committee for Oil Spill Management 2003) bringing in nearly 0.5 million barrels of crude per day through tank vessels and pipelines (Business Standard 2014). Any of the tank vessels, offshore oil platforms and associated pipelines is a potential candidate for an oil spill disaster.

According to data maintained by the Indian Coast Guard (ICG), over the past three decades, more than 80 oil spills have been recorded in Indian waters (ICG 2012). Two of the largest spills occurred in the same year, 1993. The *m.v.* Maersk Navigator spilled 40,000 tons of crude off Nicobar Islands in the South Andaman Sea and a riser pipe ruptured in Bombay High North releasing 6,000 tons of crude oil into the Arabian Sea (ICG 2010). More recently, in July 2010, close on the heels of the *Deep Water Horizon* in the Gulf of Mexico which spewed an estimated 4.9 billion barrels of oil in the United States' waters (NOAA 2010), the *m.v. MSC Chitra* leaked about 700 tons of bunkers in Mumbai harbor (ICG 2011). The consequent impact on the beaches and mangroves in Mumbai and its neighbouring districts earned the sustained focus of national media until the cleanup operations were completed. Response was immediate and effective yet, the incident triggered a review of the tiered preparedness and possible need for enhanced industry participation in developing oil spill response resources.

The state *versus* stakeholder debate

Environment protection is high on the people's agenda in the twenty-first century (Bell & McGillivray 2008, pp. 3-4) and contemporary society expects the State to work in close coordination with the local bodies, civil society, voluntary organizations and corporate bodies to address the risk (Second Administrative Reforms Commission 2006, pp. 5-7). States, including India, are therefore committed to the cause by being party to several United Nations' (UN) led international strategies, frameworks, and treaties such as the Yokohama Strategy (UN 1994), Integrated Strategy for Disaster Reduction (UN 2004), Hyogo Framework (UN 2005) and the Law of the Sea Convention (UN 1982).

The Law of the Sea Convention, or UNCLOS for short, devotes an entire part viz., Part XII to marine environment protection. Article 192 makes it obligatory for States parties to protect and preserve their marine environment. Article 194 prescribes the measures that may be adopted by States and recommends "jointness of approach" in dealing with marine oil spill response. Article 199 envisages joint development of Contingency Plans by States to deal with oil spills. At the very least, these articles under the Part XII acknowledge the fact that States may not be able to independently establish stockpiles for major oil spill disasters. (UN 1982)

In countries that rely on a publicly funded response system to impose the cost of preparing for a response and the costs expended in excess of a polluters' limit of liability on taxpayers as opposed to consumers, oil consumers would benefit (American Petroleum Institute 1994), on account of the un-internalized costs of the oil industry. Article 6 of the International Maritime Organisation (IMO) Oil pollution Preparedness, Response and Cooperation (OPRC) Convention,

1990 rightly envisages close cooperation between industry and national administration in the establishment of a minimum level of pre-positioned oil spill combating equipment, commensurate with the risk involved. Resolution 5 of the Convention urges the IMO and the United Nations Environment Program (UNEP) to approach the oil and shipping industries for particular cooperation in the developing countries in establishing equipment stockpiles on a regional or sub-regional basis, in addition to those already established. (IMO 1990)

In a tiered approach, as envisaged by the IMO, first response capability is expected to be maintained by the facility operator, on premises, and pooling of local, regional, national and international resources provide for scaling-up operations (IMO 1995). The local, regional and national inventories could be either established by private parties, typically by the oil majors or OSRO, or the State, or both (IPIECA 2007). India's National Oil Spill Disaster Contingency Plan (NOSDCP) adopts this three tier concept (ICG 2006).

As per the NOSDCP, oil handling facilities are expected to undertake risk assessment and maintain capability to respond to an oil spill in their jurisdiction. The national plan is silent on the capacity required to be established by the stakeholders to qualify as a tier-1 resource whereas it places a specific expectation of 10,000 ton response capability on the Coast Guard (ICG, 2006). At the 5th annual NOSDCP preparedness and review meeting on September 6, 2002, however, it was clarified that tier-1 preparedness expected of oil agencies constitutes a capability to respond to 100-700 tons (ICG 2002) taking a cue from the IMO Manual on Contingency Planning which states that 700 tons is usually cited as the upper limit of tier-1 (IMO 1995). However, as the IMO Manual specifies, it would be the circumstances of the spill and surrounding environment that will determine the actual level of response. Nevertheless, despite responsibility for clean-up vesting with the polluter (*M.C. Mehta & Another v. Union of India & Ors* (1987) 1 SCC 395, *Indian Council for Enviro Legal Action & Ors v Union of India* (1996) 2 SCC 212, and *M.C Mehta Vs Kamal Nath & Ors* (2000) SCC 313), and expending taxpayers' money for establishing inventories could lead to un-internalized externalities, interpretation of tier-1 resources stipulated by the national plan has perpetually been contested by the industry, possibly guided by a view that oil spill response inventories are public goods. The industry's reluctance is evident from the review of the prepositioned equipment with the individual facility operators in India listed in the NOSDCP (ICG 2006) which did not reveal its desired correlation with the quantum of risk of oil spill identified for the facility.

Given these circumstances, the State, or rather its policy makers have a choice of tools with which to achieve a particular objective – law, fiscal policy, education, research, and voluntary solutions (Bell & McGillivray 2008, p. 12). Sjafjell (2010) recalls that the corporate social responsibility movement advocates for corporate responsibility for those affected by a corporation's actions which includes the employees, other (external) workers, the local communities, as also the environment and argues that global environmental (and social) challenges are not being dealt with adequately and that externalities are not truly internalized since the corporations currently do not make sufficient contribution. This possibly explains the fate of an initiative by the Ministry of Petroleum and Natural Gas (MoPNG), Government of India in 1998. The MoPNG had then nominated the Oil Industry Safety Directorate (OISD) as the central coordinating agency for setting up oil spill response centers in India by the Ministry's Offshore Coordination Committee and decided that while all oil companies will provide tier-1 facilities in their areas of operation, the Oil and Natural Gas Commission, Indian Oil Corporation, and Reliance Petrochemicals would together establish tier-2 and tier-3 facilities at certain locations, in their capacity as a leader company (OISD 1998). It appears that pertinent issues relating to cost sharing and management of centres by the oil companies that were to be mutually discussed and agreed upon were never resolved. This may possibly be attributed to non-uniform risk potential of stakeholders and consequent lack of clarity of their level of involvement in setting up the centres. The time frame and project execution details and responsibilities were also not specific.

The international petroleum industry apparently recognizes its responsibility of facilitating proper and adequate response to oil spills. The International Petroleum Industry Environmental Conservation Association (IPIECA) carries out oil spill preparedness and response programs in close cooperation with the IMO. The Oil Companies International Maritime Forum (OCIMF) makes its professional expertise available to government and inter-governmental bodies. Indian Oil and Reliance Industries are amongst its members though. (US Department of Defense 2003)

Identifying key elements fostering private OSRO

Methodology

The study to identify the key elements that foster private OSRO was based on a careful examination of secondary sources consisting of inter alia national legislation and regulation, national and regional oil spill contingency plans, information gleaned from official websites, papers in peer-reviewed journals, and proceedings of international conferences on oil spills and corroborated through interactions with leading private OSROs and policy planners, regulators, and contingency planners at national and international forums. Nine countries were selected to constitute the sample for the study after due consideration – China and United States (being two largest consumers), Japan and Republic of Korea (being two largest receivers in the IMO International Oil Pollution Compensation Funds), Brazil (leading State in IBSA with large-scale offshore production), Australia and Canada (being world leaders in transportation safety), Norway (being a world leader in offshore safety standards), and the United Kingdom (by virtue of being traditional seat of maritime law and practice).

Findings

At least two different prescriptive, quantitative approaches prevail for determination of response capacity. Korea has defined its National Response Capability as 20,000 tons and sub-allocated responsibilities to the Korea National Marine Police Authority (KNMPA), Korea Marine Pollution Response Corporation (KMPRC), and the oil industry (Lee Bong-Gil

2001). The US has defined an Oil Spill Response Organisation (OSRO) classification matrix consisting of protective boom length, skimming capacity, and temporary storage capacity for maximum most probable discharge, and worst case discharge corresponding to each tier of capability (US Coast Guard 2001). Australia specifies 21,000 tons as its planning dimension and quantifies tier-1 limit as 10 tons, tier-2 1,000 tons, and anything above as tier-3 (Australia Maritime Safety Authority, n.d.). Canada is possibly unique in specifying a four-tier framework with tier-1 limit as 150 tons, tier-2 1,000 tons, tier-3 2,500 tons, and tier-4 10,000 tons (Turner et al 2010, p. 131). The remaining States in the sample were found to have broadly reiterated the qualitative framework suggested in the IMO Guidelines.

Illustrations varied as to the way the tier-2 or tier-3 capability was established, or provided for. An OSRO could develop entirely as an initiative of the oil industry. In Australia, the Australia Marine Oil Spill Center (AMOSC), a not-for-profit initiative of the Australian oil industry, was formed in 1991 as a wholly owned subsidiary of the Australian Institute of Petroleum (Australia Maritime Safety Authority, n. d.). The Center is financed by nine participating oil companies and other subscriber companies. The Petroleum Association of Japan Oil Spill Response (PAJ-OSR) stores and lands oil spill response equipment for those who are in need free of charge, in order to minimize the damage from tanker accident oil spills (PAJ-OSR, n.d.). PAJ-OSR is an initiative of the Petroleum Association of Japan (PAJ), a trade association comprising of eighteen oil companies engaged in refining and marketing of oil in Japan. PAJ-OSR has established bases equipped with oil spill response equipment in six locations in Japan and five locations overseas where oil spill response training is also provided. Brazil emerged as an example of a developing State, where the oil industry has established a network of tier-3 resource centres, known as Environmental Defence Centres (CDA), strategically located throughout the country for national response and international support across South America. (IPIECA 2007)

Alternatively, national legislation specifically mandated pre-contractual arrangements for clean-up in China, United States, and Canada. Further, a regime for registration of such private OSROs existed either as standalone legislation, as in the Republic of Korea, or in conjunction with the requirement of pre-contractual arrangements as in the case of Canada and the United States. Of its defined National Response Capability target of 20,000 tons, Korea has assigned 5,000 tons each to the KMPRC and the individual private companies (Lee Bong-Gil 2001). The KMPRC comprises of ninety-seven member companies and has its legal basis in the Law of Marine Pollution Prevention, 1997. About twenty-three contractors are registered under a separate, registration regime established for cleanup businesses. On the West Coast of Canada, the certified response organization is Burrard Clean Operations, also known as Western Canada Marine Response Corporation (*Canada Shipping Act 2001*). The United States has over one hundred thirty private, profit and non-profit OSROs funded by the oil industry, essentially facilitated by compelling liabilities against the industry under its Oil Pollution Act 1990 (OPA 90) (US Department of Defense 2003). Under OPA 90, tankers within US waters are required to have pre-contracted resources sufficient to deal with a number of spill scenarios including maximum most probable discharge and worst case discharge i.e., loss of entire cargo (United States, 1990). The OSROs are classified into different tiers of capability based on a specified classification matrix (US Coast Guard 2001). The United States actively facilitates private OSROs by laying down standards and certifying them based on periodical verification. China implemented on 1st March 2010 the requirement of pre-contract with an approved Chinese OSRO under Article 33 of the Regulation of the People's Republic of China on the Prevention and Control of Marine Pollution from Ships, constituted pursuant to its Marine Environment Protection Law (MEPL). (UK P&I Club 2010)

The oil industry may develop mutual access agreements for oil spill response resources. The AMOSC administers the oil industry's mutual aid arrangements to provide for equipment and personnel to respond to major oil spill. Though AMSA purchases its equipment under National Plan Funds, a master service contract between the AMSA and AMOSC supplements the Federal, State and Northern Territory Government response resources located throughout Australia. Thus, designated oil spill response resources of individual companies are made available to other companies and the Australian National Plan under contract agreements that are administered by the AMOSC (Australia Maritime Safety Authority, n. d.). A mutual access agreement for tier-1 resources exists between operators in the Gulf of Kutchch (BORL 2011) and seven other locations in India (OISD 2012).

Governments may provide a subsidy to private OSROs in furtherance of national interests. The Ministry of Economy, Trade and Industry (METI), Government of Japan provides a subsidy to the POSCO program. (US Department of Defense 2003). Responsibility for clean-up lay invariably with the industry or private contractor but never with the Government. In the United Kingdom, responsibility for pollution response and salvage vests with the Maritime and Coastguard Agency (MCA) while responsibility for cleanup lies with the Contractors who may use Coastguard equipment or hire MCA tugs (Maritime and Coast Guard Agency, n. d.). Though, as a policy, States will not engage in direct oil spill response action since responsibility for clean-up vests with the polluter in the event of a spill, States nevertheless maintained capability to act as first responder. In the United Kingdom, the Government maintains strategic overview for oil spill management and minimum essential resources for first response (Maritime and Coast Guard Agency, n. d.). In the United States, the National Response Team (NRT) comprising members of fifteen Federal agencies with EPA as chairman and the USCG as vice-chairman and thirteen Regional Response teams have planning, policy and coordination role and do not respond directly to incidents. USCG strike teams located on all three sea boards provide for specialized equipment and personnel as backup to resources from private sector (United States Coast Guard, n. d.). The USCG strategy is, "Make the polluter act, we will fill the gap". In the Republic of Korea and Norway, the government maintains significant capability for spill response, almost at par with industry.

While delegating clean-up responsibility to OSROs engaged on behalf of the polluter, government response agencies such as Coast Guards may be provided access to emergency funds to facilitate expeditious first response. Funds to the tune of £100,000 are available with UK MCA for oil spill response (Maritime and Coast Guard Agency, n. d.). An Oil Spill Liability Trust Fund (OSLTF) has been created in the United States post Exxon Valdez by levying a one-time cess on

oil for a fixed period of time. This $1 billion fund is managed by the USCG. The USCG On-scene Commander (OSC) has direct access to this open fund and can draw up to $25,000 for urgent and essential expenditure during oil spill response operation, subject to re-imbursement on settlement of claim. (US Dept. of Defense 2003)

Directing response *versus* direct response action: debating the role of government agencies

Direct response action by government agencies, such as Coast Guards is best avoided on several counts, unless the situation so warrants. Firstly, expending taxpayers' money for establishing inventories and spill response without adequate industry participation would lead to un-internalized externalities. Besides, when it comes to claims for pollution damage, the IMO International Oil Pollution Compensation (IOPC) Fund 1992, to which India is a party, at its session in October 2013, decided that Government's should be *standing last in queue* (SLQ) for compensation despite stiff opposition by France and India. Compensation claims made on the IOPC Fund in respect of efforts by government agencies in Japan and France have suffered as a consequence of the SLQ policy. State relying on private OSRO would not be adversely affected by the SLQ policy. (IOPC Funds 2013)

Maintenance and utilization of oil spill response capability by coastguard agencies other than that required for first response is a cost ineffective proposition. Typical capitation charges in respect of 'high value' naval and coastguard assets as approved by the Ministry of Defence (MoD 1992; MoD 2009) are comparatively higher than the rates levied by the industry (SCOPIC 2014) for utilization of assets of matching capability. The rejection of high compensation claims in respect of French warships and naval aircraft deployed for responding to the *m.v. Erica* spill were fiercely debated by the French government with the IOPC Funds (IOPC Funds 2013) just as the owners' Protection and Indemnity Club strongly contested the compensation claims of the Indian Coast Guard during the arbitration of the *m.v. Maritime Wisdom*. A private OSROs closer cooperation with the insurers will lend the advantage of assured cost recovery and easier settlement of claims against any damages.

Oil spill response capability is not restricted to mere stocking of equipment as trained manpower is required to deploy the equipment. Qualified experts would be required in various fields including biology, chemistry, and logistics management to deal with incident command and response coordination of large scale oil spills. Response to large spills calls for sub-contracting of jobs and labor at extremely short notice. These would clearly be inhibited by the regulations (*Financial Regulations,* n. d.) and the delegated financial powers (MoD 2010). It is also important that recovered oil is properly disposed off. About six hundred tons of oil recovered from *m.v. MSC Chitra* remained in the premises of the Jawaharlal Nehru Port Trust for want of Customs clearances. Similar was the case at Chennai in an earlier spill. All such tasks are best left to an OSRO. Appropriate experts and unskilled labour can be flexibly hired by private OSROs, at short notice if need be. OSRO China has cross trained its oil sludge collection and tank cleaning manpower to act as initial responders (OSRO China, n. d.). Socially responsible government agencies, however, may be bound to appoint staff on permanent basis despite occasional utility.

Effective public relations are an integral part of any oil spill response operation. The fact that naval and coastguard agencies usually function under the administrative control of the government could place inherent limitations on their media engagement. Moreover, if a government agency were to directly engage in oil spill response, its actions may be the subject of greater media attention and public scrutiny than a private agency engaged in the same task. On the contrary, if a government agency was to oversee and direct the response it could possibly stay clear of any unnecessary controversy that may arise in the media.

While there is a strong case for directing response as opposed to direct response action by government agency, the provisions of section 356J of the Merchant Shipping Act (1958) appear to have been inherently contradicted by the 2002 amendment to the Allocation of Business Rules (1961). The Merchant Shipping Act empowers issuance of directions to the owner, agent, master, or charterer or operator of a ship or offshore installation to minimize the pollution already caused or prevent the pollution threatened to be caused whereas, the Allocation of Business Rules requires the Coast Guard to act as the combat agency in the maritime zones of India.

Conclusions and recommendations

To conclude, only three of the nine States studied had instituted OSRO by law whereas, in the remaining six States, the oil industry had established stockpiles of their own volition. However, regardless of privately established inventories, States did maintain a minimum of first response capability. Norway and the Republic of Korea proved exceptions to the norm in maintaining inventories at par with the industry. If Norway and the Republic of Korea were to be regarded as lying at one end of a spectrum, the United States and United Kingdom could be regarded as falling at the opposite end with their abundance of OSRO tier-3 inventories and purely first strike equipment held by State agencies, and thereby having achieved an exemplary internalization of the externalities arising out of the maritime transportation and offshore exploration and production of crude oil.

As suggested by Sjafjell (2010), the way forward to achieve true internalization appears to lie with changes to corporate law but, as Sjafjell admits, opposition from powerful economic forces is likely to remain the greatest challenge. Undoubtedly, a cooperative approach between the oil and shipping industries is the key to the establishment and sustenance of an effective response framework involving private OSRO. At the same time, it would be the government's role to establish the legal and organizational framework for this relationship. The Indian oil industry is yet to demonstrate the inclination to set up an OSRO, seen in 1999. There is also no evidence of the IMO, or the UNEP, having approached the oil and shipping industries in the South-Asian region for particular cooperation in establishing equipment stockpiles on a regional or sub-regional basis in keeping with the obligation of these international organisations under the OPRC Convention. Meanwhile, a couple of venture capitalists such as Alphamers (Mr. DC Sekhar, 2014, pers. comm., 21 March)

and representatives of oil spill response equipment manufacturers e,g., Mantec Consultants (Brara & Perry 2012) have been exploring the market and expressing their keenness to government departments to establish OSRO. Positive response of the private enterprise augurs equally well for all stakeholders. A favorable political climate is an important factor in the progression of key policy decisions. In the course of reviewing the preparedness of ports to deal with oil spills post *m.v. MSC Chitra* incident, the Ministry of Shipping, Government of India has considered outsourcing of all future clean-up operations to global agencies with expertise in the area. (Business Standard 2010)

In a favorable political climate, legislation enabling private OSRO would eventually follow. All vessels destined to an Indian port could be required to have a valid contractual arrangement in place with a certified oil spill response organization prior to arrival in Indian waters. The requirement could be incorporated in the Merchant Shipping Act, 1958. Once national law is in place, the NOSDCP will require an amendment to delineate responsibilities afresh. The government, or its designated agency, would have to initiate the amendment and additionally, facilitate early establishment of OSRO by way of close cooperation, and development and implementation of certification and annual verification procedures for the private, certified OSROs.

Major oil spill incidents do act as catalysts for ushering-in reforms. The Deepwater Horizon, Exxon Valdez, Erica, and Prestige are classic examples. Yet, any change is likely to be affected by inertia. The protracted process of law making could pose a challenge to early adoption of new legislation. Moreover, while private enterprise may have come forward to explore the market for private OSRO in India, the same is not true of the oil industry and ports. Acquisition of oil spill response capabilities involves significant costs and the equipment listing in the NOSDCP does not portray the willingness to incur these costs. The anticipated huge capital costs for setting up a tier-3 OSRO, such as OSRL, could possibly be an issue of concern. There would also be recurring annual costs. The issue of funding for sustenance of such an OSRO would need greater deliberations amongst all stakeholders. Lastly, any increase in costs on account subscription to OSRO is very likely to meet with stiff resistance from the domestic shipping industry.

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UNDERSTANDING THE CAUSES OF UTTARAKHAND DISASTER OF JUNE 2013: A SCIENTIFIC REVIEW

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Abstract

India often faces natural calamities like earth quakes, landslides, floods, cyclones and drought occurring fairly frequently in different parts of the country. At times, the same area is subjected to one or more of these disasters situation in successive seasons or years. While not all natural calamities can be predicted and prevented, a state of preparedness and ability to respond quickly to a natural calamity can considerably mitigate loss of life and property and the human suffering and restore normalcy at the earliest. Hence it is important for a detailed study and analysis of each disaster. Against this background, this paper reviews the different possible causes behind the Uttarakhand Disaster of 15-17th June 2013 in detail. Uttarakhand district lies on the southern slope of the Himalayan range. The climate and vegetation vary greatly with elevation, from glaciers at the highest elevations to subtropical forests at the lower elevations. The district, in general, is prone to different disasters and the order of severity of damage are; earthquakes, excessive rains and cloud bursts, landslides, floods, forest fires and hailstorms. However, there have been numerous debates and controversies ever since the flash floods hit the state of Uttarakhand in June 2013. This has been one of the worst Himalayan tragedies in recent years in which the actual number of people buried or perished is not known as thousands are still missing. The entire Rambara, a large part of Gaurikund and many villages of Mandakini valley were also fully wiped out. Government sources have reported large number of deaths including missing of over ~5000 people in the wake of the devastating flooding. The death toll of 5,748 tops India's previous record worst monsoon flood death toll of 4892 set in July 1968 in Rajasthan and Gujarat provinces. The fact remains the same that the torrential rains triggered a massive landslide that hit Uttarakhand's Hindu shrine in Kedarnath, which lies just a short distance from the snout of two mountain glaciers. From 15 to 17 June 2013, the Indian state of Uttarakhand and adjoining area received heavy rainfall, which was about 375% more than the benchmark rainfall during a normal monsoon. This might have caused the melting of Chorabari Glacier at the height of 3800 metres, and eruption of the Mandakini River which led to heavy floods near Gobindghat, Kedar Dome, Rudraprayag district, Uttarakhand, Himachal Pradesh and Western Nepal, and acute rainfall in other nearby regions of Delhi, Haryana, Uttar Pradesh and some adjoining areas. It has been reported that the complete destruction of Mandakini River in Kedarnath on 16th and 17th June 2013 which resulted in large number of casualties especially among the floating population of pilgrims could have been avoided, if some regulations was in place to counter the mushrooming of different types of dwelling places in Kedarnath. In this context, it is important to understand torrential rain induced geodynamic processes of flash flood resulting rock falls and debris flow, Chorabari lake collapse and deposition of glacial material. This paper review the different scientific studies that have emerged during the last six months emphasizing Meteorological, Geological, Anthropogenic and other causes that lead to this catastrophic disaster.

Introduction

Natural disasters are events of the Nature which cause sudden disruptions to the normal life of the community. It eventually cause damage to the lives and property to such an extent that normal social and economic mechanism that are locally available to the community become inadequate to restore normalcy. About 80% of India's land often faces natural disasters like earthquakes, landslides, floods, cyclones, drought, lightening, avalanche, summer dust storms, hail storms forest fires, coastal erosion etc. India ranks 4th in the list of countries that were most hit by natural disasters in the year 2006. A large number of man-made disasters such as biological (pest attack, epidemics etc.); industrial and technological; environmental (air, water and land pollution); fire, road and railway accidents etc, are also cause severe setbacks to the community. More than 50 million people are affected by disasters annually in the country, and on an average over one million houses are damaged each year. "Natural disasters continue to strike and increase in magnitude, complexity, frequency and economic impact. Whilst the natural phenomena causing disasters are in most cases beyond human control, vulnerability is generally a result of human activity. Therefore, the community must recognize and strengthen traditional methods and explore new ways to live with such risk, and take urgent actions to prevent as well as to reduce the effects of such disasters. The capacities to do so are available" (Anon, 1994). Considering the increasing causality figures in the natural disasters, the United Nations launched the International Decade of Natural Disaster Reduction (IDNDR) during 1990 to 2000 to reduce through concerted international action on the loss of life, property damage, social and economic disruption which helped in creating awareness and initiative across the world. It is true that geographical and meteorological conditions are mainly responsible for the occurrence of frequent disasters resulting huge loss of life and property, it cannot be denied that the factors like inadequacy of warning communication systems, lack of preparedness and workable disaster management plans (CEE, 2004). There are many proven records in India (frequent cyclones in the coastal tracts of Andhra Pradesh, Orissa Super Cyclone, Bhuj Earthquake in Gujarat and occurrence of Tsunami in the west and east coasts of India) and Bangladesh (Floods and Cyclones) after undertaking disaster

prevention and mitigation measures, the effects of disaster have come down drastically. The Government of India realizing the importance of addressing disaster management more holistically have ended up with 'The Disaster Management Act, 2005'. Although it is impossible to fully recoup the damage caused by these disasters, it was possible to minimize the potential risks by developing early warning strategies, mobilise resources including communication, telemedicine services, food and supplies and to help in rehabilitation and post disaster reconstruction.

Geographical set up

The Himalayas are among the youngest mountain ranges on the planet and consist mostly of uplifted sedimentary and metamorphic rocks. The name Himalayas is derived from the Sanskrit word 'Hima' meaning snow and 'Laya' meaning dwelling which literally means "abode of snow". Tectonically the Himalaya comprises of four separable major litho-stratigraphical units – Siwalik, Lesser, Central Crystalline and Tethyan Group. These groups are separated from each other by a major tectonic contact – Main Boundary Fault (MBF), Main Central Thrust (MCT) and Thethyan Thrust and these thrust contacts are traceable all along the Himalayan belt. The Himalayan range crosses 5 Nations namely, Bhutan, India, Nepal, China and Pakistan (Dubey, et al 2013). The first three nations are having the autonomy over the most of the ranges. The Himalayas was lifted by the collision between Indian Tectonic Plate and Eurasian Plate. According to the modern theory of Plate Tectonics, their formation is a result of a continental orogeny along the convergent boundary between the Indo-Australian Plate and the Eurasian Plate. About 70 million years ago, the north-moving Indo-Australian Plate was moving at about 15 cm per year. 50 million years ago, this fast moving Indo-Australian plate had completely closed the Tethys Ocean. Since both plates were composed of low density continental crust, they were thrust faulted and folded into mountain ranges rather than sub ducting into the mantle along an ocean-trench. An often-cited fact used to illustrate this process is that the summit of Mount Everest is made of marine limestone from this ancient ocean. It is estimated that around 10 million years from now, the Indo-Australian plate will travel 1500 km into Asia as it is still moving at the speed of 67mm annually. The tectonic movements of these plates also results in the rising of the Himalayas by 5 mm per year, making these mountain ranges geologically active. These deep seated tectonic activities in Himalayas have made it very unstable and fragile, resulting to increase susceptibility towards natural hazards. The movement of the Indian plate into the Asian plate, further, makes this region prone to natural hazards like earthquakes and landslides, soil erosion, forest fires, flash floods, snow avalanches etc. The Siwalik is mainly consists of sedimentary rocks, Lesser Himalaya consists of sedimentary, meta-sedimentary and low grade metamorphic rocks, Central Crystallines are mainly consist of high grade metamorphic, while the Tethyans are sedimentaries (Wadia, 1976). By the tectonic set up it appear that the Himalayan rocks have subjected to several phases of tectonic movements, resulting local faults, folds and thrusts. Due to several phases of tectonic movements, the incidence of landslides and mass wastings are higher in number than any other part of the country (Joshi, et al 1998). The good example of this can be taken from the recent floods occurred in the month of June 2013 in Uttarakhand (Nair, 2013). Against this background, it has been disappointing to note the management of Uttarakhand disaster of 15-17th of June, 2013.

Uttarakhand state

The Uttarakhand is a Himalayan State, located between Himachal Pradesh of India and Nepal; with Tibet lying to its north. The entire state of Uttarakhand is a hilly terrain, incorporating the Tethys, Higher, Lesser and Sub Himalayan part along with the Great Indo-Gangetic plain falling in the Hardwar and Udham Singh Nagar districts. It covers an area of about 53,500 sq km. The state is composed of 13 districts grouped in to two division called Garhwal and Kumaon. Garhwal division includes seven districts; Chamoli, Dehradun, Hardwar, Pauri Garhwal, Rudraprayag, Tehri and Uttarkashi whereas Kumaon division includes six districts; Almora, Bageshwar, Champawat, Nainital, Pithoragarh and Udham Singh Nagar (Fig.1). The state, in general, is prone to different disasters such as earthquakes, excessive rains and cloud bursts, landslides, floods, forest fires and hailstorms. The seismic risk in the state is considered to be high. Four of the 13 districts of the state (Pithoragarh, Chamoli, Bageshwar and Rudraprayag) fall completely in Zone V of the seismic risk map of India (representing damage risk of ≥ IX on MSK scale) while five other distrcits (Uttarkashi, Tehri Garhwal, Pauri, Almora and Champawat)fall partially in Zone V and partially in Zone IV (damage risk of VIII on MSK scale) and the rest (Dehradun, Haridwar, Nainital and Udham Singh Nagar) fall totally in Zone IV (Fig.2). In the recent past the state has experienced two major earthquakes (Uttarkashi, 1991 and Chamoli, 1999). The non-occurrence of a major earthquake (M > 8 on the Richter scale) in the region in the last more than 200 years enhances seismic risk in the region. The flash floods resulted from the heavy torrential rainfall between 15th and 17th June 2013 has been one of the worst Himalayan tragedies in recent years in which the actual number of people buried or perished is not known as thousands are still missing (Uniyal, 2013). The entire Rambara, a large part of Gaurikund and many villages of Mandakini valley were also fully wiped out (Dobhal, et al 2013). As reported by media, a total no. of 28 persons including two children and three fire fighters were killed and others went missing after being washed away by flash floods in Uttarkashi and Chamoli districts. Hundreds were left homeless. A dozen bridges were washed away and debris from landslips blocked most roads including national highways leading to Gangotri, Yamunotri, Badrinath, Kedarnath and Hemkunt Sahib. The Bhagirathi soared above the danger level in Uttarkashi and the Ganga was just short of the danger mark at Haridwar. An alert was sounded in areas along the Ganga and its tributaries. The Gangotri fire station was destroyed and a fire tender and some private vehicles were washed away. The administration evacuated 200 families from the area and lodged them in government buildings. Tents were erected for people stranded in inaccessible areas. Several kilometres of the Gangotri highway and Gangotri hanging bridge were washed away (Nair, 2013). The present review summarises the Meteorological, Geological, Anthropogenic and other causes that lead to this catastrophic disaster.

Fig.1 Map of Uttarakhand State

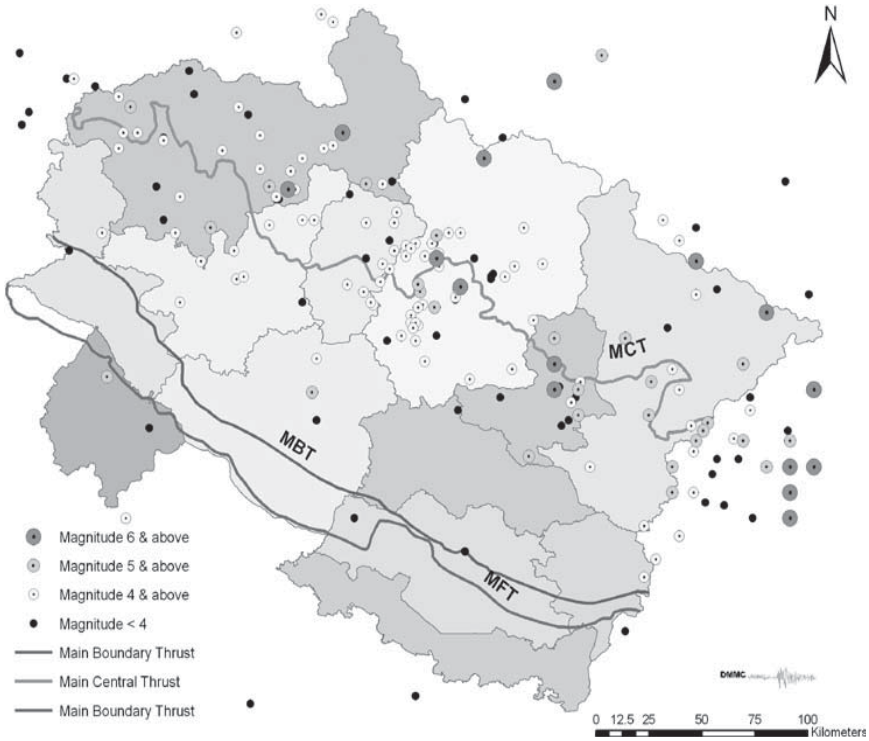

Fig.2 Map showing epicentres of earthquakes in Uttarakhand.

Meteorological causes

The IMD report shows (Table 1.) the breakup of the rainfall in the state of Uttarakhand on 15th -18th July 2013.

Table 1: District-wise Precipitation level in Uttarakhand State (Source: IMD, Issued on 14/06/13)

Districts	Rainfall on 15/06/13 (mm)		Rainfall on 16/06/13 (mm)		Rainfall on 17/06/13 (mm)		Rainfall on 18/06/13 (mm)	
	Actual Rainfall	Predicted Rainfall	Actual Rainfall	Predicted Rainfall	Actual Rainfall	Predicted Rainfall	Actual Rainfall	Predicted Rainfall
Almora	-	10	09	15	10	50	-	35
Bageshwar	-	20	16	20		70	-	50
Chamoli	-	20	08	25	10	75	-	55
Champawat	-	10	10	10	22	20	-	15
Dehradun	22	15	37	10	-	30	-	70
Garhwal Tehri	12	10	17	10	-	30	-	70
Hardwar	11	05	22	05	-	20	-	40
Nainital	-	10	18	10	17	15	-	25
Pithoragarh	-	20	09	20	12	75	-	55
Rudraprayag	09	05	09	05	-	25	-	40
Udham Singh Nagar	-	05	-	05	-	30	-	25
Uttarkashi	13	20	21	10		50	-	80

The Himalayan region in the said week was supposed to recieve a heavy to very heavy range of rainfall (wikipedia). Although, there were some reports that, it was a cloud burst, but latest report issued by government says it was not a cloud burst, since there was no rainfall such as seen during the cloud burst. (Dobhal, 2013). The cumulative rain fall till 01.06.2013 showed 3.15% increase from normal rain distributed to all districts (Table 2).

Table 2: Cumulative R/F till 1st June, 2013 (Source: http://cm.uk.gov.in/pages/display/1179)

MET. SUBDIVISIONS	Cumulative R/F till , since 01.06.13		
UTTARAKHAND	ACTUAL	NORMAL	DEP (%)
ALMORA	625.0	498.3	25
BAGESHWAR	1031.3	498.3	107
CHAMOLI	1234.5	482.6	156
CHAMPAWAT	971.0	771.3	26
DEHRADUN	1764.4	1053.8	67
GARHWAL PAURI	533.9	700.8	-24
GARHWAL TEHRI	688.2	611.6	13
HARDWAR	917.7	526.2	74
NAINITAL	1337.2	830.9	61
PITHORAGARH	1025.7	991.5	3
RUDRAPRAYAG	1119.5	953.9	17
UDHAM SINGH NAGAR	789.1	632.7	25
UTTARKASHI	1066.3	624.2	71
SUBDIVISION RAINFALL	1018.4	703.8	45

The Tropical Rainfall Measuring Mission (TRMM) data shows heavy rainfall in the area of Uttarakhand (about 500 mm) in the week of 11th June 2013 (Fig 3). The enormous amount of rainfall or precipitation that may include thunder storms and hail storms, which does not last for more than few minutes or couple of hours is basically known as cloud burst.

The cloud burst is capable of creating flood conditions. The rainfall is usually termed as cloud burst if the rainfall measured is more than 100 mm per hour. Usually, in the Indian subcontinent, the cloudburst occurs when the pregnant monsoon cloud drift towards the Northern parts from the Bay of Bengal or the Arabian Sea, across the plains and over the Himalayan belt. The ascending clouds that are laden with moisture tend to become heavy after a certain point and hence produce violent and heavy rainfall in a short period of time. The cloud burst mostly occurs in the hilly areas and not the plains. The reason behind this is the orographic lifting of moisture laden unstable air that takes place in the area that has the potential energy necessary for cloudburst in the hilly terrain. The image of 17th June 2013, released by NASA's space satellite shows us the cloud formation over the northern parts of India, which are more prominent over Himalayan region

(Fig. 4). The state of Uttarakhand received enormous amount of rainfall on 16th and 17th of June 2013, which in turn led to the catastrophe that took away many lives in no time. All the 13 districts in Uttarakhand have been affected by the floods of which four districts were the worst affected ones (Uttarkashi, Rudraprayag, Chamoli and Pithoragarh).

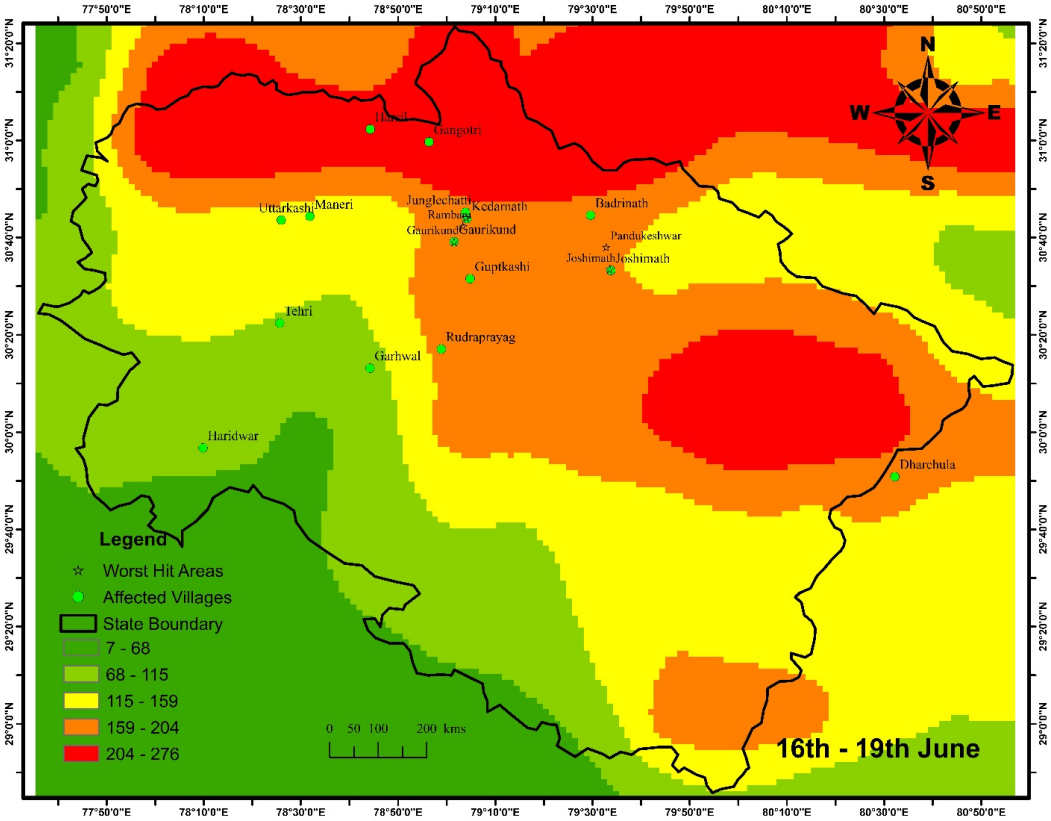

Fig. 3: Rainfall Fig Distribution Map of Uttarakhand as on 16th June to 19th June 2013.

Geological cause

Landslides were also a cause for the disaster. The term 'landslide' includes all varieties of mass movements of hill slopes and can be defined as the downward and outward movement of slope forming materials composed of rocks, soils, artificial fills or combination of all these materials along surfaces of separation by falling, sliding and flowing, either slowly or quickly from one place to another (Kato, 2011).

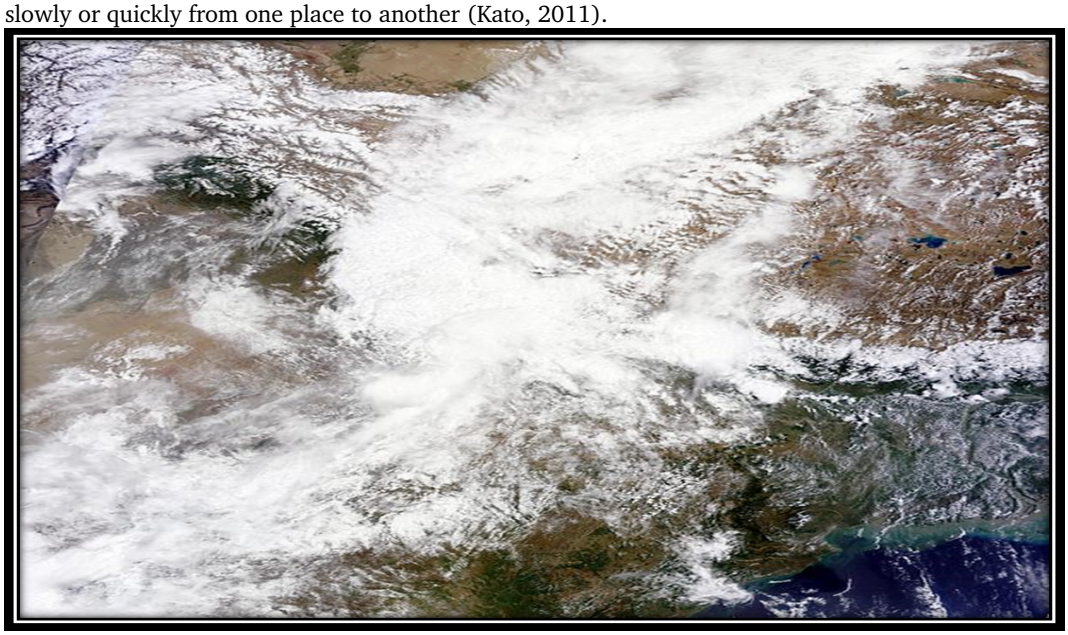

Fig. 4: Satellite imagery showing the cloud cover over Uttarakhand on 16 June 2013 (NASA)

Although the landslides are primarily associated with mountainous terrains, these can also occur in areas where an activity such as surface excavations for highways, buildings and open pit mines takes place. Many factors contribute to slides, including geology, gravity, weather, groundwater, wave action and human actions. Although landslides usually occur on steep slopes, they also can occur in areas of low relief. Underwater landslides usually involve areas of low relief and small slope gradients in lakes and reservoirs or in offshore marine settings. Typically, a landslide occurs when several of these factors converge. Some of the Natural causes are mainly (i) Gravity (ii) Geological (iii) Heavy and prolonged rainfall and (iv) Earthquakes (Nair, 2013).. When earthquakes occur on areas with steep slopes, many times the soil slips causing landslides. Furthermore, debris flows caused by earthquakes can also trigger mass movement of soil.

Flood/flash flood/glacial lake outburst flood (GLOF)

Flash floods are known to occur in the hilly terrain in India. Flash floods are described as rapid and sudden flooding of low lying areas (Fig. 5). The main causes of flash floods can be heavy rain associated with thunderstorms, cloud bursts, hurricane, severe tropical storms or melt water from ice or snow. Flash flood occurs when rain falls rapidly on saturated soil or dry soil that has poor absorption ability. The runoff collects in gullies and streams, which join to form larger volumes of the water body and often forms into a fast flowing water front along with debris. It mostly occurs in normally dry areas that have received heavy rainfall recently. It may be seen anywhere downstream from the source of the precipitation, at times it can be seen even many km away from the source. Flash flooding can also be caused by extensive precipitation released by storms as well as the sudden thawing effect of ice dams (Wikipedia). A flash flood is an event that occurs within six hours following the end of the causative event that result in life and property loss. It usually evolves rapidly and the steep and sloppy terrains are more prone to it. Flash floods do not last longer; in fact it rarely lasts more than 12 hours. This event, like flash floods, results in loss of life and property. Same as the flash floods, the hilly terrain are prone to the floods, but it can also occur in the plains, especially the low lying areas and areas closer to the sea. Usually floods last longer than flash floods, it is often seen that these lasts for more than 24 hours (Nair, 2013)..

Glacial lakes

As the country emerges from the devastation caused by the cloudburst and flood in the Uttarakhand Himalayas, geographers have sounded a grim warning that can be perceived as a ticking natural time bomb. There have been found to be 200 such lakes in the Himalayan region which can burst anytime. Now if a cloudburst and the resultant floods can cause so much of destruction to have turned the pilgrimage towns of the region into 'ghost towns', imagine the destruction that would be caused by all the water from the 200 lakes hurtling down at a incredible speed and force down the rugged Himalayan slopes.

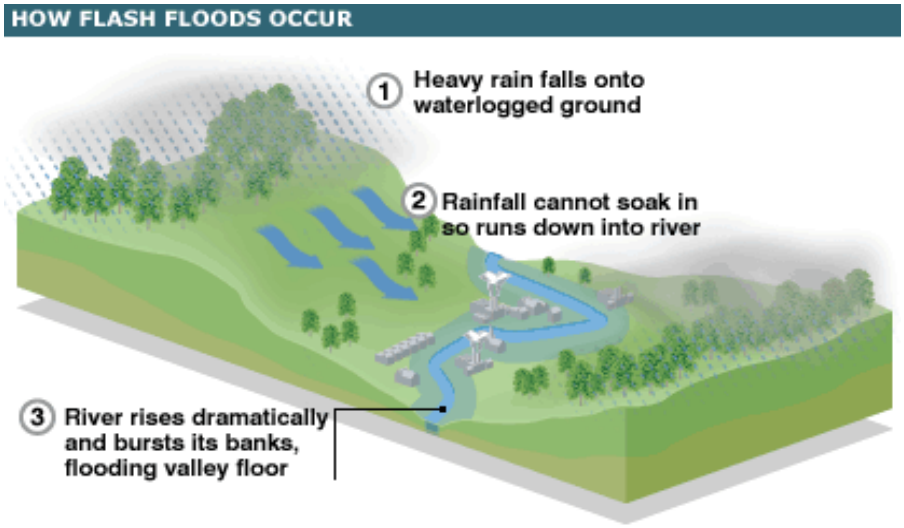

Fig.5 Occurrence of Flash Floods (Source: BBC News)

The International Centre for Integrated Mountain Development in Nepal in its periodic studies has pointed out the rapid building up of glacial lakes in the region. As a result of global warming, melting of glaciers has increased and this has led to the formation of the glacial lakes. The mountains weakened by landslides holding the lakes are a frightening prospect. It has been reported that there are nearly 8,000 glacial lakes in the Hindukush-Himalaya area and excessive snowfall or rainfall or storms can cause these lakes to overflow, giving rise to flash floods in the region (Nepal Disaster Report 2011). According to the National Disaster Management Authority (NDMA) guidelines, the IMD was expected to install by September, 2009 Doppler Radars to forecast sudden floods, but even today not even 5 such radars have been put up in geologically and geographically sensitive areas like Uttarakhand.

Anthropogenic causes

Uttarakhand's geography is very dynamic, vast and 90% of the area is mountainous region. Deforestation, land grazing, illegal development on the soft bed of rock leads to disasters when a flash flood hit the area. Experts are of view that while tampering with the Himalayan slopes, one need to be extra careful as these are the slopes, which have evolved by exogenic and endogenic processes and hence are dangerously balanced, which makes them more vulnerable to disasters. The Uttarakhand floods have seen such a disaster, ranging from multiple landslides, run offs, to buildings on the low lying areas being pulled down by the floods, damaged roads, etc. The satellite pictures of the recent disaster shows that the river Mandakini changed its route in many places and also geographically many tributaries were developed affecting many places that otherwise should not have been affected (Nair, 2013). The experts further add that environmental degradation and glacial melt down is for this massive destruction. The release of 17.6 cusecs of water further added to the disaster. Of late the glaciers of Mandakini Valley have been melting down at a faster speed. The evidence can be traced by noting the U shaped valley and moraines up to Rambara. In the recent past the Valley of Mandakini has faced climatic changes to an extent that has affected the glaciers in the valley (Mehta, 2012) Adding to the melting glaciers the huge infrastructural growth has further led to the environmental degradation in the region. The antecedent rainfall saturated the region and exceeded the limit on 16th and 17 June, which triggered multiple landslides and flash floods in the Mandakini Valley. Although the Chaurabari Glacier is seasonal in nature but the heavy rainfall and snow cover in the area increased the water level that made the lake over flow due to saturation of the moraines, hence, increasing the volume of the streams in the region, making them broader and therefore submerging the low lying areas in the valley. The picture below shows the increased size of the streams and generation of many other streams due to heavy downwards flow of water and debris, which destroyed the Kedarnath region of Uttarakhand. The image illustrates that the stream in the background of Kedarnath was narrow prior to the flash floods. Due to heavy flow of water the riverine widened up. Some signs of mobilization of the lateral moraine over the catchment of the Companion Glacier are noticeable. This took down the debris to hit the settlement coming in its way destroying Kedarnath. A new stream can also be seen in the satellite imagery (Fig. 6). The occurrence of many streams has fresh sediments in its bed now due to the flash floods (Nair, 2013).

It can be seen that a very high gradient of glacier has snout, steep to moderate slope in the areas of moraine deposits and moderate to gentle slopes in the Kedarnath valley followed by the increasing gradient from very steep towards Gaurikund. Due to high gradient slope the velocity of debris was really fast from Kedarnath to Gaurikund and Rambara. This in turn led to the colossal damage to infrastructure, lives and property in the areas lying near the downstream. There was a large devastation of property near Kedarnath Dham and surrounding areas. The roads and buildings are heavily damaged due to multiple landslides. Maximum damages can be seen in the areas of Kedarnath, Guriaya, Lenchuri, Hhindurpani, Rambara, Gaurikund and downstream areas up to Rudraprayag. Although there have been no damages in glaciers Chaurabari and Companion but the middle moraine debris has been washed out due to overflowing single stream. Initially it was being believed that Vasuki Tal may have been responsible in the colossal damage but the satellite imagery confirms that Vasuki Tal did not play any role in devastation.

Fig. 6: Streams in Kedaranath before and after the disaster (NRSA).

A combination of factors such as degraded forest cover, change of moderate debris-laden slopes into near vertical slopes during road widening and illegal building construction without keeping in view the safety and lacking adequate and appropriate engineering measures made the slopes vulnerable to the onslaught of torrential rainfall in the region.

In the urban clusters the obstructed natural drainage was responsible for slope destabilization and diversion of the debris-laden water into the settlements. Approximately two-thirds of the landslides in the Alaknanda Valley were accelerated by anthropogenic intervention, mostly by the removal of slope toes for the purpose of road construction. There is no denial that the existing roads in Uttarakhand are unable to cope with the increase in traffic. According to an estimate, during the pilgrim season nearly 200,000–300,000 vehicles barrage between Rishikesh and Badrinath; similar is the case on the Gangotri route, which is heavy for the soft rock bed like that in the state of Uttarakhand. In addition, innumerable hydel projects which have increased in the river valleys require wider roads for the transportation of heavy machinery. Additionally, since the creation of Uttrakhand, a noteworthy increase in the built up areas in the Alakananda Valley has been seen particularly, in the areas around Srinagar, Devprayag, Rudraprayag, Karnprayag, Nandprayag and Joshimath. Unfortunately, knowing the fact that India is situated on an active tectonic plate, the government has yet to do much to safeguard its population from natural hazards. Diggings down mountains to construct roads also have added to this massacre. The roads and building are being built in this area without understanding the geology of the region. The blasting often moves the rocks and makes the area vulnerable to hazards (Nair, 2013).

Other causes

The disaster in Uttarakhand has many reasons. The rumours are rife that this could be the case of Cloud seeding done by China. The other belief is that this is due to shifting of Dhari Devi temple from its actual site to the other venue (Down To Earth, July, 2013). And yet another belief that due to human intervention the environment has degraded to an extent that it can't be replenished. Where some believes it was due to heavy rainfall, the other says it was due to environmental causes and some want to blame it on the geology of the region?

The government needs to wake up to the call of environment and find out the best possible plan for the rehabilitation of the highly vulnerable region of Uttarakhand. The need of the planned and sustainable development rather than just increase in economic growth of the region must be the main priority now (Panda, 2014).. Since the vulnerable area only faces a disaster when it is exploited, now it's the time that we must not further damage the environment of the area and by undergoing proper scientific and geological studies in this area, rebuild a better and safer environment to live in. The government now has a greater role to play, since this disaster was only due to one major reason that the "Ecologically Sensitive Areas" are overburdened with a lot of establishments of poor quality and improper planning. Now it is high time for the Government of India to think for a proper "Land Use Plan" for the entire Himalayan region on a watershed basis.

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ACADEMIC INITIATIVES OF MAHATMA GANDHI UNIVERSITY, KERALA, INDIA IN THE FIELD OF DISASTER MANAGEMENT

DRVC2014
2nd Disaster Risk & Vulnerability Conference

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Abstract

The Mahatma Gandhi University (MGU) in Kerala is one of the premier institution for 'Higher Education and Learning' in India. It was institutionalized on 2nd October 1983 to commemorate Mahatma Gandhi on his 115th birth anniversary, by Government of Kerala. Amongst one of the Department Schools from MGU the 'School of Environmental Sciences' stands unique and vital for interdisciplinary subjects, that had been established in the year 1995. Owing to the regular academic course program i.e., 'Master of Science in Disaster Management (established in the year 2006)' later changed as 'Master of Science in Environment Science and Disaster Management (from the year 2010) pioneers in Master of sciences that have been ever established in Indian Universities. The status and credential only pertains to Mahatma Gandhi University, Kerala, India. The School of Environmental Sciences from the MGU is been pacing the best forward in Disaster Management program to the students with deferential strengths to study and analyze the sciences of occurring varied disasters in day to day life through field real studies, empower unique tools and techniques to study and strings upped with scientific, social, economic and humanitarian aspects of manmade and natural disasters arising. The program link with industries and government and non government organizations. Currently the academia of Mahatma Gandhi University in disaster management having a notable contribution at all fields of disaster management spectrum. The websites of the school are http://www.sesmgu.org/ and http://mgu.ac.in/index.php?option=com_content&view=article&id=286&Itemid=503

Key words
Mahathama Gandhi University, Disaster management, Training, NGO

Introduction

Disasters, whether natural or man-made, have had adverse effects on human beings ever since the dawn of our existence. The number of people affected by disasters rose from 147 million per year to 211 million per year during the period of 1991-2000. Natural disasters are unpredictable, destructive and often deadly (World Bank, 2006). The increase in the natural and anthropogenic disasters in India, is posing a serious threat to the country and the citizens developmental efforts. Hence now there is a growing importance of the disaster management in higher education and research. The importance of Disaster Management in developmental initiatives has been recognized and the activities in the area have been invigorated by the initiatives and influx of funds by the Government of India. This has lead to the mainstreaming of disaster risk reduction in the planning process, which in turn ensures that Disaster Management gains its due importance in the process of development planning through its incorporation for the first time in the Tenth Five Year Plan.

The Mahatma Gandhi University in Kerala stands foremost among the developing universities of India for various aspects. The School of Environmental Sciences is one of the premier centers in India offering academic and research programs in environmental science and disaster management. The School can be an ideal venue for interdisciplinary research along with human resource development with field practice as it interlinks environmental science, disaster management and sustainable development themes. The curriculum is carefully designed with an objective of developing human resources in all the field of emergency management with sufficient training in disaster mitigation and relief.

As the part of the curriculum the students must undergo a group project and individual project at third and fourth semester respectively, in final semester they had to undergo internship in any of the reputed institutes in the district, state or national level. Detailed group projects already conducted flood risk reduction management, Industrial cluster modeling in chemical disasters, a site specific account of physical and social vulnerability to debris flow and multipronged community risk and disaster management, traditional knowledge in disaster risk reduction etc. Students accomplish their projects works at esteemed research institutes in the field of emergency management of our nation such as National Institute of Disaster Management (NIDM)', 'National Disaster Response Force (NDRF), Indian National Centre for Ocean Information Services (INCOIS), Atomic Energy Regulatory Board (AERB), Indian Institute of Tropical Meteorology (IITM) etc.. The notable internships carried recently under Kerala State Disaster management Authority, Institute of Land and Disaster Management (ILDM), Hazard Vulnerability Risk Assessment (HVRA) cell and District Disaster Management Authorities (DDMA) in Kerala state.

School of environmental sciences

Field study

Community programmes

DRVC-2011

For revamping the disaster education at University level by collating and incorporating expert suggestions in the above said area, the school of environmental sciences conducted a 'Three day National Conference' - 'Disaster Risk Vulnerability Conference (DRVC) on March 12-14, 2011'. The conference brought together specialists, practitioners, academicians, students and the public to a common platform, where theoreticians and practitioners with diverse backgrounds, unified under their concern for 'Disaster Management' present their research, debate on the issues, and discuss the challenges, opportunities and areas of mutual cooperation. School also conducts dynamic research in the field of disaster management.

A good percentage of students got placement in various organizations and institutes as interns as well as other posts immediately after the completion the course. Number of students actively presented their works at several national and international workshops related to disaster management. Few students carrying out their Doctoral research in foreign countries, owing the merit with notable International Fellowships. The School has also established linkages with various R&D departments and NGOs of the country.

The Non Governmental Organization 'Charitable Society for Humanitarian Assistance and Emergency Response Training (C-HAERT)' an initiative of the Disaster Management students and alumni of the school is an added account. This Nongovernmental organization was registered (07/06/2011) under the "Travancore – Cochin Literacy", and 'Charitable Society Registration Act 1955' with register number (K201/2011). This nongovernmental organization acts as a nodal agency for the training of professionals in the disaster management field especially in the humanitarian accepts. The C-HAERT develops and maintains a structured platform to facilitate publishing, collaborative education, training and research in the current and emerging fields of Disaster Management spectrum, human resource development one of the key issues dealing in the field of disaster management, humanitarian aid and participation in relief, rehabilitation and reconstruction activities of disaster affected community are the key objectives of this non profit organization.

The school of environmental sciences has established good network of academic collaboration with many national and international organizations, institutions and industries, which help in interdisciplinary research, training, consultancy programmes and exchange of information, faculty and students. The publications thus produced stand as testimony of such collaborative works. The school is getting financial and technical support from various national and international agencies like KSCSTE, DoECC, UGC, DST, MoES, MoEF, ISRO, WWF, UNDP and some western universities such as University of Kuopio (Finland), and ITC (Netherlands), Brown University (USA), California Institute of Technology, IISc, KFRI, CESS for operating projects, establishing infrastructural facilities and to carryout research in various disciplines of environmental science and disaster management. It has also received the prestigious Obama Singh Knowledge Initiative grants too recently.

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TSUNAMI HAZARD ASSESSMENT ALONG THE CAR NICOBAR ISLANDS, INDIA USING GEOSPATIAL TECHNOLOGIES AND N2 MODELING

DRVC2014
2nd Disaster Risk & Vulnerability Conference

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Abstract

This study deals with the hazard assessment along the coasts of Car-Nicobar Island in the Andaman Sea of India, which was affected by the 26 December 2004 tsunami generated due to the Sumatra earthquake (M 9.3). The epicenter was 163km away from the Great Nicobar islands and it was strongly felt in the Andaman group of island including Car-Nicobar. The tsunami has been simulated using the Tunami-N2 numerical modeling using the corresponding focal parameters. The simulated tsunami run-up heights at the coasts were extracted and the extent of the inundation has been derived using the Shuttle Radar Topographic Mission (SRTM) topographic data. Further, Remote Sensing and Geographic Information System (GIS) techniques were used to identify and assess the Tsunami hazard. The Enhanced Thematic Mapper (ETM+) onboard Landsat-7 and Linear Imaging Self-scanning Sensor (LISS)-III onboard Indian Remote Sensing (IRS)-P6 satellite data are used to assess the changes in the vegetation and shorelines during the pre and post tsunami. The analysis result reveals that the estimated tsunami run-up height along the coast was in the range of 5-10m and 65% of the total vegetation has been completely changed due to the tsunami.

Key words

Tsunami hazard assessment, Vegetation change, Shoreline changes, N2 Modeling

Introduction

India has a coastline of around 7,500 km and rational development of coastal areas, which form the habitat of over 25% of the country's population, living within 60 km of the shore line (Rao, 2008). A variety of natural hazards regularly threaten this coastal zone. Severe meteorological events such as hurricanes, tropical cyclones, etc... are particularly harsh on coastal areas. Tsunamis, whose destructive force is characterized by potentially devastating flood inundation, are uniquely coastal events resulting from offshore earthquakes, landslides, or volcanic activity. Intensive development in the coastal zone not only places more people and property at risk to coastal hazards, but it also degrades the natural environment, interfering with nature's ability to protect the human environment from severe hazard events (NOAA, 2013). The main purpose of RS and GIS platform mainly is to promote the use of satellite information to monitor geological, hydrological and climatic conditions to facilitate planning, mitigation and rapid response in the event of natural disasters (Maccann, 2011 and Thomas, 2007). Remote-sensing techniques and GIS tools are frequently used in applications for disaster management in pre- and post-disaster activities (Saravanan, 2009). Pre-disaster applications are associated with mitigation and preparedness efforts. Mitigation refers to activities that reduce the vulnerability of societies to the impacts of a disaster, while preparedness refers to activities that facilitate preparation for responding to a disaster when it occurs (Mansourian, 2005)

Study area

Car Nicobar is the northernmost island of the Nicobar group of islands with an area around 127 sq km, which in turn are the southern part of the Indian union territory of the Andaman and Nicobar Islands (Fig:1). The area south to the Ten-degree channel comes under Car Nicobar headquarter. The geographical extent of Car Nicobar Island from 92.68° to 92.87° E longitude and 9.07° to 9.27° N latitude. It is a fertile island covered with cluster of coconut palms and enchanting beaches with a roaring sea all around. In the census of 2001 its population was declared to be about 29,145. The population of Car Nicobar is more than the half of the total Nicobar population.

Materials and methods

Topographic data. For modeling coastal inundation, topography of the entire coastline of the country is required at 1:5000 scales with contours at intervals of 0.5 m for a stretch of at least 1 km to 3 km from the coastline in general and for 10-25 km at selected areas near coastal water bodies (e.g. estuaries, backwaters). The National Remote Sensing Centre

has completed the mapping of topography for 3,300 sq. Km out of about 15,000 sq Km area with airborne LIDAR and Digital Camera data in conjunction with GPS control survey. CARTOSAT – 1 data is being used for generating Digital elevation model (DEM) of the coastal region. LANDSAT ETM+ (18-02-2001) and LISS III data (14-01-2005) are the satellite imageries and ArcGIS Desktop 10, ERDAS Imagine 9.1 are the software's used for the present study.

Fig: 1 Location Map of the Study Area.

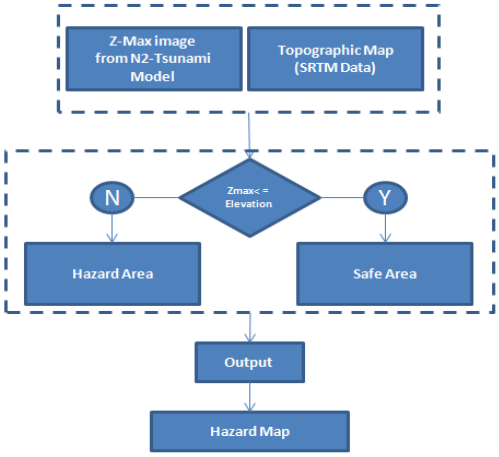

Fig: 2 Methodology involved in preparing hazard map

Tsunami N2 modeling. The use of Numerical modeling to determine the potential run-ups and inundation from a local or distant tsunami is recognized as useful and important tool, since data from past tsunamis are usually insufficient to plan future disaster mitigation and management plans (Imamura2006). Tsunami N2 model is a tsunami numerical simulation program with the linear theory in deep seize and with the shallow water theory in shallow sea and on land with constant grid length in the whole region and is authored by Fumihiko Imamura in Tahoku University, Japan.

Tsunami hazard assessment. The detailed methodological flow chart for Tsunami hazard assessment is given in Fig: 2

Zmax has been extracted from N2 Tsunami model and topographic map has (Elevation) been extracted from SRTM Data. This is an example of holistic approach, here the surge height at the coast will inundate up to the elevation equal to surge level (Mahendra, 2011).The Zmax vale at the coastal grid has been extracted and the extent of the tsunami vulnerable area has been extracted up to the elevation contour equal to the Zmax. Otherwise the coastal topography greater than or equal to the nearest Zmax is considered as the safe area (Usha, 2009). The value of Zmx can be <=0. If it satisfies the following condition, then the area is Safe area or the area is safe, if the condition is not satisfied, then the area can be considered as Hazard area. This condition has been used to generate the tsunami hazard maps along the Car Nicobar coast.

Vegetation change map. Landsat ETM+ and LISS III images covering the Car Nicobar Island acquired during 2001 (representing pre tsunami) and 2005 (representing post tsunami) respectively were used for to estimate the vegetation changes. After applying all the necessary pre-processing corrections NDVI has been calculated, NDVI composite image were further classified into vegetated and non-vegetated areas and transferred to shape files in GIS environment. After complete the process of calculation then get the vegetation map of B.T (area of vegetation before tsunami) and A.T (area of vegetation after tsunami). The changes were assessed based on the criteria BT-At <0 is damaged and BT-AT≥0 is not damaged. The vegetation change maps were prepared based on the above criteria. The methodological flow chart is given in fig: 3.

Results and discussion

The maximum run-up heights estimated from Tsunami-N2 Model is given in Fig: 4. In this map there are different classification is given based on the wave height in meter. The map displaced meter wave height as blue color, 3 meter as light blue color, 6 meter as light yellow color, 9 meter as yellow color and wave height 10.2 meter as red in color. The hazard map of Car-Nicobar Island is given in Fig 5. These map shows that 2004 tsunami affected areas. In this map there were mainly two classifications is given, one is safe zone and other one is un-safe zone. The map displays safe zone as green color and un-safe zone as red color.

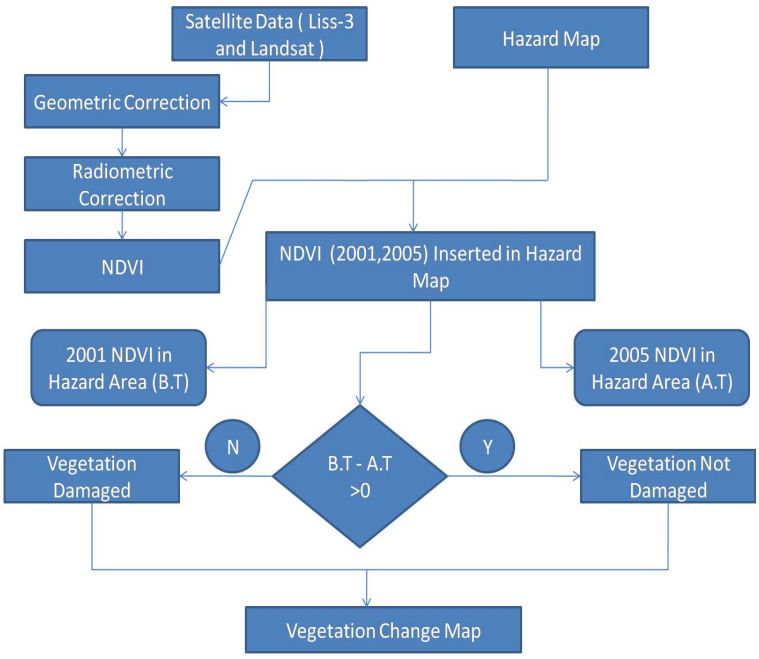

Fig: 3 Flow chart for the preparation of vegetation change map

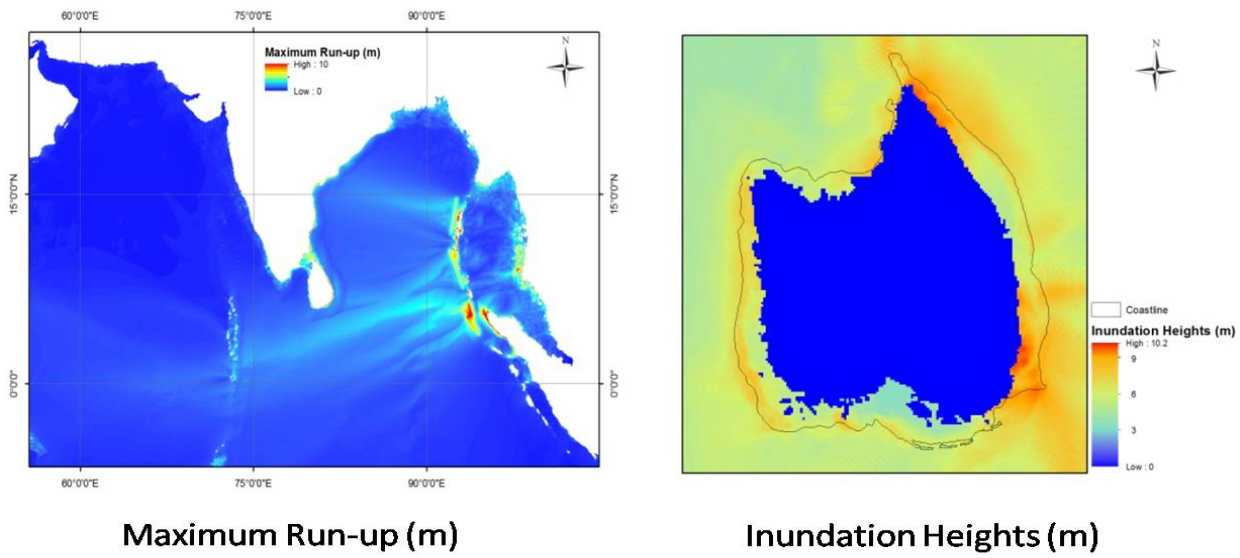

Fig: 4 Estimated run up heights

The costal low lying areas which are vulnerable to coastal inundation due to the tsunami in the Car-Nicobar have been given in the above figure. A total 127 Sq.km which constitutes 36.7Sq.km is unsafe zone and remaining 90.3 Sq.km is safe zone. And it is observed that 29% of the total geographic area of Car Nicobar recorded as tsunami hazard zone. Tsunami Hazard zones are represented here are unsafe and prone to be inundated during tsunami.

Vegetation change pre and post tsunami. The map shows (Fig: 6) that the vegetation changes in hazard area (pre and post tsunami). In this map there were mainly three classifications is given, vegetation area, non-vegetation area and other area. The map is displaced vegetation area as green color, non-vegetation area as red color and other area as light white color.

Table 1. Change in vegetation areas (2001–2005)

YEAR	VEGETATION (Sq.km)	NON-VEGETATION (Sq.km)
2001	36.5	0.2
2005	12.3	24.4

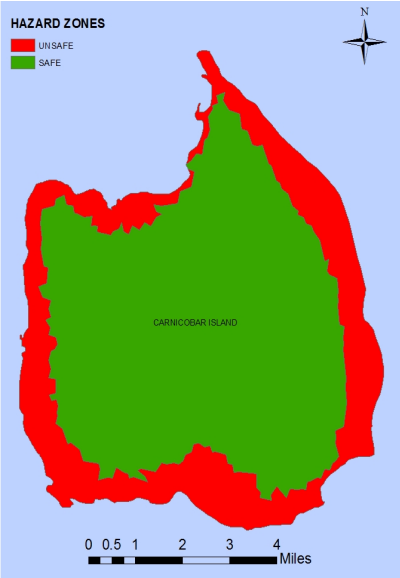

Fig 5: The hazard zonation map of Car Nicobar island.

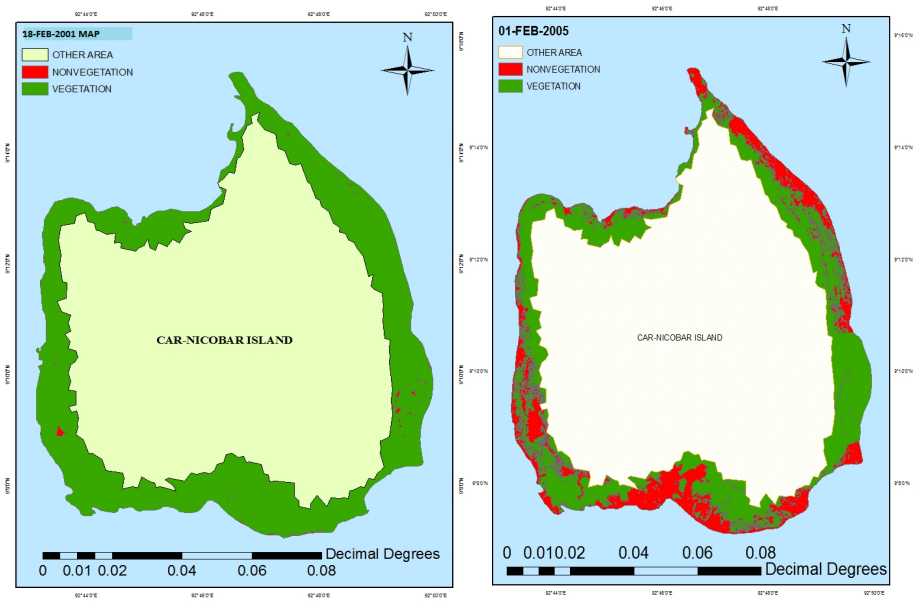

Fig: 6 the vegetation changes in hazard area (2001, left and 2005, right)

Conclusions

The techniques and the data used in the current study feasible in understanding the hazard assessment of 2004 tsunami. The current approach is able to provide an overview on the tsunami hazard and generate the maps in minimum possible time based on the tsunami numerical model. Further efforts were made to decipher the changes in vegetation and shoreline using the multi-temporal satellite data. The maps produced in current study helps in understanding the coastal vulnerability due to tsunami and thereby aid in disaster management plans for the Car Niccobar Island. The present study has been carried out based in the data availability and the study could have been improved by using the high resolution topography and multi-temporal satellite data.

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COASTAL CLIFFS AND THE STABILITY OF THE SOUTHWEST COAST OF INDIA

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Abstract

In Earth System Science (ESS), a cliff is a significant vertical, or near vertical, rock exposure. Cliffs are formed as erosion landforms due to the processes of erosion and weathering that produce them. Cliffs are common on coasts, in mountainous areas, escarpments along rivers and around closed water bodies. They are usually formed by rock that is resistant to erosion and weathering. Their steepness causes them to be so narrow in plan that they make up only a very small area compared with the areas of the plateaus, hills, or mountains that they separate from the ocean. Nevertheless, sea cliffs are ubiquitous, occurring along nearly 80% of the ocean coasts of the earth and at all latitudes. Rock formations of varyingage, fromPre-Cambrian to Holocene, outcrop on the world'scoastlines, but most cliffs have been shaped during Pleistocene and Holocene times, mainly the past 9,000 years, when the sea has stood at or close to its present level.Some cliffs have been produced by uplift ofthe land margin as the result of faulting; othersfollow fault lines, but are partly or wholly the outcome of differential erosion, where faulting has placed weak rock formations (ex: laterite) alongside resistant rocks. A steep cliff coast produced by faulting, where the sea ward slope coincides with the plane of the fault, along which the land has been raised, is termed a fault coast: a tectonic feature known as a fault scarp. Some coasts were initiated as fault coasts, but have been cut back by marine erosion and now stand landward of the fault. Now these cliff under goes erosion, slumping and sliding; and are common phenomenon seen on permeable cliff shorelines of the world and Indian coasts of this are of no exception. These cliff shorelines and their adjoining beaches are one such area, which needs attention. However, very little studies are available on the proper documentation of these permeable cliffs and their vulnerability for appropriately utilizing them for coastal protection and developmental activities. The present study documents the cliff shorelines and their vulnerability between Kanniyakumari and Mangalore in the south west coast of India with the effective utilization of Remote Sensing Data in conjunction with GPS and GIS. The geomorphological mapping revealed that 82.25 km cliff shoreline is available between Kanniyakumari and Mangalore. These cliffs has been further classified into very stable, moderately stable, stable, unstable & very unstable depending on their vulnerability (tectonic activities, geotechnical properties, weathering processes, climatic factors and human interference). "Cliff Shoreline Map" for the Vettur – Varkala – Edava region has been prepared in detail for its effective use in the Geological Park which is being envisaged at Varkala. The results derived for the entire 700 km coastline from this study may be of help for CZMA, SDMA as well as other agencies of both State/ Central Governments and Non-Governmental, interested in the coastal protection and other different developmental activities in the coastal zone of Kannyakumari-Mangalore sector in the south-west coast of India.

Key words
Coastal Landslides, Geomorphology, Stability, Landuse Control Plans, Stability

Introduction

In Earth System Science, a cliff is a significant vertical, or near vertical rock exposure. Cliffs are formed as erosion landforms due to the processes of erosion and weathering and are common on coasts, in mountainous areas, escarpments and along rivers. They are usually formed by rock, soft and hard, resistant to erosion and weathering. Sedimentary rocks are most likely to form sandstone, limestone, chalk, and dolomite where as Igneous rocks, such as granite and basalt also often form cliffs. Laterite Coastal Cliffs are also common in many parts of the world. Steep rocky coast rising almost vertically above sea water is called Coastal Cliff. The steepness of true vertical cliffs depends on variations of lithology, geological structure, relative rate of sub-aerial weathering, erosion of cliff face and marine erosion of cliff base (Singh, 2008). These not only border ocean coast but also lakes and other smaller water bodies. Coastal cliffs are ubiquitous, occurring along nearly 80% of the ocean coasts of the earth and at all latitudes (Emery and Kuhn, 1982; Bird, 1969 & 2000).

The Indian coastline is about 7517 km, of which 5423 km along the mainland and 2094 km along the Andaman-Nicobar, and Lakshadweep Islands. The coastline comprises of headlands, promontories, rocky-cliff shores, sandy spits, barrier beaches, open beaches, embayment, estuaries, inlets, bays, marshy land and offshore islands. The Indian mainland consists of nearly 43% sandy beaches, 11% rocky-cliff coast, 36% mud flats and 10% marshy coast (Kumar *et al*., 2006). Shoreline fluctuation along the Indian coast is seasonal, largely depending on

South West and North East Monsoons. Some of the beaches regain their original profiles by March/April. Fifty per cent of the beaches that do not regain their original shape over an annual cycle undergo net erosion. At present, about 23% of shoreline along the Indian main land is affected by erosion resulting loss of life and property of the people, who dwell, in some parts of all these coastal states. Government of India and the respective state governments may take necessary protective measures in all these areas, however, more detailed micro-level studies are necessary to find short/long term solutions to coastal cliff erosion and related problems.

Cliff erosion/sliding and slumping (coastal landslides) are common phenomenon seen on cliffed coastlines of the world and Indian coasts are of no exception. These cliffed coastlines and their adjoining beaches are such areas, largely inhabited by people who depend up on fishing as their livelihood measure. These areas also attract large number of domestic and foreign tourists. South West coast of India is highly privileged by these unique natural beauty and geographical setting. Even though large number of studies related to coastal erosion is available in India, very little attempts are made on coastal landslides. Hence documentation on coastal cliffs, their characteristics and vulnerability to coastal landslides needs to be attempted in detail. Isolated studies on the Cliff slumping of the permeable cliffed shorelines (Nair, 2005 & 2008), distribution of coastal cliffs in Kerala (Kumar, *et al* 2009), delineation of coastal cliff, their characteristics and their vulnerability between Kanyakumari and Mangalore (Nair and Ramachandran, 2010, 2011 & 2012), confining to the South West Coast of India, however, studies on other parts of Indian coast is lacking.

State of art

International. Research studies of this nature have earned international importance as they bestow light on management and sustainable development of this type of coastal sensitive ecosystem, resource sharing, bettering quality of life of the people and meeting the needs of the present and future generations. Coastal cliffs are steep slopes that border ocean coast, lakes and other small water bodies. Although most of Coastal Cliffs are nearly vertical and composed of bedrock, there is a wide range of cliff types, depending on material, morphology, and relief. Material variations within or among coastal cliffs often are reflected in morphologic variations. On global and regional scales, coastal morphology often correlates closely with tectonic setting (Inman and Nordstrom, 1971). Nevertheless, coastal cliffs are ubiquitous, occurring along nearly 80% of the ocean coasts of the earth and at all latitudes (Emery and Kuhn, 1982). Large number of studies on coastal landslides/slumping has been reported world over (Cambers, 1976; McGreal, 1979; Buckler and Winters, 1983; Sunamura, 1983; Suwardi and Rosengren, 1983; Tanaka *et al*. 1993; Isobe, 1994; Moon and Healy, 1994; Mimura *et al* 1996; Lee, 1997; Hutchison *et al*. 1998; Mitas and Mitasova, 1998; Wilson and Lorang, 1999;Woodroffe, 2002; Hall *et al*. 2000a, 2000b; Lee and Jones, 2004, Hampton and Griggs, 2004, Greenwood and Orford, 2007).

The cliffs that rise from the back of shore platforms are commonly called wave-cut cliffs, but, as with any sub-aerial escarpment, mass wasting is the dominant process of cliff retreat (Johnson, 1972; Bloom, 2003). If the marine erosion at the base of cliff is much faster than the sub-aerial weathering of cliff face and crest, overhanging cliff with steep vertical face is formed, on the other hand, if sub-aerial processes dominate over marine processes the verticality of cliff disappears and the cliff loses its true cliff character (Singh, 2008). Climate has been an important influence on the weathering of coastal rock outcrops, which results from physical, chemical and biological processes, related partly to sub-aerial conditions and partly to the presence or proximity of the sea. Rock debris falls to the cliff base as talus, which must be consumed or removed by wave action if cliff recession is to continue (Bird, 2008). Cliff retreat produces a mesa, which is a table topped plateau bordered on all sides by cliffs (Strahler and Strahler, 2009).

Extensive reaches of eroding bluffs occur only along the inland shores of estuaries, such as the Calvert Cliffs of Chesapeake Bay (Wilcox *et al*. 1998; Ward *et al*. 1989). Tectonic uplift along the coasts of California and Oregon has preserved older, degraded wave-cut platforms (uplifted or emergent marine terraces) with their abandoned sea cliffs, at present elevations of up to several hundred meters above sea level (Bradley and Griggs, 1976). There are high cliffs around the British Isles, as well as in northern France, southeastern Australia, and eastern Canada (Kelley *et al*. 1989; Kelley and Dickson, 2000). The majority of cliffs along today's coastlines are relatively young geologic features, having formed after the most recent ice age—the Wisconsinan stage of the Pleistocene epoch—or during earlier Pleistocene transgressions (Minard, 1971). These global events were imposed on a variety of regional geologic frameworks and processes, resulting in a substantial diversity of cliffed coastlines. Coastal cliffs carved into glacial till or alluvium typically consist of relatively weak gravelly, sandy, and muddy sediment that is particularly susceptible to erosion. As the ice retreated across the Maine coast about 14,000 years ago, the ocean flooded the coastal lowlands, mantling them with glacial-marine mud (Dorion *et al*. 2001). Later, the land rebounded upward, and relative sea level fell locally to a low-stand about 60 m below present. Relative sea level has risen since then, with consequent erosion of sea cliffs, as a result of land stability and eustatically rising ocean waters (Barnhardt *et al*. 1997). Marine erosion at the toe of the coastal slope erodes bedrock, removes fallen debris, steepens the coastal slope and produces instability that results in persistent recession (Bray and Hooke, 1997). Cliff factors (geology, hydrology and profile geometry) govern the sensitivity of the cliff to the perturbations at its toe. Self regulation by negative feedback is possible because recession may yield sediments that support, protect or load the toe. Hard rock coasts erode very slowly due to the constraining factors of material

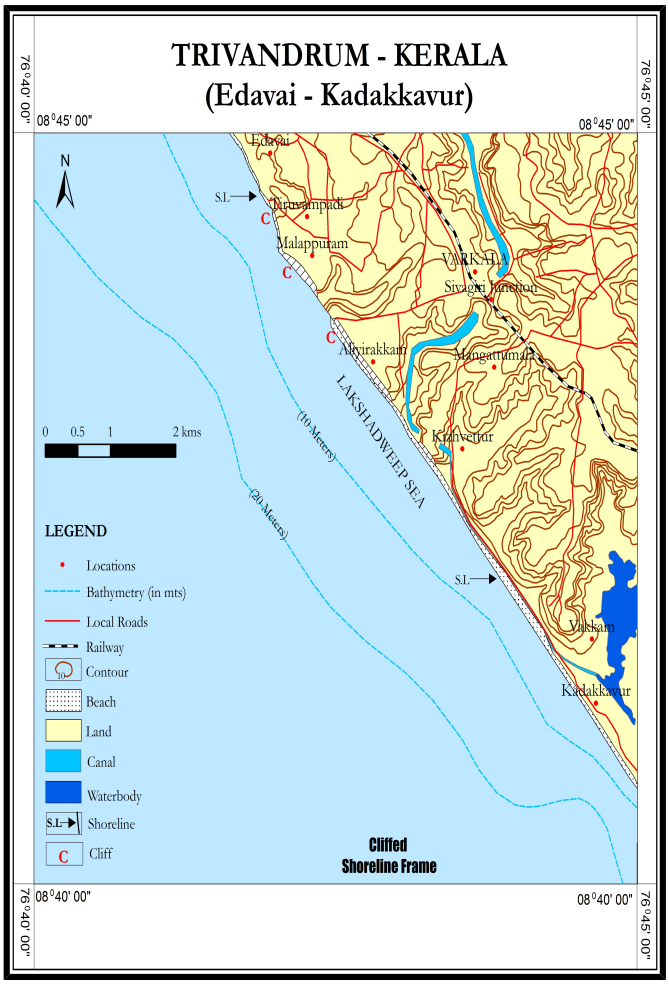

Fig.1: Map of the study area

Fig.2 Cliffed Shoreline between Edava and Kadakkavur

strength and rock mechanics. They should remain essentially stable as sea-level rises. By contrast, soft-rock cliffs are subjected to additional weakening by weathering and degradation by mass movements; these processes are likely to operate more rapidly in the wetter and warmer climate.

National. During the last three decades, many scientists in India have been extensively studying on the coastal process on the west coast and east coast and in the last two decades researchers are utilising Remote Sensing coupled with GIS technology on the different aspects on coastal environment (Nayak & Sahai, 1985; Nair & Sankar, 1995; Bhat, 1995; Subrahmanya, 1992; Jayappa, 1996, Swamy *et al*. 2012) However, little attempts have been made to understand the coastal cliff's behavior and their sliding/slumping. Many uncertainties are highlighted in this review as serious obstacles to reliable prediction of future cliff recession. Cliffs in energetic open coasts environments with longer active profiles are shown to be more sensitive than those in more sheltered locations. Higher cliffs are more resilient against sea-level rise providing that their sediments are sufficiently coarse to remain stable on the active profile. The coastal areas of the southern part of the Indian peninsula are composed of either Precambrian crystalline and/or Tertiary formations with recent and sub recent sedimentary formations. Lateritic formations cover parts of shore north of Ponnani and south of Kollam. Bedrock outcrops can be seen all along the coast for short distances, between north of Kozhikode and Poovar, near Thiruvananthapuram (Nair & Ramachandran, 2010, 2011 & 2012). Shoreline erosion of Kerala coast is going on since centuries, causing loss of land (Moni, 1976). Cliff slumping of permeable cliffed shorelines of Varkala cliff in the southern part of Kerala has been examined and a Landuse Control Plan (LCP) has been developed for stabilization of the cliff (Nair, 2002, 2003, 2005; Nair *et al*. 2006; Nair, 2008 & 2009). Hence coastal protection is a must in these affected beaches where remedial measures like construction of walls, groins of different length and spacing is necessary (Kumar *et al*. 2009). At places where natural sand is not sufficient, beach sand nourishment is required. Sand dunes act as barrier only for normal stones, tides and waves. Suitable stabilization measures by fencing and plantation of vegetation should be under taken to hold the sand which will otherwise migrate. The main causes of coastal

erosion in west coast of India may be due to (i) onslaught of the monsoon, (ii) geological factors, (iii) sea level rise, (iv) level of backshore, (v) occurrence of Mud banks (mostly restricted to Kerala Coast), (vi) lack of littoral supply, (vii) uncontrolled river outlets and (viii) lateritic cliff erosion. For example, there is laterite cliff erosion in certain areas north of Tellichery and south of Quilon (the constant wave attack undermines the base of the cliff, the slope becomes unstable and finally a sliding type of failure occurs). The problem of incoming incident surface water waves normally incident against a vertical cliff was examined by Chakkrabarti and Sahoo (1997). Assuming there is no reflection of these waves, a source or sink type behaviour at the shoreline was introduced, to account for the fact that the wave amplitude remains finite at the origin.

Methodology

The present study area covered between Kanniyakumari (latitude 8^0 03' 00", longitude 77^0 34' 00") and Udiyavara near Mangalore (latitude12^0 45' 00", longitude 74^0 52' 00"), a total coastline of about 700 km in the south west coast of India (Fig.1). Geomorphological mapping of the cliffed shoreline and their vulnerability for sliding/slumping has been carried out through extensive field surveys and effectively utilizing satellite remote sensing data in conjunction with GPS and Arc GIS. Survey of India Topographical Maps on 1:25,000 scale, along with IRS LISS III imageries and Google Images has been used for the preparation of 'Cliffed Shoreline Map" of the area covered by each of the Topographic Maps. Cliffed Shoreline areas covered 19 Topographic Maps and prepared an "Atlas of Cliffed Shoreline between Kanniyakumari and Managalore". Classification on the Stability of these Coastal Cliffs have been arrived by documenting data on 13 parameters; tectonic activity, earthquake frequency, geotechnical properties, weathering processes including physical/mechanical, chemical and biological; climate factors like temperature, pressure, rain, wind, waves and tides along with human interference.

Results and discussion

Mapping of the Coastal Cliffs along with Coastal Geomorphology revealed a large number morphological units including Stacks, Beaches, Coastal Land, Streams (perennial and non-perennial), Rivers, Shoreline, Inlets, cliffs (permeable and impermeable) etc between Kanniyakumari and Mangalore. The results have been summarized into 34 permeable shoreline maps and 19 impermeable (cliffed) shoreline maps. Cliffed Shoreline between Edava and Kadakkavur (Fig.2) and Cliffed Shoreline between Tellicherry and Rayarangoth (Fig.3) as selected results for this publication. The mapping revealed a cumulative length of 82.25 km cliffed shoreline present between Kanniyakumari and Mangalore (Table 1). The stability of Cliffed shoreline have been classified into Very stable, Moderately stable, Stable, Unstable & Very unstable (Table. 2). Also the Varkala Cliff has been examined in detail on its slumping behaviour. Coastal cliffs can be unstable due to the combined effect of several factors; (i) erosion of the foot of the cliff caused by wave action and storm surge and (ii) sliding or weathering of the slope due to geo-technical instability. The erosion of the foot of the cliff normally initiates geo-technical instability, but the sliding/collapse can be of different nature depending on the geo-technical conditions of the slope. The upper regions of the cliff break unevenly with very large boulders sitting right from the surf zone to the high water and the storm elevated levels. These Cliffed Shoreline has been classified into Very stable, Moderately stable, Stable, Unstable & Very unstable as given in the map on Classification of Shoreline stability between K'kumari & Kollam, SW coast of India (Fig.4) is listed below:

VERY STABLE : Free from tectonic forces, climatic factors including waves and tides – Climatic factors have less influence which results in – No Weathering – less impact of geotechnical properties due to less influence of waves and tides – least human influence.

MODERATELY STABLE : Minor tectonic activity can cause minor imbalance on cliffs – Due to varying climatic conditions weathering process can have moderate effect – Geotechnical properties may be moderately influenced due to minor fractured and joints – No such human disturbances.

***STABLE*:** Less tectonic activity and moderate tremors makes the rock fractures and faults react with chemical weathering - High temperature leads to expansion of rocks - Climatic factors are moderately influenced - Geotechnical properties have less impact - Waves and tides action is moderate - Moderate human influence.

UNSTABLE : Unstable cliffs tend to break down due to tectonic activity - Geotechnical properties influence is high due to unstable cliff - Possibility of considerable chemical action at water level on limestone and related rocks - High influence of climatic factors results in weathering of rocks - Tidal influence is high along the surface of cliff and the planes of weakness - Human activities are more.

VERY UNSTABLE : Regions with high tectonic activity and very high tremors leads to male the rock disintegrated due to its instability - Permeable cliff with high porosity makes it very unstable - Climatic factors are very actively influenced which leads to very high impact of weathering - Geotechnical properties influence is very high - Waves and tides impact is very high - Human activities are also very high.

Table 1: Cliffed Shorelines – Kanyakumari to Mangalore

Sl. No.	Latitude	Longitude	Coastal Area	Cliff (Km)
1	$8^0$03'00" – $8^0$05'00"	$77^0$34'00"- $77^0$30'00"	Kaniyakumari, Kanniyakumari – Kovalam	2
2	$8^0$08'00" – $8^0$09'00"	$77^0$19'00" – $77^0$18'00"	Tamarakulam,Periyakattuturai, Ganapatipuram,Kolachel	4.5
3	$8^0$11'00" – $8^0$12'00"	$77^0$15'00" – $77^0$13'00"	Kodimurai, Kurumpanai, Midalam, Tangapalam	4.5
4	$8^0$21'30" – $8^0$22'30"	$77^0$01'00" – $77^0$00'00"	Manjatappu, Pozhiyur, Puvar, Adimalatura, Chovvara,, Vizhinjam	3.25
5	$8^0$22'30" – $8^0$23'30"	$76^0$59'00" – $76^0$58'30"	Kochuvelli, Valiatura, Vazhamuttam Vizhinjam	4
6	$8^0$40'30" – $8^0$45'00"	$76^0$45'00' – $76^0$41'30"	Kadakkavur, Vakkam, Kizhvettur, Tiruvampadi, Edavai	10
7	$11^0$09'30" $11^0$10'00"	$76^0$48'30"– $76^0$49'00"	Kadalundi, Beypore, Nagaram, Kozhikode	2
8	$11^0$26'30" – $11^0$28'00"	$75^0$40'30" – $75^0$37'30"	Kappad, Tuvappara, Mannamancalam, Vellarakad, Vimangalam, Kadalur	8
9	$11^0$28'30" – $11^0$30'00"	$75^0$37'30" – $75^0$37'00"	Mudadi, Tikkodi, Trikottur	4
10	$11^0$42'00" – $11^0$45'00"	$75^0$32'00"– $75^0$28'45"	Rayarangoth, Uralungal, Madakkara Mahe, Tiruvangad, Tellicherry	8.5
11	$11^0$54'30' – $11^0$55'00"	$75^0$18'00"– $75^0$18'30"	Padannapalam, Aramkottam, Minkunnu Azhkkal, Mattul North	2
12 (i)	$11^0$45'00" – $11^0$47'00"	$75^0$28'45" – $75^0$27'00"	Tellicherry, Chettamkunnu, Dharmadam	8
(ii)	$11^0$48'30" – $11^0$51'30"	$75^0$26'00" – $75^0$22'30"	Kizhunna, Kadatayi, Marakkarakandi	9
13	$11^0$51'30" – $11^0$52'00"	$75^0$22'30"– $75^0$21'00"	Ayikkara, Barnnasseri, Cannanore Payambalam	4
14	$12^0$01'30" – $12^0$00'15"	$75^0$13'30" – $75^0$12'00"	Mattul, Vadikkal, Mattambram, Chuttad Ezhimala, Taikadapuram, Trikkaripur South	4
15	$12^0$23'30"– $12^0$25'00"	$75^0$02'00" – $75^0$01'30"	Totti, Bekal, Kappil, Chattankai	4.5

Table 2: Classification on the Stability of Coastal Cliffs

CHARACTERISTICS		VERY STABLE	MODERATELY STABLE	STABLE	UNSTABLE	VERY UNSTABLE
TECTONIC ACTIVITY		-NIL-	RELATIVELY LESS	LESS	MODERATE	HIGH
EARTHQUAKE		LESS	RELATIVELY LESS	MODERATE	HIGH	VERY HIGH
GEOTECHNICAL PROPERTIES		LESS	MODERATE	HIGH	HIGH	VERY HIGH
WEATHERING PROCESS	PHYSICAL/ MECHANICAL	NO IMPACT	LESS IMPACT	MODERATE	HIGH IMPACT	VERY HIGH IMPACT
	CHEMICAL	-NIL-	LESS IMPACT	LESS IMPACT	MODERATELY IMPACT	HIGH IMPACT
	BIOLOGICAL	-NIL-	LESS IMPACT	LESS IMPACT	MODERATELY IMPACT	HIGH IMPACT
CLIMATIC FACTORS	TEMPERATURE	LESS	RELATIVELY LESS	MODERATE	HIGH	VERY HIGH
	PRESSURE	LESS	LESS	MODERATE	MODERATE	HIGH
	RAIN	LESS	LESS IMPACT	MODERATE	HIGH	VERY HIGH
	WINDS	-NIL-	LESS	LESS	MODERATE	HIGH
	WAVES	LESS IMPACT	LESS IMPACT	MODERATE	HIGH	VERY HIGH
	TIDES (Micro)	LESS IMPACT	LESS IMPACT	MODERATE	HIGH	VERY HIGH
HUMAN INTERFERENCE		NO IMPACT	LESS IMPACT	MODERATE	HIGH	VERY HIGH

(Source: Nair & Ramachandran, 2010)

Varkala cliffed shoreline

Cliff erosion and slumping is a common phenomenon seen on the permeable cliffed shoreline of Varkala, located in the sea coast of Papanasam, about 43 km north-west of Thiruvananthapuram, Kerala State, in the south-west coast of India. The erosional status briefly states that the upper regions of the cliff breaks unevenly with very large boulders sitting right from the surf zone to the high water and the storm elevated levels, highlighting the disastrous risk involved in life and property of the people. Cliffed shoreline Map of Edava - Kadakkavur (Fig.2) covers this famous Varkala beach, backed by seven km long Varkala Cliff with a gap of less than 25 m in the middle subjected to different forces like waves, winds and rains during south-west and north-east monsoons (Nair, 2005). This is a geological type cliff section for the Warkalli beds, belonging to the Tertiary sediments in Kerala. This cliff sequence with Laterite of about 35 to 40 ft on the top followed by Sand, Sandy clays or Lithomarge of 58 ft, Alum of clays 25 ft, Lignite beds and sand of 7 to 15 ft in the cliff toe, totaling to about 120 to 138 ft (40 to 50 m) in height (King, 1882). Field and laboratory studies revealed that the laterities of the Varkala Cliff is very hard and porous (Nair 2005). The soils in the southern cliff are in a loose state than that of northern cliff as they have lower values of dry densities. It has also been found that the natural water content of the samples taken from the southern cliff is higher than that of the northern cliff; however, the specific gravity of all samples falls in the normal range. Studies on Atterberg limits classifies the soil according to their plasticity indices and these soils are ideally non-plastic or low plastic soils and the permeability tests shows that most of the samples are semi-pervious or impervious. It is interesting to note that initially cracks were developed in the top lateritic layers of the cliff which may be due to the presence of weak planes or faults, water thrust, change in temperature, lightening and seismic shocks (Hansmann, 1990). The presence of small cracks is required for the initiation of failures. Water moving along these cracks erodes according to dispersibility of the soil and flow velocity. Tunneling has also been initiated in soils with a permeability as low as 10-5 cm/sec. It may also be noted that both cliffs consists of bottom white clay layer of about 3 m thickness.

Management plans for the varkala cliff section

In order to save the cliff top edges from slumping or sliding, the following five action plans have been suggested for its immediate implementation (Nair, 2005 and 2009). (i) Bio-fencing may be provided for a suitable distance (at least 5 m) from the cliff edge; (ii) Walk-way/foot-path may be planned for 2 m width from the eastern side of the bio-fencing; (iii) Pavements (non-metled path) of suitable width (at least 3 m) be designed, so that auto-rickshaws may be used; (iv) A suitable buffer zone be demarcated further on the eastern side of the pavement (75 – 100 m) for all future developments like Coastal Geological Museum or a Geopark etc. and (v) Suitable water drains be designed depending upon geo-technical properties of different layers in the cliff section similar to the already existing five water pipes (two at the north cliff toe and three on the south cliff toe). The water thus derived may be utilized for recreational purpose. The Thiruvananthapuram Tourism Development Council partially attempted, however lack of continued management, there was little success for containing the cliff top edges from slumping. For stabilization of the cliff, three stage action plan has been proposed; (i)Terracing in the cliff section has to be designed based on the geo-technical properties of the different layers; (ii) Artificial generation of beach

in the toe region of the cliff by beach nourishment, submerged breakwater and other required location specific coastal engineering structures; and (iii) Two small streams presently flowing through the beach may be diverted to the big pond which is located in the backshore. The Irrigation Department of the Government of Kerala did make some attempts on the report submitted by Nair *et al*. 2006, with little progress. Now the Government of India and Government of Kerala together have shown interest in developing a "Geopark" in this area. This particular area is within the CRZ Act (KSCZMA) and a disaster prone (KSDMA) area, it is suggested that if all the interested parties of both State and Central Agencies join together to formulate "An Integrated Coastal Zone Management Plan for Vettur-Edava of Varkala Muncipality Area (ICZMP-V)". All the developments envisaged including "Geopark" could be brought within this ICZMP-V and once this ICZMP-V fulfill its task, Vellur-Edava area may be developed in to an International Tourism Centre which will help the local people for their livelihood as well as benefit to the Government of Kerala.

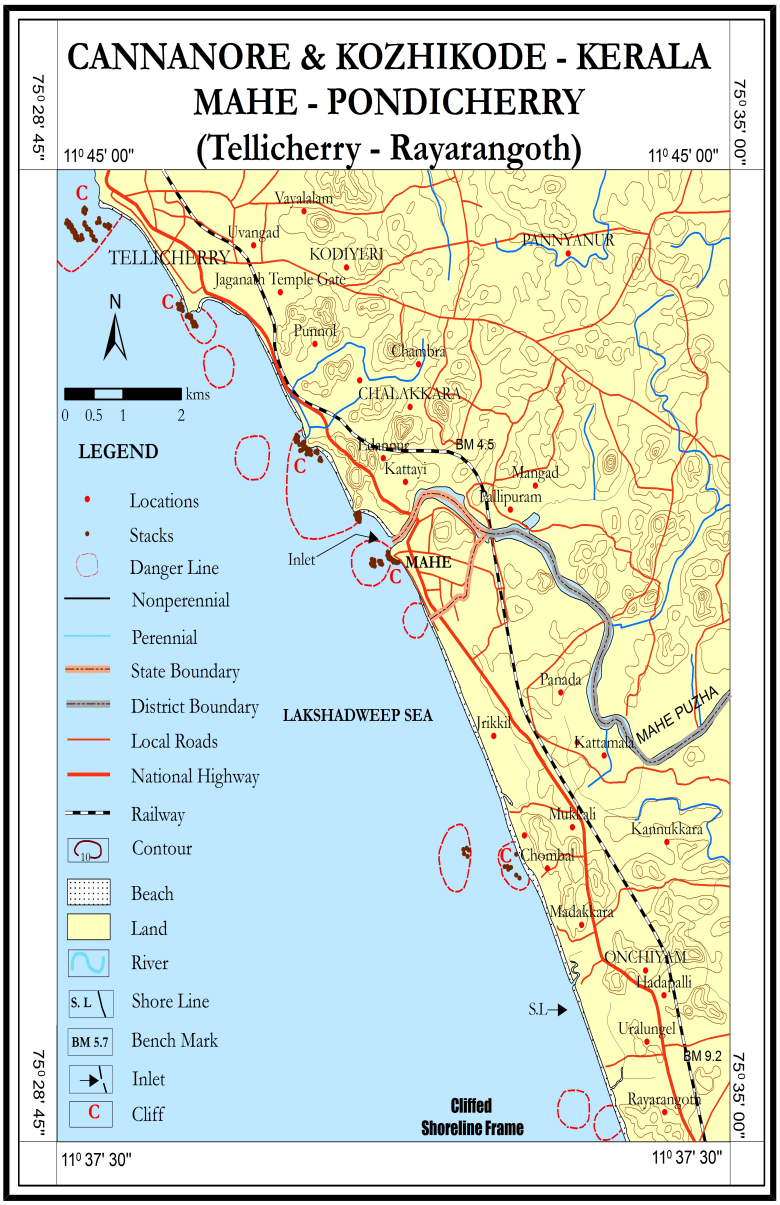

Fig.3 Cliffed Shoreline between Tellicherry and Rayarangoth

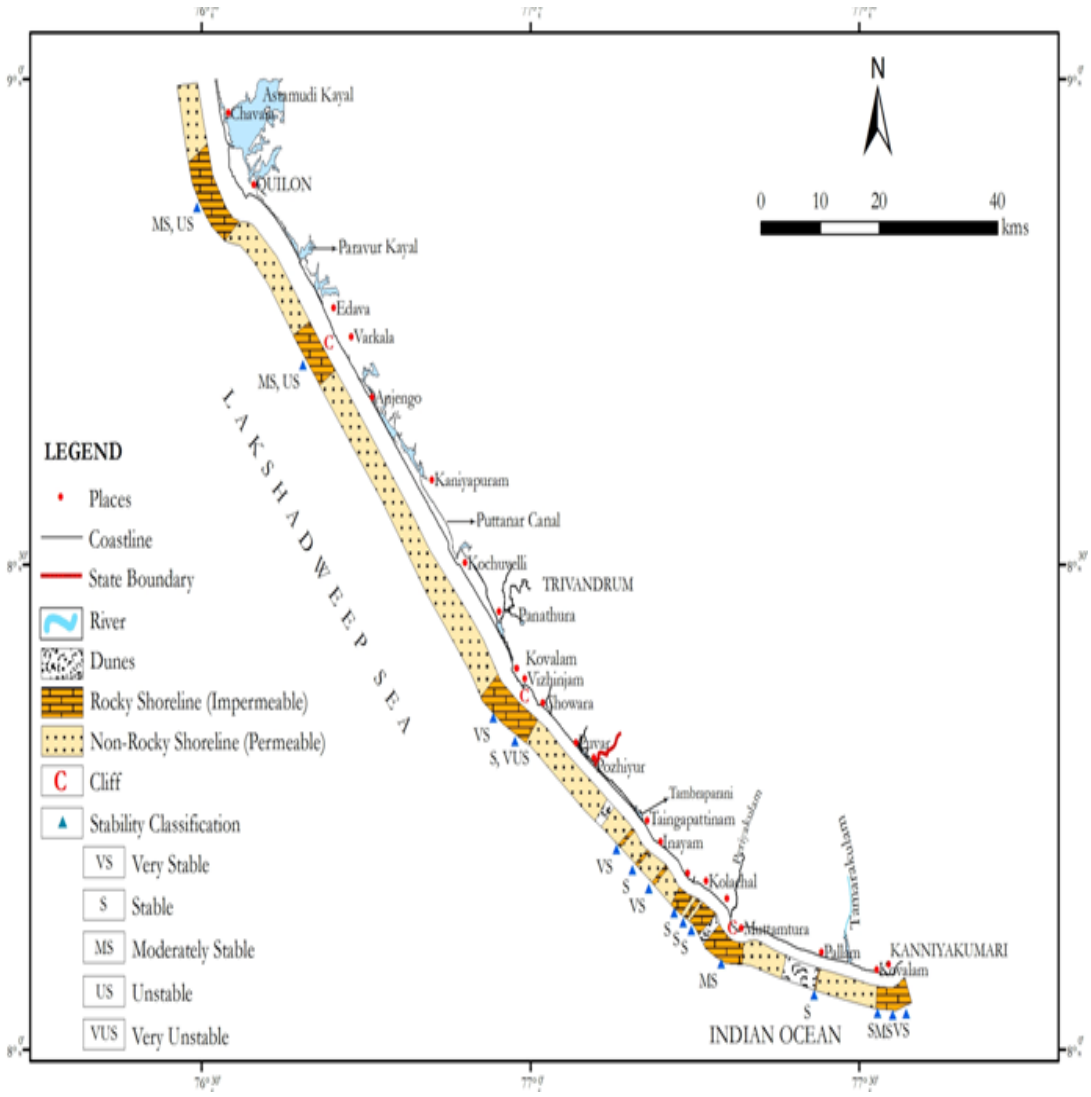

Fig.4 Classification of Shoreline stability between K'kumari & Kollam, SW coast of India

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CHEMICAL & INDUSTRIAL DISASTERS

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Abstract

With globalization and industrial growth, there are emerged a quantum jump in chemical production, handling and transportation of hazardous chemicals across the globe, which is associated with a non speculative rises of fire, explosion, toxicity, environment pollution, etc. such disasters which occurred in past worldwide are eye openers. Chemicals disasters are always man-made. Unlike emergencies caused due to natural disasters which are difficult to prevent, industrial and chemical accidents can be prevented and their impacts minimized by better planning, preparedness and response. Advancement, transfer and sharing of knowledge are key foundation for disaster risk management. This paper reviews on the Bhopal gas disaster, also referred to as the Bhopal gas tragedy, was a gas leak incident in India, considered the world's worst industrial disaster & factors responsible & preventative measures to avoid such type of incidents.

Keywords

: Definition, Indian industrial disasters scenario, Bhopal gas tragedy, Preventative Measures

1. Introduction

Major industrial chemical accidents are low frequency, but highly significant events in terms of loss of lives, injuries, environmental impact and material damage. These accidents may occur in industrial process, energy-related and transport activities. They are generally associated with either large inventories of flammable, explosive, or very reactive substances or of common toxic chemicals in process industries or smaller quantities of very toxic and persistent chemicals. Chemical accidents involve a series of events starting with a technical breakdown or human error initiating uncontrollable physico-chemical phenomena, such as runaway chemical reactions, fires and explosions. These events are followed by propagation beyond the plant boundaries of toxic compounds in gaseous or liquid phase or as particulates. Human beings and non-human targets may suffer injury from acute and/or residual exposure in the form of immediate, acute effects or long-term consequences.

2. Some major disaster globally

***2.1 Chernobyl disaster**:* April 26, 1986. At the *Chernobyl nuclear power plant* in *Prypiat*, *Ukraine* a test on reactor number four goes out of control, the resulting in a nuclear meltdown. The ensuring steam explosion and fire killed up to 50 people with estimates that there may be between 4,000 and several hundred thousand additional cancer death over time. Fallout could be detected as far away as *Canada*. The *Chernobyl Exclusion Zone*, covering portion of *Belarus* and *Ukraine* surrounding *Prypiat*, remain contaminated and mostly uninhibited.

***2.2 Fukushima I nuclear disaster**:* - March 2011. Regarded as the largest nuclear disaster since the *Chernobyl disaster*, there were no direct deaths but a few of the plant workers were severely injured or killed by the disaster conditions resulting from the earthquake.

3. Major disasters in india

3.1 Bhopal gas tragedy: December 3 1984:- The *Bhopal gas Disaster* in *India* is one of the largest industrial disaster on record. A runaway reaction in a tank containing poisonous methyl isocyanate caused the pressure relief system to vent large amounts to the atmosphere at a *Union Carbide India Limited Plant*. Estimates of its death toll range from 2,000 to 20,000. The disaster caused the region's human and animal populations severe health problem to the present.

4. Prevention of major industrial accidents/disaster:-

4.1. Safety systems

All major hazard installation should be equipped by works management with safety system, the form and design of which will depend on the hazards present in the installation.

To prevent deviation from permissible operating conditions, works management should provide the major hazard installation, as appropriate, with:

Sensors and controllers to monitors temperature, pressure and flow, and to initiate action such as emergency cooling, etc;

Protective measures should be taken by works management to limit the consequences of an accident. Such measure may be include:-

Water spray system (to cool tank or to extinguish a fire);

Water jets;

Steam-spray system;

Collecting tanks and bunds;
Foam generating system;
Detector generating system.[1]

4.1 Inspection, maintenance and repair

Taking into account the contribution of the workers familiar with the installation, works management should draw up a plan for the inspection, maintenance and repair of the major hazard installation.

For repair work, strict procedure should be specified for carrying out any tasks involving hot works, opening of normally closed vessels or pipelines, or work which could compromise a safety system or which involve any change in design or component quality. These procedures should cover the qualifications required by personnel, quality requirements for the work to be performed and requirements for the supervision of repair work.

Requirements specified in national or international recognized standard or practices for inspection and repair work should be considered by works management as minimum requirement for major hazard installations.[1]

4.2 Training of workers

The overall safety measurements and major hazard installation should recognize that the human factor is critical to the safety of the installation. Therefore, works managements should adequately train workers in the safe operation of the major hazard installation. For new installation, this training should take place before start-up. Necessary facilities for such training should be provided by works management.

The training should include, but should not be limited to, such topics as:

Broad understanding of the overall process used in the installation;

The hazards of the process and the substance used, and precaution to be taken;

Process control and monitoring of all operating condition, including those at start-up and shut-down;

Emergency procedure exercises;

Safety training for workers by work management should be continuous process. Training session should be repeated at regular intervals under condition as near to reality as possible. The effectiveness of safety training should be assessed and training programs reviewed in co-operation with workers and their representatives. [1]

4.3 Alarms and communication

Works management should inform all workers of the procedures for raising the alarms to ensure that the earliest possible action is taken to control the situation.

Works managements should consider the need for emergency alarm system, depending on the size of the installation.

Where an alarm system is installed, there should be an adequate number of points from which alarm can be raised.

In area where there is a high level of noise, works management should consider the installation of visual alarm to alert workers in those areas.[1]

4.4 Emergency control centre

The centre should be equipped to receive and transmit information and direction from and to the site incident controller and other areas of the installation, as well as outside.

Where applicable, the emergency control centre should contain, for example:

An adequate number of both internal and external telephones;

Radio and other communication equipment;

Equipment for measuring and indicating wind speed and direction;

List of local authorities and emergency services with addresses and telephone numbers.[1]

5. Bhopal gas tragedy

5.1 Introduction

Bhopal gas tragedy, the worst industry disaster in history, is especially significant in generating the environmental revolution by triggering the mechanisms to prevent or contain hazards in works or living environment that otherwise may need vulnerable land-uses and result in measures disasters. In essence, about 41 metric tons of methyl isocyanate was released from the Union *Carbide India Limited (UCIL)* pesticide plant in *Bhopal* just after midnight on December 3, 1984. This gas spread slowly southward from the plant site during the early morning hours with very stable weather conditions. Of the 900,000 population within the city, over 200,000 people were exposed to MIC tainted air. Documented death counts are listed at 3,787.The number of undocumented deaths will never be known, but estimates are over 10,000. Chaos surrounded the city afterwards. Thousands panicked. The event that caused the release was traced to a runaway reaction created by the contamination of a storage tank of methyl isocyanate with a substantial amount of water. A water curtain spray designed to mitigate releases did not reach the elevation of the release plume. Thus, MIC exited at an elevation from ground level of approximately 35 meters for a period of 15 to 30 minutes. The cloud then descended to ground level (MIC gas is approximately 2 times as dense as air), infiltrating the surrounding residential areas (illegal shanty towns), and flowing slowly towards the center of *Bhopal*, located about 2 km to the south [2].

5.2 Cause

5.2.1 Faulty location. The *UCIL plant* was built on the outskirts of the city barely one km from the *railway station* and 3 km from two major hospitals, *Hamidia* and *Sultania*. This was done against the advice of authorities. [3]

5.2.2 Careless handling of MIC. MIC was stored in three tanks, each with a capacity of 15,000 gallons. All three tanks were in use. It is expected that one tank will be kept free for emergency purposes. It is expected that tanks should be no more than half full; however, prior to the fateful night in *Bhopal*, the Tank 610 was 87% full, which is far above the recommended capacity of 50% at the West Virginia plant and the 60% specification for the *Bhopal plant* (*Diamond*, 1985; *Reinhold*, 1985; *Varadarajan*, 1985). [4] The *Union Carbide* manual (Union Carbide, 1978) specifies that the alarm should respond when- ever the temperature goes above 11°C; in *Bhopal* it was set at 20°C. Most evidence suggests that MIC in the *Bhopal plant* was generally at or above 15°C.

5.2.3 Failure of safety devices. The scrubber and flare tower, which at their best could handle minor leaks, were nonfunctional at the time of the accident. The scrubber, if functional, can neutralize MIC entering at 90 kg/hour at 35°C and a maximum pressure of 15 pounds per square inch (psi); the pressure at which MIC escaped was approximately 200 times higher at 6 to 10 times the desired temperature. Similarly, the flare tower can only burn miniscule amounts of MIC. The third main safety device, the water spraying system, was functional and turned on at 1:00 AM in the morning of December 3. [3]

5.2.4 Shoddy maintenance. There were serious lapses in the day-to-day operations. Some operators were high school graduates and brought from other plants. The staff was reduced from 12 operators, 3 supervisors, 2 maintenance supervisors, and 1 superintendent per shift to 6 operators, 1 supervisor, and no obligatory superintendent. The plant was not automated to monitor leaks, which used to be detected by workers by irritation of eyes and throat. No effective public warnings system was installed. The alarm was similar to those sounding for various other purposes.[3]

5.3 Impact

The immediate effect of the poisonous gas was irritation in the eyes and difficulty in breathing. By early morning on December 3, 1984, streets were littered with dead or dying humans, buffalos, cows, dogs and other animals. Those who could manage were rushing to the hospital. Deaths within the first 4 days of the leak were caused by pulmonary edema [3]. Voluntary agencies working in *Bhopal* reported nearly 200,000 affected people and about 50,000 seriously affected. Breathlessness, sleeping and digestion problem were reported to be so acute in 5,000-10,000 people that they were incapable of performing even light physical labour and would probably never be able to earn a living[4].

5.4 Measures to prevent another Bhopal gas tragedy

Highly toxic substance should be ban.
All Technologies which are not proved to be safe should stop transferring.
Impose strict on pollution.
Regulate industry for safety

Conclusions

Based on the aforesaid discussion and data this can be concluded that to prevent Chemical Disaster Safety Audit plays an important role in chemical complex and subject each area of plant activity to a systematic critical examination with the object of minimizing loss. Chemicals are boom for boosting for prosperity and quality of human life however if not manage proper without understand them chemicals can be ban.

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NANOTECHNOLOGY AND SUSTAINABLE CONSTRUCTION

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Abstract

Nanotechnology is anticipated for its sustainability, lesser related to the construction sector. The key aspect in the early development and application of sustainable nanotech solutions in the construction sector is nanoconstruction. This paper provides a framework for addressing relevant issues of green nanoconstruction, considering current challenges. Sustainable nanoconstruction has the potential to simultaneously enhance the competitiveness and climate potential as a key strategic factor for the sector ahead. However, the considerable lack of knowledge on eco-opportunities and risks of nanoconstruction and the industrial dynamics involved forms a serious barrier in business and policy for pursuing nanoconstruction as a serious strategic target.

1. Introduction

Despite the enormous and still rising research and development (R&D) investments in nanotechnology worldwide, nanotechnology is still at an early formative stage of development; much nanoscience is still pre-commercial [Aitken. R.J., et. al. (2006), BMBF (2004), Build-NOVA (2006), Luther. W (2004), Lux Research (2004), Nanoforum (2003)]. The hype (extensive focus, debate and phantazising) related to nanotechnology is considerable, with grand expectations of nanotechnology to restructure the world atom by atom. There are especially high expectations to nanotech's eco-innovative (climate friendly, 'green') potential. It is difficult to find a nanoreport or policy document where major environmental benefits are not a main or important claim [EC (2004), Friends of the Earth Germany - BUND (2007), Lux Research (2004), NSET (2003), Schmidt. K.F (2007), Willems (2004), Wood. S., et. al. (2003)]. As the climate agenda is becoming increasingly important for the competitiveness and development of the construction sector, the "nanoconstruction" eco-innovative potentials are increasingly interesting. At the same time concerns regarding possible environmental and health risks related to nanotechnology are increasingly being addressed by policy makers, NGOs, and more lately also nanoscientists and companies and Aitken. R.J., et. al. (2006), Andersen. M.M., et. al. (2006), Arnall. A.H (2003), Colvin. V (2002), EPSTOAC (2007), Geiker. M.R., et. al. (2008), Kemp. R., et. al. (2004), [36] Royal Society (2004), and Willems (2004).

There are concerns, that regulation is lacking behind the rapid advances in nanotechnology and a precautionary principle is called for by the European Commission (2008). Andersen. M.M., et. al. (2006) unfolds overall still much uncertainty both as to the environmental risks and opportunities related to nanotechnology. The construction sector was among the first to be identified as a promising application area for nanotechnology back in the beginning of the 1990s; but today we see that the fragmented, generally low tech-tech and conservative construction sector is falling behind the Green Technology Forum (2007). When talking about eco-innovation in nanoconstruction we are still dealing more with potentialities than with actual developments. Data and analyses are lacking in Andersen. M.M., et. al. (2007), Hansen, S.F., et. al. (2007), and Hullmann, A (2006). This paper seeks to highlight key aspects in the early development and application of eco-innovative nanotech solutions in the construction sector. The paper provides a framework for addressing relevant issues of green nanoconstruction and takes stock of current challenges.

2. Trends and key issues in sustainable nanoconstruction

The great diversity of nanotechnologies means that it is not easy to identify what green nanotechnology could mean for construction. The high environmental expectations to nanotechnology are related to some fundamental features of nanotechnology. Potentially the atom-by-atom construction of nanomaterials may lead to optimized tailoring of materials and products without dangerous and messy by-products. Self-assembly, i.e. the attempt to mimic nature's intrinsic way of building on the nanometre scale, molecule by molecule through self-organization, has eco-potentials because it is extremely resource efficient (Royal Society (2004) pg.39). Also the large surface area of nanoparticles leads to a high reactivity which may lead to higher energy efficiency, e.g. increasing absorption rates for light and facilitating reaction processes at reduced temperatures and with less materials loss (NSET (2003) pg.89).

An important feature of relevance for nanoconstruction is that nanotechnology allows the design of materials with multifunctional properties. A single nanomaterial can replace several traditional ones potentially increasing the resource efficiency. E.g. nanocomposites can be made strong, light, thin, electrically conductive and fireproof. Nanocoatings can be self-cleaning, de-polluting and antimicrobial. See also Andersen. M.M., et. al. (2007), Gann. D (2003), Hullmann, A (2006), NSET (2003), and Zhu. W., et. al. (2004) for early but not very thorough discussions on green nanotech opportunities in construction. The goal of Andersen. M.M., et. al. (2007) was to identify the potentials of nanotechnology to meet the needs and solve the problems of the construction sector including the environmental challenges. In this work six nanopillars emerged that systematize the potentials of nanotechnology in relation to the

construction industry: 1) nanostructured materials, 2) nanostructured surfaces, 3) nanooptics, 4) nanosensors & electronics, 5) nanointegrated energy production & storage, 6) nanointegrated environmental remediation. Table 1 gives an overview of nanoresearch and technology areas and their construction relevance.

Table 1 Overview of nanorelated areas and their relevance for the construction sector

Nanorelated research and technology areas	**Relevance for the construction sector**	
Topics	**Application**	**Important environmental properties**
1. Nanostructured materials a) Nanoporous materials, incl. cement and wood based materials b) Polymers c) Composites d) Other materials	Construction materials in general Insulation materials, Load carrying materials	Strength - weight ratio, Durability, Fire resistance, Self-cleaning, impact on indoor and outdoor climate, Energy & resource efficiency, Recyclability, Degradability
2. Nanostructured surfaces as coatings and thin films a) Chemically modified surfaces b) Physically modified surfaces	Everywhere in buildings and civil works, none the least renovation	Strength and toughness, Durability including aesthetics, Impact on indoor climate Hygiene, Maintainability, Self-cleaning
3. Nanooptics a) Planar light wave circuits b) Photonic crystal fibers c) Light emitting diodes, LED & OLED d) Integrated optical sensors	Integrated functions in general Electrical and lighting systems, Climate control	Energy efficiency, Fire and other safety
4. Nanosensors & electronics For monitoring and transmission a) Biosensors b) Optical sensors c) Chemical sensors d) Gas sensors e) Microorganisms f) Electro active materials	Monitoring and control everywhere in buildings and civil works	Embeddedness, Durability, Maintainability, Resource efficiency
5. Nanointegrated energy production & storage a) Solar cells b) Fuel cells c) Other	Heating and cooling systems Building envelope, Electricity supply	Energy self-sufficiency and efficiency in buildings and utility systems
6. Nanointegrated environmental remediation a) Catalytic cleaning b) Other separation and purification processes	Air purification in buildings and infrastructures, Water systems (supply and waste), Waste systems	Inbuilt air and water cleaning, Environmental remediation in general, Indoor climate, including cleaning and hygiene, Degradability, Resource efficiency, Substitution of hazardous materials

The overview illustrates the great variety and scope of the many emerging nanotechnological areas, and the broad application opportunities which address almost all aspects of construction. They are interesting because they point to novel climate solutions for achieving resource efficient and intelligent buildings and cities and because many can be applied in existing buildings where the climate potential is considerable; e.g. via surface treatments, applications of thin panels and high efficient insulation. The majority of the novel solutions are in an early stage of development, but some are fully commercial. Data are poor but two consultancy reports on green nanoconstruction , Hullmann, A (2006) and Zhu. W., et. al. (2004) identifies a wide range of commercially available products worldwide, illustrating that much is beginning to happen in this area. However, so far, it is the major industrial multinational players who are pioneering the development and application of nanotechnologies in construction, while the majority of (predominantly small) construction companies, universities and other knowledge institutions have little insight and experience with nanotechnology [Andersen. M.M., et. al. (2007), Bartos. P.J.M., et. al. (2004), CRISP/SPRU (2003), Gann. D (2003), Hansen, S.F., et. al. (2007) and Malinowski. N., et. al. (2006)]. A Danish innovation analysis shows a generally weak demand for nanotechnology in the construction sector:

'The overall picture of the demand for, knowledge of, and views on nanotechnology in the construction sector is that knowledge and expertise are currently too fragmented to allow for a substantial uptake, diffusion and development of nanotechnological solutions in the construction industry. At present, only very vague ideas of the possible benefits can be identified among key agents of change such as architects, consulting engineers and facility managers. Furthermore the demand side will be reluctant about introducing nanotechnological materials until convincing documentation about functionalities and long-term effects is produced. A need for documentation of the consequences for health and safety is evident'. (Andersen. M.M., et. al. (2007) pg.32). According to Hullmann, A (2006) and Zhu. W., et. al. (2004) on green nanoconstruction, barriers for the wider development of climate friendly nanoconstruction are considerable and lie mainly in four areas: a) the lack of knowledge of nanotech opportunities in the construction sector b) reluctance of the sector towards (radical) innovation, c) the high costs of some, but not all, nanotechnologies, and d) public concern about nanorisks.

But another, and often overlooked factor, is that there are also barriers on the nanoside. Today most nanotechnologies are targeted at other applications than construction, mainly more knowledge-intensive areas such as medico, food and

military [Andersen. M.M., et. al. (2006), Andersen. M.M., et. al. (2007), Lux Research (2004) and Nanoforum (2004)]. It will take effort and time to shift the attention and capabilities among the nano scientific community towards the construction area. Also on the innovation dynamics of nanoconstruction are analysis and insights lacking.

3. Strategies for sustainable nanoconstruction

In the strategic priorities of the European Construction Technology Platform (ECTP) see Table 2, climate issues, here 'becoming sustainable', is given considerable attention. The ECTP defines sustainable development in construction quite broadly, encompassing resource efficiency, environmental impact, utility networks, and the cultural heritage and safety issues.

Table 2 List of strategic research priorities ECTP 2005 (Source: http://www.ectp.org/documentation/ECTP-SRA-2005_12_23.pdf)

A: Meeting client / user requirements	**B: Becoming sustainable**	**C: Transformation of the construction sector**
Healthy, safe and accessible indoor environment for all	Reduce resource consumption (energy , water, materials)	A new client-driven, knowledge-based construction process
A new image of the cities	Reduce environmental and man-made impacts	ICT and automation
Efficient use of underground city space	Sustainable management of transport and utilities networks	High added-value construction materials
Mobility and supply through efficient networks	A living cultural heritage for an attractive nation	Attractive workplaces

Generally nanotechnology offers opportunities for meeting many of the challenges addressed by the ECTP strategy. These include A) meeting the user requirements both in terms of developing intelligent, fashionable and efficient buildings and cities and an improved indoor environment; B) achieving high resource efficiency and contributing to environmental remediation and energy production; as well as C) renewing the sector in making it more knowledge based and automated. Nanotechnology may particularly address the climate/sustainability agenda in simultaneously contributing to making the construction sector both more clever and clean and hence improve the innovation capacity and competitiveness of the sector [Andersen. M.M (2008), Andersen. M.M., et. al. (2006)]. In doing so, the nanoconstruction area fits well with the rapidly rising policy and business interest into "eco-innovation" The climate agenda is increasingly moving away from the more general sustainable development agenda towards the market oriented "eco-innovation" agenda [Andersen. M.M (2008) and Luther. W., et. al. (2006)].

The eco-innovation policy perspective seeks to address the specific challenges different sectors and types of companies face when they are eco-innovative. "Sustainable construction" has recently been identified as one of the six 'lead markets' for innovation in the EU and one out of four eco-innovation policy priority areas [EC (2008), EC SANCO (2004) and ECTP (2005)]. Germany launched a major programme within nanoconstruction, which includes climate issues in Gann. D (2003). This underlines the recent considerable interest in promoting eco-innovation in the construction sector which could form a window of opportunity for the development of nanoconstruction.

4. Conclusions

Eco-innovative nanoconstruction has the potential to simultaneously enhance the competitiveness and climate potential of the construction sector and could become a key strategic factor for the sector ahead. This paper has shortly discussed a wide range of potential nanotechnologies applicable for construction with promising climate impacts, most, however, in an early stage of development. They are none the least interesting because they point to novel climate solutions for achieving resource efficient and intelligent buildings and cities and because many can be applied in existing buildings where the climate potential is considerable. It is essential, however, that the current knowledge gap on risk issues, eco-opportunities and industrial dynamics are met if green nanoconstruction is to move from expectations to a serious strategic target for business and policy makers.

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POST-TRAUMATIC STRESS DISORDERS (PTSD) AMONG SURVIVORS OF DISASTERS – A COMPARATIVE STUDY IN ALAPPAD GRAMA PANCHAYATH AND CHAVARA GRAMA PANCHAYATH

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Context of the study

India woke up to one of the worst natural disasters on the 26th of December 2004 that the country has ever seen in the recent history. On December 26th, 2004 at 6.28am, a rupture on the sea floor along a 1000 Km fault line triggered a quake of magnitude 8.9 on the West Coast of Northern Sumatra in Indonesia. This resulted in the ocean bed rising more than 10 meters and displacing overlying water generating a massive tsunami traveling at speed up to 700km/hr. Tsunamis are high tidal waves caused due to the sea water entering into the coastal land areas. It was when the tsunami struck Indonesia, Thailand, Maldives, Malaysia ,Somalia, Kenya, Tanzania, Seychelles and the South Eastern Coast of India killing and affecting thousands of people. In India, the states of Tamil Nadu, Kerala, Andhra Pradesh and union territories of Pondicherry, and Andaman and Nicobar Islands witnessed massive destruction following the huge surging tsunami waves hitting the coastal land on 26th of December 2004. Tamil Nadu, Andaman and Nicobar Islands, Pondicherry. Andhra Pradesh and part of Kerala were devastated by the tsunami. It was the first of its nature in our country. The tsunami took away the lives of thousands, destroyed houses and disrupted the entire fabric of the fisher folk and others living in the coastal areas.

Official estimates issued by the Ministry of Home Affairs (2005), says that death toll due to tsunami was 9,995, with Tamil Nadu accounting for 7,923 death alone. The number of missing people was put at 6011 after thirteen days of the tsunami disaster. The total loss accounting for the loss of houses, means of livelihood and other infrastructures estimated were Rs.47 billion in Tamil Nadu, which alone become the 50% of the total loss in the South India, followed by Rs 13 billion in Kerala and Rs. 5 billion in Pondicherry respectively. The loss in Andhra Pradesh was calculated to be Rs 3.4 billion. A total of 2,260 kilometers of cost line besides Nicobar Islands was affected. More than 2,83,100 people were killed, 14,100 are documented to be missing around 1,126,900 people were displaced by earth quake and subsequent tsunami. In India approximately 10,749 people lost their lives.1,57,393 dwelling units in 891 villages have been damaged. The quake waves devastated the costal life of Kerala in a terrifying manner. The fear and agony that were left in the minds of people of Kerala were indefinable. Everything was not what it was before. All shattered …., lives, homes, herds and dreams.168 person were killed in Kerala. Tsunamis attack was merciless in Alappad Panchayath of Kollam District. 130 were killed in this small panchayath itself. The whole physical and organizational structure of the community was deeply changed. Homes were destroyed, people were relocated, close relatives were dead, records and other valuables were lost and changes were evident in psycho social patterns and human transactions.

In Kerala especially in Alappad Panchayath people manifested different types of emotional reactions, Numb in the beginning, people appeared to show signs of relief and elation for having survived. Post traumatic reactions like intense feeling of anxieties, depression, fear, frustration etc were the most common reactions replaced by the survivors. Certain specific stresses like displacement of individual to the other geographic areas, prolonged life in camps, unemployment, inactivity and lack of recreational possibilities were found to affect people physically, socially and mentally. The fostering of dependency in survivors, general disruptions in social fabric and the breakdown of traditional forms of social support left devastated effects on people. As part of rehabilitation measures people were re-localised and de-localised. The insecurity feelings, apprehensions about the future problems yet to be tackled were haunting the survivors in Alappad Panchayat.

Post-Traumatic Stress Disorders

An important advance in the scientific study of responses to disasters was the recognition of Post Traumatic Stress Disorder (PTSD) in the third edition of the Diagnostic and Statistical Manual (DSM-III; APA, 1980). PTSD is probably the most commonly studied diagnosis after disaster. It requires that symptoms be present for at least one month post trauma, and may have its onset of symptoms immediately, soon after the event, or it may be delayed. The clinical picture can be a dramatic one, with mental confusion, massive anxiety, and repetitive intrusive memories and dreams of the disaster event (Burkle, 1996). The intrusive thoughts are the most frequent symptoms, followed by exaggerated startle responses. Hyper arousal reactions with acute PTSD have been linked to the severity of stress exposure in 80% of adults; reactions appear immediately or within hours (DSM-IV, APA, 1994).

Although there have been a great number of studies reporting PTSD after disasters, prevalence rates have been so variable that they range from 0% to 100%. This variability may be attributed to type of trauma, sample selection and use of different assessment tools; which typically range from clinical interviews to standardised assessment instruments, and self-report measures (Bryant & Harvey, 2000). Again, a representative example pertinent to the tsunami finds among an exposed Thai population 8 weeks after tsunami, 12% of displaced and 7% of non-displaced reported PTSD. At 9 month follow-up this reduced to 7% and 2% (van Griensven et al., 2006). The pace of decline may not be linear. The relatively small number of studies that do contain multiple observations of the same individuals over time find that elevated psychological distress persists in the months after the event but then begins to decline dramatically at periods beyond a year since the onset of disaster (Shaw et al. (1996); Phifer & Norris (1989); Carr et al. (1997); Norris et al. (2004)
A community-based household survey in fishing villages in Indonesia (Salur and Labuhan) that had been hit by the tsunami reported a PTSD prevalence of 13%, considerably lower than studies in other disasters (ICMH, 2006; Mollica, Cui, McInnes, & Massagli, 2002). Other studies of ICMH found that PTSD rates were no higher in affected areas than in randomly selected subject groups (ICMH, 2006). In Sri Lanka where little consensus emerged on the nature of psychosocial problems in general, PTSD as such was not highlighted; and in India, research undertaken in the weeks that followed the disaster reported few diagnosed cases of the syndrome (ICMH, 2005b). On the other hand, six months after the disaster, a series of focus group studies in two villages in Indonesia (Salur and Labuhan) found that the level of fear was still high, and that people were still presenting severe physical and cognitive reactions.

Pyari, Raman and Sarma (2013) conducted a study in Risk factors of post-traumatic stress disorder in tsunami survivors of Kanyakumari District, Tamil Nadu, India. In this study sample, women had 6.35 times higher risk of having PTSD as compared to men, when adjusted for other variables. The higher risk of PTSD among homemakers also strongly supports the vulnerability of women to PTSD as all homemakers were women in our study population. Studies on Oklahoma City bombing survivors and earthquake survivors in Turkey have shown an increased risk of PTSD among women than men.The experiences of Oxfam, a non-governmental organization (NGO) which had worked in tsunami affected areas in South India, highlight the genderspecific problems and their role in increasing the stress of women.Other studies related to tsunami and PTSD also was associated with poor mental health outcomes.On the contrary, there were some data from India in a disaster setting, suggesting that people of all the socioeconomic strata were equally affected by PTSD.

Objectives of the study

1. To study the Post Traumatic Stress Disorders (PTSD) and its sub variables (Avoidance, Intrusion and Hyper arousal) expressed by the tsunami survivors in Alappad Grama Panchayath and make a comparative analysis with the people of non affected Chavara Grama Panchayath.
2. To make a longitudinal assessment of Post Traumatic Stress Disorders (PTSD) and its sub variables with survivors in Alappad Panchayath immediately after tsunami, after one year and after two years of occurrence
3. To study the Post Traumatic Stress Disorders (PTSD) in relation to selected socio demographic variables(Age, sex, Education, Income, Type of Family, Marital Status, Occupation, Family Relationship, Type of Loss and Type of Displacement).

Hypotheses

1. There will be no significant difference between the survivors of Alappad Grama Panchayath and people of Chavara Grama Panchayath in Post Traumatic Stress Disorder (PTSD) immediately after tsunami.
2. There will be no significant difference in Post Traumatic Stress Disorder(PTSD) among the survivors in Alappad Grama Panchayth immediately after Tsunami, after one year and after two years of its occurrence
3. There will be no significant difference in Post Traumatic Stress Disorders (PTSD) among the survivors in Alappad Grama Panchayath in relation to the selected socio demographic variables. (Age, Sex, Education, Income, Type of Family, Marital Status, Occupation, Family Relationship, Type of Displacement, Type of Loss)

Methodology

Research design

Keeping in view the nature of the study, ex-post facto research design was adopted for this study. Ex-post facto research is a systematic empirical enquiry in which the researcher does not have direct control over independent variables because their manifestations have already occurred or because they are inherently not manipulable and inferences about relations among variables are made without direct intervention, from concomitant influence of independent variables on dependant variables (Kerlinger, 1966)

Population

The population of the study was the total number of population of the Alappad Grama Panchayath. As per the 2001 census total population of Alappad Panchayath was 24931.It comprised of 12468 males and 12463 females

Sample

The sample size was estimated based on a total reference population of 3707 House Holds, living in 14 relief camps of Alappad Panchayath. Cluster sampling method was used for the study with probability proportional to size. The cluster was taken as relief camp which comprises of the survivor population of a particular geographical area say wards. The total survivor population of Alappad Panchayath was divided in to 14 clusters .6273 adult males and 6979 adult females were

included in the sampling frame. The sample proportion was fixed as 10:1 .The sample size was estimated on the basis of the table proposed by Krejcie and Morgan (1970) for estimating the sample size. According to this, the number of respondents to be included in the sample was 407. This number was finally rounded to 500 to avoid all sampling errors.

Tools Used

The study intended to assess Post Traumatic Stress Disorders; the following tools were used to study these aspects throughout the study.

The following tools were used for the present study

1. Family Schedule (Indian Council of Medical Research 1998)
2. Impact of Event Scale Revised (IES-R)–Adult Version. (Weiss and Marmar, 1997).

Statistical techniques

One way Analysis of Variance(One way ANOVA), Independent sample 't' tests, Repeated ANOVA, Least Square Deviation Method (LSD) were used for statistical analysis

Results

1. Significant difference was observed in Post Traumatic Stress Disorders (t= 106.28, p<.001) between Alappad and Chavara Grama Panchayaths.
2. Significant difference was found in Avoidance (t= 85.31, p<.001) between Alappad and Chavara Grama Panchayaths.
3. Significant difference was found in Intrusion (t= 74.02, p<.001) between Alappad and Chavara Grama Panchayaths.
4. Significant difference was found in Hyper arousal (t= 44.72, p<.001) between Alappad and Chavara Grama Panchayaths.
5. Study shows significant difference in Post Traumatic Stress Disorders (F=641.79, p<.001) in survivors among Phase I, Phase II and Phase III in Alappad Panchayath.
6. High Significant difference in PTSD was observed among the pairs Phase I (immediately after disaster) and Phase II (after one year) (MD=24.51,p<.001) ,Phase I and Phase III (after two years) (MD=29.85,p<.001) and Phase II an Phase III(MD=5.34,p<.001)
7. Study shows significant difference in Avoidance (F=343.58, p<.001) in survivors among Phase I, Phase II and Phase III in Alappad Panchayath.
8. High Significant difference in Avoidance was observed among the pairs Phase I and Phase II (MD=9.230,p<.001) ,Phase I and Phase III (MD=29.85,p<.001). A contradictory result was observed in pairs Phase II and Phase III(MD=.096,p>.05)
9. Study shows significant difference in Intrusion (F=392.84, p<.001) in survivors among Phase I, Phase II and Phase III in Alappad Panchayath.
10. High significant difference was observed in Intrusion among pairs Phase I and Phase II(MD=8.57,p<.001) ,Phase I and Phase III (MD=9.34,p<.001) and Phase II and Phase III(MD=.77,p<.05)
11. Study shows significant difference in Hyper arousal (F=411.50, p<.001) in survivors among Phase I, Phase II and Phase III in Alappad Panchayath.
12. High significant difference was observed in Hyper arousal among the pairs Phase I and Phase II(MD=6.67,p<.001) ,Phase I and Phase III (MD=11.07,p<.001)and Phase II and Phase III(MD=4.39,p<.001)
13. No significant difference was observed in Post Traumatic Stress Disorders (PTSD) (F=1.00, p>.05) immediately after tsunami with respect to the age of the survivors in Alappad Grama Panchayath.
14. No significant difference was observed in Post Traumatic Stress Disorders (PTSD) (t=.24, p>.05) immediately after tsunami with respect to the Sex of the survivors in Alappad Grama Panchayath.
15. No significant difference was observed in Post Traumatic Stress Disorders (PTSD) (F=1.12, p>.05) immediately after tsunami with respect to the Marital Status of the survivors in Alappad Grama Panchayath.
16. No significant difference was observed in Post Traumatic Stress Disorders (PTSD) (F=.26, p>.05) immediately after tsunami with respect to the Educational Status of the survivors in Alappad Grama Panchayath.
17. No significant difference was observed in Post Traumatic Stress Disorders (PTSD) (F=.62, p>.05) immediately after tsunami with respect to the Occupation of the survivors in Alappad Grama Panchayath.
18. No significant difference was observed in Post Traumatic Stress Disorders (PTSD) (F=1.04, p>.05) immediately after tsunami with respect to the Income of the survivors in Alappad Grama Panchayath.
19. No significant difference was observed in Post Traumatic Stress Disorders (PTSD) (F=.77, p>.05) immediately after tsunami with respect to the Family Relationships of the survivors in Alappad Grama Panchayath
20. No significant difference was observed in Post Traumatic Stress Disorders (PTSD) (F=.07, p>.05) immediately after tsunami with respect to Type of Family of the survivors in Alappad Grama Panchayath.
21. No significant difference was observed in Post Traumatic Stress Disorders (PTSD) (t=.43, p>.05) immediately after tsunami with respect to Life Loss in Alappad Grama Panchayath.
22. No significant difference was observed in Post Traumatic Stress Disorders (PTSD) (t=-.35, p>.05) immediately after tsunami with respect to the Livelihood Loss of the survivors in Alappad Grama Panchayath
23. No significant difference was observed in Post Traumatic Stress Disorders (PTSD) (t=-.99, p>.05) immediately after tsunami with respect to the Property Loss of the survivors in Alappad Grama Panchayath.
24. No significant difference was observed in Post Traumatic Stress Disorders (PTSD) (F=1.29,p>.05) immediately after tsunami with respect to the Displacement Pattern of the survivors in Alappad Grama Panchayath

Conclusions

Comparative analysis of Post Traumatic Stress Disorders (PTSD) and its sub variables (Avoidance, Intrusion and Hyper arousal) expressed by the tsunami survivors in Alappad Grama Panchayath and the people of non affected Chavara Grama Panchayath had revealed that the survivors of tsunami in Alappad panchayath had reported higher level Post Traumatic Stress Disorders when compared to the people of Chavara panchayath

The longitudinal assessment of Post Traumatic Stress Disorders (PTSD) and its sub variables (Avoidance, Intrusion and Hyper arousal) with survivors in Alappad Panchayath immediately after tsunami, after one year and after two years of occurrence had revealed that the PTSD is continuously decreasing from Phase I to Phase II and reach at minimum in Phase III due to psycho social intervention programmes made by the Governmental and Non governmental agencies during this time.

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APPRAISAL OF MSW LEACHATE CHARACTERISTICS AND THE GROUNDWATER QUALITY IN THE SURROUNDINGS OF BRAHMAPURAM MUNICIPAL SOLID WASTE DISPOSAL FACILITY IN ERNAKULAM DISTRICT, SOUTH INDIA

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Abstract

The study was conducted to assess the physico-chemical and the bacteriological quality of groundwater around the Brahmapuram Municipal Solid Waste Disposal Facility in Ernakulam district during pre-monsoon and monsoon seasons of the year 2012. The study also aims to find out the physical, chemical and bacteriological characteristics of MSW leachate from the disposal plant. The potability of groundwater samples in the study area were assessed by determining the Water Quality Index. From the results of the study, the drinking water quality of well water samples collected from the study area were identified as bad, and are heavily polluted with total and faecal coliforms. The study concluded that the activities in the municipal solid waste treatment plant at Brahmapuram cause negative impact on the drinking water quality due to the percolating MSW leachate with contaminants to the subsurface environment. The values obtained for Percentage sodium, Sodium Adsorption Ratio [SAR], Exchangeable Sodium Percentage [ESP], Magnesium hazard [MH], Residual Sodium Carbonate [RSC] and Permeability Index [PI] revealed that majority of the well water samples in the study area are good for irrigational and domestic purposes. The study also recommends that the groundwater must be disinfected before consumption.

Key words
Solid waste, leachate, groundwater, Sodium Adsorption Ratio, Water Quality Index

Introduction

Water, the nectar of life, is one of the most important natural resource for the entire living organisms, whether unicellular or multicellular since, it is required for their metabolic activities (Fair *et al.*,1980). Sources of groundwater pollution are countless and most important concern is due to human activities of misuse and pollution. The solid, liquid and the gaseous wastes that are generated, if not treated properly, results in pollution of the environment; and this affects groundwater too due to the hydraulic connectivity in the hydrological cycle. Effluents from sewage are the main source of organic pollutants whereas the inorganic pollutants are derived from industrial wastes (Chatterjee et al., 2005). The quality of groundwater is as important as the quantity. Changes in water quality from one area to other indicate variation in the medium through which it has moved (Faure,1998).

Much of the ill health affecting human beings, especially in developing countries can be attributed to lack of safe and quality water supply. The disposal of municipal solid waste on large scale by landfill method is primarily responsible for groundwater contamination either locally or globally (Agarwal, 2002). Waste placed in landfills or open dumps are subjected to either groundwater under flow or infiltration from precipitation. The dumped solid wastes gradually release its initial interstitial water and some of its decomposition by-products get in to water moving through the waste deposit. Such liquid containing innumerable organic and inorganic compounds are called leachate. The installed capacity of the Brahmapuram Municipal Solid Waste Disposal Facility in in Ernakulam district of Kerala was to treat 250 tonnes of Municipal Solid Waste a day. The residents near the Brahmapuram Municipal Solid Waste Disposal yard have complaints about the leakage of land fill and open dump leachates from the disposal plant into the surrounding water bodies. People in this area are also suffering from odour nuisance and pollution problems. Therefore the present study was undertaken to find out the Municipal Solid Waste (MSW) leachate characteristics and the extent of ground water contamination in the surroundings of Brahmapuram Municipal Solid Waste Disposal

Facility in Ernakulam District, Kerala state. The study also evaluates the potability and irrigational suitability of the groundwater in the study area.

Materials and methods

Study area

The area chosen for the present study is the surroundings of Brahmapuram Municipal Solid Waste Disposal Facility in Ernakulam District, Kerala. The District covers an area of 3068 sq km and situated on the western coastal plain of India, with an average rainfall of 3432 mm. The region has a moderate climate and mostly falls within the Malabar Coast moist forest eco-region. It lies at latitude 9° 59' 58" N and longitude 76° 22' 32" E, and situated at an altitude of 500 m above the mean sea level. The location map of the study area showing the sampling stations is given in **Fig.1**. The waste disposal plant at Kochi is an integrated Solid Waste Management Project under the Jawaharlal Nehru National Urban Renewal Mission [JNNURM]. It is managed for collecting the municipal solid waste from various regions including Cochin Corporation, Kalamassery, Thripunithara Municipality and thirteen panchayats of Ernakulam District. The Solid waste Disposal Plant is a part of Cochin Corporation, and is located in the first ward of Vadavucode - Puthenkurishu panchayat of Ernakulam District. The Brahmapuram solid waste disposal plant is also close to the confluence of three water bodies, Kadambrayar, Chithrapuzha, Manakkakadavu creek. The soils of the study area are sandy loam in nature.

Sampling stations

Stations for ground water sampling were selected after a detailed field survey of the study area. Seven stations (W_1, W_2, W_3, W_4, W_5, W_6, W_7) with open dug wells (at a regular distance of about 1.5 km) in the residential areas, covering 25 sq km near the Solid Waste Disposal Plant were selected for the study. Municipal solid waste leachate sampling station (L) in the effluent disposal site of the Municipal Solid Waste Disposal Facility was also selected to collect the MSW leachate. The samples were collected in labeled clean plastic bottles for physico-chemical analysis, and in sterile glass bottles for bacteriological analysis during pre-monsoon season (April) and monsoon seasons (July) of the year 2012.

Methodology

The analyses of the physico-chemical and bacteriological characteristics of well water and leachate were carried out following the standard procedures described in APHA (1995) and by Trivedi & Goel (1986), and Saxena (1998). For heavy metal (Cd, Cr, Fe, Pb and Zn) analysis, the leachate and water samples were acid digested, filtered and concentrations were determined using an Atomic Absorption Spectrophotometer (Thermofischer, ICE 3500). The potability of groundwater during pre-monsoon and monsoon season was evaluated by calculating the Water Quality Index [WQI]. Thirteen physico-chemical parameters like pH, EC, TDS, TA, TH, TSS, Ca, Mg, chlorides, nitrates, sulphates, DO, BOD were selected for the calculation of WQI. For the evaluation of WQI of representative well water samples and to assess its potability, the water class rating adopted by Chatterji and Raziuddin (2002) was followed.

The overall water quality index was calculated by the weighted arithmetic index method by aggregating the quality rating with the unit weight linearly, which is of the form, $WQI = \Sigma q_n W_n / \Sigma W_n$

where, q_n = Quality rating for the nth water quality parameter which is calculated by the following equation,

$$q_n = 100 [V_n - V_{io}] / [S_n - V_{io}].$$

where, V_n = Estimated value of the nth parameter at a given sampling station, S_n = Standard permissible value of the nth parameter, V_{io} = Ideal value of the nth parameter in pure water.

Unit weight was calculated by a value inversely proportional to the recommended standard value S_n of the corresponding parameter.

$$W_n = K/S_n$$

where, W_n= unit weight for the nth parameters, S_n = standard value of the nth parameters,
K = constant of proportionality.

Residual Sodium Carbonate, Exchangeable Sodium Percentage, Permeability Index were determined following the procedures by Richards (1954), Dwievedi and Pathak (2007), Domenico and Schwartz (1990) respectively, to classify and understand the basic chemical composition of groundwater and its suitability for irrigation purpose. The corrosion susceptibility of collected well water samples were evaluated by Corrosivity Ratio (Ryner, 1944). The groundwater with corrosivity ratio < 1 is considered to be safe for transport of water in any type of pipes, whereas >1 indicate corrosive nature and hence not to be transported through metal pipes (Raman, 1985). The susceptibility of groundwater to corrosion was expressed as ratio of alkaline earth to saline salts in groundwater, which is defined by the formula,

$$\text{Corrosivity Ratio [CR]} = \frac{[Cl/35.5] + 2 [SO_4/ 96]}{2[HCO_3/100 + CO_3/ 100]}$$

where, all the ions are expressed in ppm of groundwater.

Results and discussion

Physico-chemical and Bacteriological characteristics of Leachate

Physico-chemical and bacteriological characteristics of municipal solid waste (MSW) leachate samples collected during the pre-monsoon and monsoon seasons are given in **Table 1.** The leachate sample collected in the pre-monsoon season was pale yellow in colour and with pungent odour. In monsoon season, it was brown in color and with fishy odour. The present investigation showed that the values recorded for important physico-chemical characteristics like temperature, turbidity, BOD, TDS and Fe content of the MSW leachate from Brahmapuram Muncipal solid waste disposal facility were high, and some of them are also not satisfying the maximum standards permissible limits for the disposal of treated leachate to the inland surface water bodies/land set by CPCB (2005). The bacteriological characteristics of MSW leachate determined during the premonsoon and monsoon seasons showed high MPN index values for total coliforms & feacal coliforms.

The elevated temperature of leachate imparts high metabolic activity and low dissolved oxygen to surface and ground waters in this area. The high amount of total solids make the leachate turbid while high chloride content imparts yellowish orange color/ brown to the leachate. The high BOD of leachate discharged to the nearby river, the Kadambrayar makes the water in the receiving water body unfit for domestic use and causes aquatic impairment. The increased nutrient status *i.e.,* beyond the permissible limit, imparted eutrophic and anaerobic condition in nearby well waters. The report by KSPCB (2011) also is in agreement with the present findings.

Physico-chemical and Bacteriological characteristics of Well water

The results of the physical and chemical parameters analyzed in the ground water samples are shown in **Table 2, 3 & 4** respectively**.** The data of bacteriological parameters determined in the ground water samples are given in **Fig.2.** The most of well water samples in the study area were colourless except W3 and W5 in pre monsoon season. Most of well water samples studied is with unobjectionable taste, except W_1, W_3 and W_4; and with unobjectionable odour except W_1 and W_5 in both pre-monsoon and monsoon seasons studied. The water samples showed an average temperature of 29.71^0C during pre-monsoon, and 29.57^0C during monsoon. Low dissolved oxygen content was recorded in the well, W6 (4.06 mg/L) during pre-monsoon, and in the W_3, W_4, W_6, W_7 during monsoon season. High concentration of phosphates was detected in the water samples from W_1 during pre-monsoon season, and in W_3, W_4 and W_6 during monsoon season, emphasizing the negative impact of landfill leachate on the groundwater quality. The concentration of heavy metals Cd and Pb in the ground water samples of the study area were below detectable limits. The mean concentrations of Fe (0.21 ppm, Cr (0.05 ppm) and Zn (0.36 ppm) in ground water analysed were within the standard permissible limits for drinking water quality standards prescribed by WHO (1984).

The bacteriological analysis of well water samples from different sampling stations of the study area showed high microbial load in drinking water during the two different seasons studied, and recorded highest values during monsoon season. The MPN index/100ml of total coliforms was upto 1100, and that of the faecal coliforms was upto 240 in the ground water of the study area during monsoon season, and the coliform counts detected were above the standard permissible limits prescribed by WHO (1984). The presence of E.Coli and faecal coliforms in water may cause health risk to residents consuming this raw water for drinking and other domestic purposes. Therefore the percolating MSW leachate with high concentration of chemical and bacteriological pollutants may be responsible for the contamination of ground water and surface water bodies in the surrounding areas of the solid waste treatment plant.

Water Quality Index

The potability of groundwater samples was assessed by determining the Water Quality Index [WQI], considering thirteen important physico-chemical parameters. The results of the water quality index values of the open wells in the surroundings of Brahmapuram Solid Waste Treatment Plant are discussed here. Drinking water quality of well water samples collected from the sampling stations, W_2,W_3,W_4 were identified as badly polluted [WQI, class rating: 51-75 (poor water quality] and the water from W_1,W_6,W_7 were unsuitable for drinking [WQI, class rating: >100] during the pre-monsoon and monsoon seasons of the study period. Therefore the areas near landfills have a greater possibility of groundwater contamination because of the potential pollution source of leachate originating from the solid waste disposal site. The polluted ground water in the study area is unfit for drinking and its consumption may cause water borne diseases like hepatitis A, typhoid, cholera in humans.

Irrigational suitability and Corrosion susceptibility of Groundwater

The results of Irrigational quality parameters of groundwater during pre-monsoon and monsoon seasons are given in **Table 5 (a)** and **5 (b)**. The values obtained for percentage sodium [%Na], Sodium Adsorption Ratio [SAR], Exchangable Sodium Percentage [ESP], Magnesium Hazard [MH], Residual Sodium Carbonate [RSC] and Permeability Index [PI] showed that most of the well water samples collected during the study period near the solid waste treatment plant are good for irrigational and domestic purposes. The results of corrosion susceptibility of ground water [**Table 5 (a)** and **5 (b)**] in the study area showed that the water sample W_7 (1.45) in pre-monsoon, and the samples W_3 (1.09), W_6 (1.48) and W_7 (2.17) in monsoon season were having the corrosivity ratio above the permissible range [CR>1]. About 67% of well water in the study area is found to be safe for transportation in any kind of pipes since

the corrosivity ratio is less than 1, and the remaining 33% of well water has corrosivity ratio more than1, and needs noncorrosive pipes for lifting groundwater.

Conclusions

The present study concluded that the activities in municipal solid waste treatment plant at Brahmapuram in Ernakulam district causes degradation in the water quality of groundwater sources in the surrounding areas. The open dug wells in the study area are physically, chemically and bacteriologically polluted with the contaminants from the municipal solid waste treatment plant leachate, therefore the groundwater in the surroundings of municipal solid waste treatment plant are suitable only for domestic and agricultural purposes, and not useful for drinking without proper treatment. Steps may be taken by the State Pollution Control Board authorities for the periodic monitoring of the physico-chemical and bacteriological characteristics of the leachates from the solid waste disposal facility. Also programmes must be conducted among the residents in the study area by Health Department authorities to give awareness about the need of periodic cleaning and proper maintenance of the wells.

Acknowledgement

The authors sincerely thank Kerala State Council for Science, Technology and Environment (KSCSTE) for providing the financial assistance for this study.

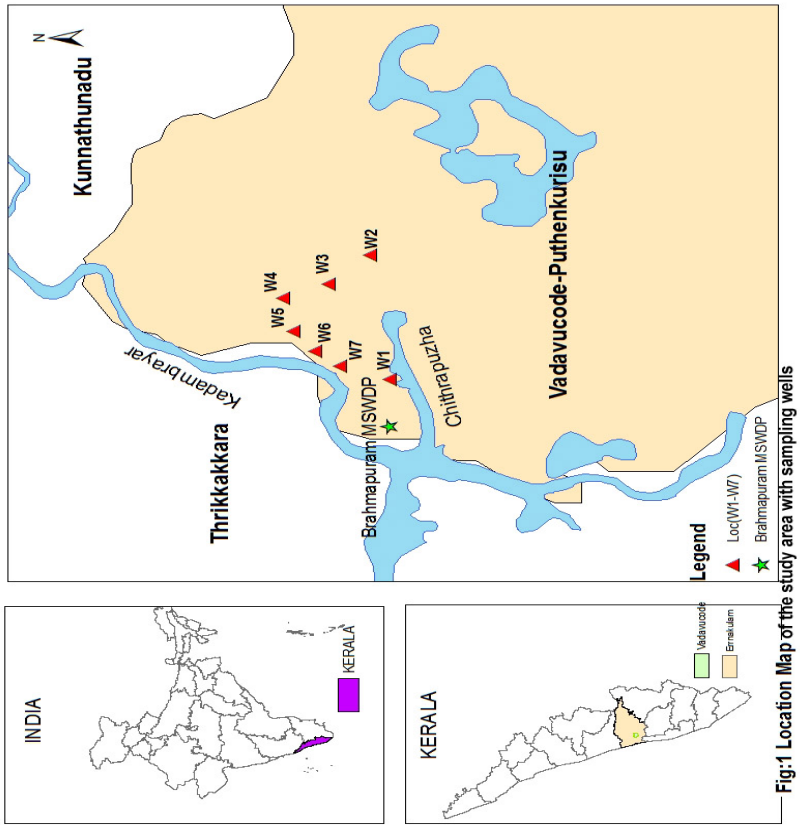

Fig.1. Location Map of the Study Area showing Sampling stations

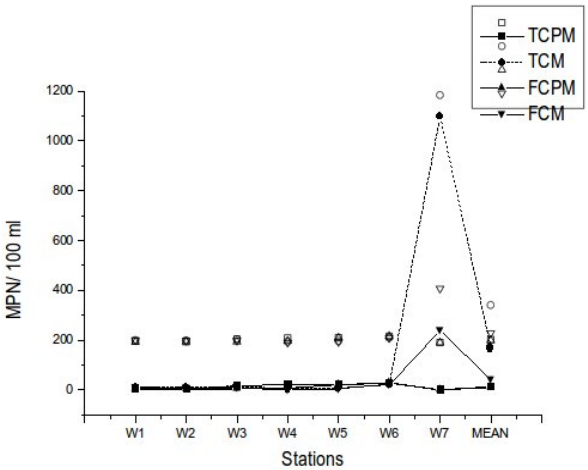

Fig.2 Bacteriological Quality of Groundwater in Pre-monsoon and monsoon seasons

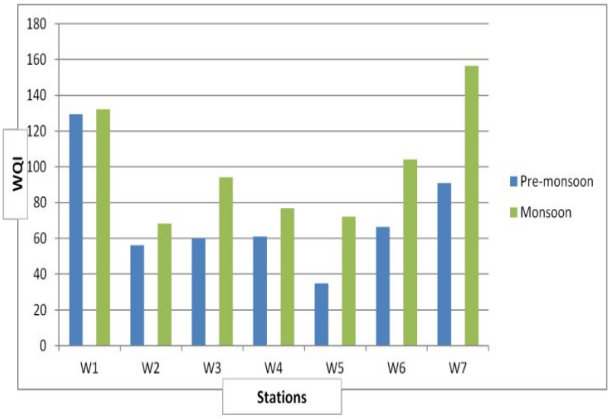

Fig.3 Seasonal variations in Water Quality Index (WQI) of Groundwater

Table 1. Physico-chemical and Bacteriological characteristics of MSW Leachate

Sl.No.	Parameters	Pre-monsoon	Monsoon	CPCB Standards for disposal of treated leachate to	
Inland Surface water	Land				
1	Color	Yellowish orange		Dark Brown	-
2	Odour	Pungent		Fishy	-
3	Temperature(^{0}C)	35		32	-
4	pH	7.8	6.03	5.5- 9.0	5.5- 9.0
5	EC (mS/cm at 25^{0}C)	5.61	3.55	-	-
6	Turbidity (NTU)	10	11.5	-	-
7	Total Alkalinity (as $CaCO_3$,mg/L)	550	650	-	-
8	Hardness (as $CaCO_3$,mg/L)	396	356	-	-
9	Ca^{2+} (as $CaCO_3$,mg/L)	118.6	123.4	-	-
10	Mg^{2+} (as $CaCO_3$,mg/L)	24.36	11.69	-	-
11	Total Dissolved Solids (mg/L)	1630	1050	2100	2100
13	DO (mg/L)	BDL	BDL	-	-
14	BOD_5 (mg/L)	61	60.97	30	100
15	Cl^- (mg/L)	426	234.3	1000	600
16	Nitrates (mg/L)	0.13	0.05	-	-
17	Nitrites (mg/L)	11.58	0.42		
18	Phosphates (mg/L)	0.78	0.43	-	-
19	Sulphates (mg/L)	48.14	13.18	-	-
20	Na^+ (mg/L)	76.2	34.0	-	-
21	K^+ (mg/L)	255.7	12.4	-	-
22	Iron (mg/L)	0.90	3.53	3	-
23	Cd (ppm)	BDL	BDL	2	-
24	Cr (ppm)	0.069	BDL	2	-
25	Pb (ppm)	BDL	BDL	0.1	-
26	Zn (ppm)	0.007	BDL	5	-
27	Total Coliforms	43	1100	-	-
28	Fecal Coliforms	43	1100	-	-

BDL : Below Detectable Limit

Table 2. Physical characteristics of Groundwater during Pre-monsoon and Monsoon seasons

Parameters	Pre-monsoon	Monsoon														
	Sampling stations	Mean	Sampling stations	Mean												
	W_1	W_2	W_3	W_4	W_5	W_6	W_7		W_1	W_2	W_3	W_4	W_5	W_6	W_7	
Color	UO	UO	PY	UO	LY	UO	UO	-	UO	UO	PG	UO	UO	UO	UO	-
Taste	O	UO	O	O	UO	UO	UO	-	O	UO	UO	UO	UO	UO	UO	-
Odour	O	UO	UO	UO	O	UO	UO	-	O	UO	UO	UO	O	UO	UO	-
Temperature (^{0}C)	30	29	30	29	31	30	29	29.71	30	30	30	29	31	29	28	29.57
pH	6.65	5.88	5.22	5.15	5.82	6.55	5.66	5.84	5.58	4.89	3.86	3.56	3.94	3.28	3.40	4.07
EC (μS/Cm)	1102	120.6	175	200.2	69.8	322.3	577.8	366.81	902.3	147.4	210.9	200.4	93.56	428.1	714.8	385.38
Turbidity (NTU)	0.7	0.8	0.9	0.9	0.8	0.8	0.6	0.78	0.8	0.6	0.7	0.8	0.6	0.7	0.7	0.7

PY : Pale Yellow; LY : Light Yellow; PG: Pale Green; O : Objectionable; UO : Unobjectionable

Table 3. Chemical characteristics of Groundwater during Pre-monsoon season

Stn	Alkalinity (mg/L as $CaCO_3$)	Hardness (mg/L as $CaCO_3$)	Ca^{2+} (mg/L as $CaCO_3$)	Mg^{2+} (mg/L as $CaCO_3$)	TDS (mg/L)	DO (mg/L)	BOD_5 (mg/L)	Cl^- (mg/L)	NO_3^- (mg/L)	NO_2^- (mg/L)	PO_4^{3-} (mg/L)	SO_4^{2-} (mg/L)	Na^+ (mg/L)	K^+ (mg/L)
W_1	175	156	35.27	16.56	342.7	5.08	1.02	113.6	0.24	0.13	8.35	39.91	7.3	12.3
W_2	50	40	4.80	6.82	44.67	5.6	0.3	28.4	0.10	0.09	0.08	6.37	2.2	3.8
W_3	25	24	4.80	2.92	52.55	6.2	1.2	28.4	0.46	0.05	0.03	2.21	1.8	4.1
W_4	50	28	3.20	4.87	59.03	6.09	0.8	28.4	0.60	0.06	0.01	2.47	2.2	4.3
W_5	50	20	1.60	3.89	21.22	6.5	0.2	21.3	0.13	0.05	0.03	1.85	2.3	4.0
W_6	25	48	1.60	3.89	96.84	4.06	1.5	35.5	0.36	0.06	0.05	2.21	0.5	13.0
W_7	25	52	8.01	7.79	172.3	5.8	0.5	56.8	0.67	10.26	0.07	0.70	1.9	12.8
Mean	57.14	52.57	8.46	6.67	112.7	5.61	0.78	44.62	0.36	1.52	1.23	7.96	2.6	7.75

Table 4. Chemical characteristics of Groundwater during Monsoon season

Stn	Alkalinity (mg/L as $CaCO_3$)	Hardness (mg/L as $CaCO_3$)	Ca^{2+} (mg/L as $CaCO_3$)	Mg^{2+} (mg/L as $CaCO_3$)	TDS (mg/L)	DO (mg/L)	BOD_5 (mg/L)	Cl^- (mg/L)	NO_3^- (mg/L)	NO_2^- (mg/L)	PO_4^{3-} (mg/L)	SO_4^{2-} (mg/L)	Na^+ (mg/L)	K^+ (mg/L)
W_1	125	128	32.06	11.69	280.6	5.08	2.03	92.3	0.10	0.28	0.05	36.19	7	1.9
W_2	25	20	6.41	0.97	44.45	5.08	1.02	28.4	0.05	0.01	0.09	0.61	0.3	2.0
W_3	25	16	4.80	0.97	60.94	3.04	2.03	42.6	0.02	0.02	8.35	0.97	1.0	2.0
W_4	25	16	3.20	1.94	57.09	3.04	1.01	35.5	0.09	0.10	0.12	3.53	0.8	2.0
W_5	25	12	3.20	0.97	27.34	6.09	2.03	28.4	0.02	0.02	0.06	0.26	0.3	2.0
W_6	25	32	9.60	1.94	126.7	4.06	1.01	56.8	0.38	0.19	0.26	1.23	2.5	2.0
W_7	25	40	9.61	3.89	209.8	1.2	5.08	85.2	0.77	3.39	0.05	0.44	5	1.9
Mean	39.28	37.71	9.84	3.19	115.27	3.94	2.03	52.74	0.20	0.57	1.28	6.17	2.41	1.97

Table 5(a). Irrigational quality parameters of Groundwater during Pre-monsoon season

Stations	% Na	SAR	ESP	RSC	PI	MH	CR
W_1	16.62	0.24	-0.90	6.21	63.68	43.72	0.51
W_2	18.55	0.14	-1.06	1.86	123.29	70.88	0.41
W_3	26.56	0.14	-1.06	0.85	142.59	51.06	0.75
W_4	25.67	0.17	-1.02	0.77	123.43	72.72	0.76
W_5	34.48	0.23	-0.93	2.27	228.12	81.57	0.28
W_6	47.94	0.04	-1.22	2.27	253.74	81.57	0.46
W_7	27.97	0.11	-1.11	0.29	70.27	62.13	1.45

Table 5(b). Irrigational quality parameters of Groundwater during Monsoon season

Stations	%Na	SAR	ESP	RSC	PI	MH	CR
W_1	11.76	0.26	-0.87	4.1	65.89	37.64	0.60
W_2	13.63	0.02	-1.25	0.94	182.05	18.42	0.72
W_3	23.07	0.10	-1.13	1.02	217.64	23.33	1.09
W_4	21.05	0.07	-1.17	1.02	221.21	50.00	0.96
W_5	21.42	0.03	-1.23	1.1	308.69	31.81	0.72
W_6	19.48	0.18	-1.00	0.7	150.53	24.19	1.48
W_7	24.27	0.33	-0.77	0.54	70.70	39.74	2.17

SAR - Sodium Adsorption Ratio; ESP- Exchangeable Sodium Percentage; RSC -Residual Sodium Carbonate;
PI- Permeability Index; MH-Magnesium Hazard;. CR -Corrosivity Ratio.

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Contents

Preface

The Disaster, Risk and Vulnerability Conference (DRVC) 2014 is an outcome of the interest that was generated and the requests for a repeat of the first DRVC, which was held in the School of Environmental Sciences (SES), MG University, Kottayam, in March 2011. The world has witnessed a series of disasters over the intervening period and the Uttarakhand flood was the most devastating and immediate amongst those. Each disaster brings upon us the onerous task of conducting a post-mortem, and inevitably the harsh reality of lessons not learned becomes evident. It is in this context that conferences like the DRVC gain importance as avenues where practitioners from diverse areas that touch upon disasters could come together and listen to each other, share ideas and experiences and discuss possible success stories that could be replicated elsewhere. The papers that populate this volume range from those utilizing technology to tackle disasters or mitigate their effects to those that look at post-disaster interventions, community-based adaptation strategies to GIS-based disaster management strategies.

The University of Kerala is specially thanked for sponsoring the conference at short notice. The Kerala State Council for Science Technology and Environment (KSCSTE) has been very quick to approve the proposal for the DRVC2014, and on behalf of the Organizing Committee I extend my sincere gratitude to the KSCSTE. The Atomic Energy Regulatory Board (AERB) has been keenly associated with the DRVC2011 and had subsequently maintained a close contact with the SES, MG University, which in turn lead to the AERB extending their sponsorship to this progamme. I thank the Secretary, AERB for his support of this conference and for readily agreeing to be part of the inaugural function. The Institute of Land and Disaster Management of the Govt of Kerala (Dept of Revenue) is a co-organizer of the conference, and I thank them for the association which has helped in the planning and execution of this event.

I also thank all my colleagues for their unstinting support in organizing this conference. All the students of the department are thanked for their generous help, and I especially thank my doctoral students, Rajesh and Prasanth, and Saran, an alumnus of the MSc Disaster Management program of SES, MGU for assisting me in all aspects of the conduct of the DRVC2014. Finally, I thank all the delegates who have send in their papers and have gathered here from far and near, for their support and presence here. I also thank the associates of this conference: the Stuttgart, Germany-based Applied Geoinformatics for Society and Environment (AGSE) headed by Prof.Dr.Ing.Franz-Josef Behr, the Stuttgart Active Alumni Group (SAAG), the Charitable Society for Humanitarian Assistance and Emergency Response Training (CHAERT), and the Indian Institute of Emergency Medical Services (IIEMS) for their contributions in the conduct of this conference.

I wish all of you a pleasant stay in Trivandrum and days of fruitful discussions in the conference, and hope to meet all of you again at the next DRVC.

Trivandrum, India
24 April 2014

Dr.A.P.Pradeepkumar
Organizing Secretary, DRVC2014

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HAPHAZARD INDUSTRIALIZATION AND THE RISK OF FIRE: A STUDY ON GARMENTS INDUSTRIES IN DHAKA

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DRVC2014
2nd Disaster Risk & Vulnerability Conference

Abstract

Readymade garments are the most important export item from Bangladesh, yet the working conditions and fire safety records in the factories are often not up to the standard. In Bangladesh, fire accidents in export-oriented garment factories continue to kill workers, most of them women and children. Despite a number of initiatives to curb fire accidents in the garment industry, there are still a significant number of fire occurrences in this industry. The main focus of this paper is to find out garments workers vulnerability to fire risk due to haphazard industrialization in the different areas of Dhaka. Beside this, some other issues also examined such as existence of fire warning system in the garments, workers knowledge about the fire equipments, their personal experience and opinion about fire hazard, any visit from fire service, people's knowledge about existing law on fire drill, condition of gas and electricity lines in the buildings, emergency exit condition etc. For the purpose of the study quantitative methodology was employed and interview is used as a technique of data collection. Six garments were selected randomly by which 180 (30 from each garment) garments workers were interviewed in a same manner. The study revealed that the safety scenario of the Bangladesh garment industry is one of the worst in the world. Since this is a highly labor intensive industry (hence Bangladesh's competitive advantage through its abundant supply of unskilled cheap labor) the sector is also the largest industrial employer in the country with around 3.6 million people directly working in these factories. Inclusion of backward and forward linkages would further increase the number of employees' dependant on this sector. Due to those reasons industries haphazardly grow here and there without following any kind of construction law that enhances the risk of fire hazard further. Fire is one of the most frequent and damage inducing accidents in these factories in Bangladesh. Fire is also purported to be the largest cause of on-the-job injuries and fatalities in this sector. Each new incident of fire and related damage adversely affects the reputation of the industry abroad, especially since the working conditions in the manufacturing sectors in the developing countries is a general cause of concern in many developed countries. Despite the various measures, rules and regulations implemented in the past decades, there are still several instances of fire outbreak in the garment factories every year, resulting in significant losses of lives, livelihoods (through injuries), equipments and materials. These incidents raise questions about the effectiveness of existing fire prevention and fire fighting rules, regulations and practices. Based on this conceptions finally this study formulated a number of recommendations to bring a positive change in the garments industries and round up with conclusion.

Keywords

Industrialization, Risk, Haphazard, Fire, Garments industries

Introduction

The 1980s mark the beginning of the rapid integration of Bangladesh's a small and open home based garment industry into global garment chain as a result of liberalization of the economy. At present the readymade garment industry (RMG) is a highly globalize industry with more than 78% of the country's total foreign earnings generated from this sector. From a humble beginning of 12 enterprises in 1978, the garment industry currently consists of 4,500 factories of various sizes (Muhammad 2011), although around 3,500 are currently operating (Prothom Alo 2013). Almost all of these factories are distributed primarily in the two of the largest cities – Dhaka, the capital and Chittagong, with Dhaka hosting over 70% (Muhammad 2011). The sector is also the largest industrial employer in the country with around 3.6 million people directly working in these factories. Inclusion of backward and forward linkages would further increase the number of employees' dependant on this sector. Fires have been a persistent problem in the country's readymade garment (RMG) industry for over a decade. Clothing is easily flammable and as such fire is one of the most frequent and damage inducing accidents in these factories in Bangladesh. Fire is also purported to be the largest cause of on-the-job injuries and fatalities in this sector. There is some disagreement about the number of worker deaths in the industry. According to the Bangladesh Institute of Labour Studies, 431 workers died in 14 major fire incidents between 1990 and 2012 (Islam & Adri 2008). However, according to Bangladesh Fire Department, 414 garment workers were killed in 213 factory fires between 2006 and 2009 alone (The Daily Star 2010). Given the importance of fire safety in the garment sector, there have been concerted efforts from the government, the industry lobby (Bangladesh Garments Manufacturers and Exporters Associations, BGMEA) and the international buyers of the apparel products, to improve the fire safety culture and this has indeed reduced the fire incidents and losses significantly. However, the battle has not been fully won yet. Despite the various measures, rules and regulations implemented in the past decades, there are still several instances of fire outbreak in the garment factories every year, resulting in significant losses of lives, livelihoods (through injuries), equipments and materials (Ahmed and Hossain 2009). These incidents raise questions about the effectiveness of existing fire prevention

and fire fighting rules, regulations and practices and whether more could be done to limit fire occurrences and fire induced losses of lives and injuries. Especially, enforcement of the rules and regulations and day-to-day health and safety management practices on factory floor is a major issue.

Objectives and scopes of the study

The present study tries to explore the fire hazard vulnerability of garments industries in Dhaka. The study also focuses on fire hazard management scenario of garments industries in Dhaka from the point of institutional capacity of Bangladesh Fire Service and Civil Defense (BFSCD). Beside this some other issues such as existence of fire warning system in the garments, worker's knowledge about the fire equipments, their personal experience and opinion about fire hazard, any visit from fire service, people's knowledge about existing law on fire drill, condition of gas and electricity lines in the industries are the other issues followed during the time of the research.

Methodology

For conducting the research a questionnaire was made for interview where the pattern of the questions was structured. Through the questionnaire the main intention was to find out all possible answers related with fire hazard. That means to know the level of fire risk in the study area. The method applied here was quantitative method. For study purpose six garments were selected randomly from six different areas by which 180 garment workers were interviewed in a same manner as sampling unit. The garments are Borhan Fashions Limited, Mohsin Apparels Limited, Agomony Garments, Monowar Sweeter International, Reliance Stitches Limited and Vai & Vai Garments. For collecting data only interview technique was applied. The entire respondent gave face to face interview. During the time of interview the questionnaire was used as a guideline and beside the selected questions some other questions were also asked to the respondents on the basis of the nature of their answer. After the overall data collection all the data is analyzed manually. The major limitation of the study was the small sample size and absence of any specific theory related with the topic. Considering to the overall boundary of the study area very small number of garments are covered for study. Besides this absence of garments industries authorities' opinion on fire fighting facilities of the industry and failure to get any opinion of the nearest fire station officials is another limitation the study.

Literature review

The fire service department of the government says that nearly 150 workers died due to fire accidents in garment factories from 1990 to 2000. Unofficial sources say this death toll exceeded 250. Over this period, at least 40 incidents of fire have been recorded in different garment factories. In the year 2000 alone, three major fire accidents in three different factories claimed at least 60 lives and injured over 200 people. In 1990, a fire in the Saraka Garments in Mirpur Dhaka left 32 workers dead in stampede. One major cause of this was that the main gate was locked and the panicked workers could not get out of the factory. The reasons and the patterns of deaths in garment fires have remained the same throughout the decade of the 1990s and even in the new millennium. In September 2000, 12 women workers died in a stampede following a fire in Globe Knitwear in Dhaka. The main collapsible gate of the factory was locked during the accident. In October of the same year 50 workers were seriously injured in stampede following a fire in another Dhaka factory. According to Bangladesh Fire Department, 414 garment workers were killed in 213 factory fires between 2006 and 2009 alone. According to the Bangladesh Institute of Labour Studies, 431 workers died in 14 major fire incidents between 1990 and 2012. On the night of 24 November 2012, a fire broke out in Tazreen Fashions, an eight-story garment factory in the Ashulia district on the outskirts of the capital Dhaka. Of the estimated 1,150 people working that night to fill orders for various international brands, 113 were killed and another 200 wounded. The fire reportedly originated from an electrical malfunction on the ground floor, where bales of yarn and fabric were improperly stored. While many workers managed to escape to an adjacent building, others were burned or suffocated to death. On the worst affected third floor sewing unit, sixty-nine bodies were recovered.

Table 1: Deaths in fire accident in garments factories in Dhaka

Year	Deaths
1990	32
1991	5
1993	12
1994	5
1995	9
1996	10
1997	13
2000	60
2004	23
2005	23
2006	62
2010	52
2011	98
2012	132

Source: Research Reference Cell, *Dainik Janakantha, The Daily Star, 27 February 2010, The Daily Star* 15 December 2010, *New Age* 15 December 2010, and bdnews24.com 15 December 2010, 2012.

Theoretical framework

Giddens (2006) said the process of industrialization generated the concept of urbanization where a large number of populations move toward cities and towns. Later the development of modern cities has had an enormous impact not only on habits and modes of behavior but on pattern and thoughts of feeling. On that time cities were seen the fount of dynamism and cultural creativity. Cities maximize opportunities for economic and cultural development and provide the means of living a comfortable and satisfying existence. According to Gunther (1981) and Dodge (1996) fire is one of the earliest innovations of civilization and an essential part of our existence on the earth. Still it is the dreaded demon which burns everything into ashes when it gets out of control. Fire can cause widespread destruction within no time and is one of the most feared scourges of modern civilization. Although fire hazards cannot be fully eliminated, corresponding risk can be minimized by better preparedness and well planned mitigation strategies developed on the basis of comprehensive analysis based on his spatial, temporal and causal pattern. It is vital that hazard level be assessed in order to understand the spatiality of fire hazards and enable distribution of the optimum dynamic resources in a balanced manner. Rayner's (1992) view on this matter is that emergency services need current information to provide quick and adequate response. Such information includes spatial details on land-use, functions of structures, access network and availability of resources. To combat the menace of fire hazard it is required to integrate the spatial context and potential population exposure together with technical and engineering aspects. Blakie (1994) says that the concept of vulnerability is important during the time of fire hazard. It is encompassing the physical relationship between hazards and communities at risk, accident preparedness and the mitigation and the social geography of potentially affected populations. Ulrich Beck was one of the first theoretical giants to recognize the strange paradox in late modern society; that risk might in fact be increasing due to technology, science and industrialization rather than being abated by scientific and technological progress. Rather than a world less prone to risk, late modernity might actually be creating what Beck famously described as a "world risk society." Human species always had to face risks of one kind or another, but today's risks are qualitatively different from those that came in earlier times. Until quite recently, human societies were threatened by external risk-dangers such as drought, earthquakes, famines and storms that spring form the natural world and are unrelated to the actions of humans. Today, however, we are increasingly confronted with various types of manufactured risk (risks that are created by the impact of our own knowledge and technology on the natural world). As we shall see, many environmental and health risk facing contemporary societies are instances of manufactured risk; they are the outcomes of our own interventions into nature.

Findings and discussions

For conducting the research the major limitation was that the sample size was too small. But still some important findings are come out from the conducted research.

Fire Fighting Facilities in the Garments Industries. The main intention of the study was to see the risk of fire in the garments industries. That's why respondents were asked about the existing facilities in the buildings for control fire situation.

Table 2: Existence of proper fire fighting facilities in the garments industries

	Name of Garments Industries					
	Borhan Fashions Limited	Mohsin Apparels Limited	Agomony Garments	Monowar Sweeter International	Reliance Stitches Limited	Vai &Vai Garments
Existence of proper fire fighting facilities	3	9	4	5	30	2
Absence of proper fire fighting facilities	27	21	26	25	0	28
Total	30	30	30	30	30	30

Source: Field work, 2012

Questions were asked on the fire fighting equipments and respondents knowledge about those equipments. Considering the overall study among the six garments industries of the study area only one garments industry has existence of proper fire fighting facilities (Reliance Stitches Limited) however majority of the respondents in other five industries said that they lack from proper fire fighting facilities. So they are in a very vulnerable situation to the risk of fire.

Existence of the Hydrant Box. Hydrant box is a necessary item for every industry in modern time. The respondents were asked about the existence of hydrant box in their industry. 30 respondents (almost 17%) said that in their garments they have hydrant box and 150 (almost 83%) of the respondents said that they have no hydrant box. All the thirty respondents are from Reliance Stitches Limited. As in most of the industries there is no availability of the hydrant box that express the high risk situation of garments industries to fire hazard.

Existence of Fire Extinguisher. Fire extinguisher is the most important thing for fire like situation in both commercial and residential buildings. The respondents were asked about the existence of fire extinguisher, number of extinguisher in per floor and also their knowledge about how to handle it. Among the respondents 120 respondents (almost 67%) said that they have fire extinguisher. The important thing is that some of the respondents said that in the building they have several

extinguishers but most of them are not working and without any expiry date. However, another 60 respondents (almost 33%) said they have no extinguisher in the industry. These sixty respondents are from Borhan Fashions Limited and Vai &Vai Garments.

Table 3: Existence of the Hydrant Box

Answer of the respondents	Number of the respondents	Percentage
Yes	30	16.67
No	150	83.33
Total	180	100

Source: Field Work, 2012

Table 4: Existence of fire extinguisher

Existence of fire extinguisher	Number of respondents	Percentage
Yes	120	66.67
No	60	33.33
Total	180	100

Source: Field work, 2012

Existence of Alarm Bell and Smoke Detector. Existence of alarm bell and smock detector is two most influential equipments in fire like situation. The respondents were asked about the existence of alarm bell and smock detector. Among all the 180 respondents almost all of them said that they have existence of alarm bell. While only 30 respondents agreed about the existence of smock detector and all of them are from Reliance Stitches Limited. There is no availability of smoke detector in other five industries. In any industrial or commercial building absence of these equipments can enhance the possibility of fire like situation.

Table 5: Existence of alarm bell and smoke detector

Existence of alarm bell	Number of respondents	Existence of smoke detector	Number of respondents
Yes	180	Yes	30
No	0	No	150
Total	180	Total	180

Source: Field work, 2012

Fire Exit in the Buildings. According to BNBC (Bangladesh National Building Code), a fire escape is must in non-residential multi storied building with fire resistant door and also with easy access and unhindered route. On the basis of this questions were asked and 90 respondents said that they have fire exit in the industry and they also specify the position of the emergence exit door. On the other hand 90 of the respondents said they have no fire exit in the building. In Mohsin Apparels Limited, Monowar Sweeter International and Reliance Stitches Limited they have one fire exit and the exits are separated from the main office place by a corridor. But in Borhan Fashions Limited, Agomony Garments and Vai &Vai Garments the entrance and exit is same that is why there is no existence of fire emergency exit which make these industries highly vulnerable to fire.

Table 6: Number of fire exit in the buildings

Name of the industries	Number of fire exit
Borhan Fashions Limited	0
Mohsin Apparels Limited	1
Agomony Garments	0
Monowar Sweeter International	1
Reliance Stitches Limited	1
Vai &Vai Garments	0

Source: Field work, 2012

Existence of Under Water Reservoir. The respondents were also asked about the existence of under water reservoir in the building. 30 respondents (16.67%) said that in their garments they have existence of under water reservoir and 150 respondents (83.33%) said that they have no under water reservoir. All the 30 respondents are from Reliance Stitches Limited.

Table 7: Existence of under water reservoir

Existence of under water reservoir	Number of respondents	Percentage
Yes	30	16.67
No	150	83.33
Total	180	100

Source: Field work, 2012

Number of Lift and Staircases. The respondents are asked about the total number of staircases and lift facilities in the garment industry. On the basis of this question nobody mentioned lift facilities in their respective industry. On contrary only Reliance Stitches Limited has multiple numbers of staircases whereas others have only 1 staircase.

Table 8: Number of lift and staircases

Name of the industries	Number of lift	Number of staircases
Borhan Fashions Limited	0	1
Mohsin Apparels Limited	0	1
Agomony Garments	0	1
Monowar Sweeter International	0	1
Reliance Stitches Limited	0	2
Vai &Vai Garments	0	1

Source: Field work, 2012

Condition of Gas and Electricity Line. The respondents were asked questions whether the gas and electricity lines are checked regularly or not in their building. Among 180 respondents only 42 respondents said the electricity and gas line is checked regularly while 48 respondents mentioned no checking. Furthermore most of the respondents observed that the electricity line and gas line is checked on problem basis whereas 5 respondents was not sure about that matter. In garments industries electricity and gas line should be regularly checked otherwise due to short circuit fire incidents could be happen.

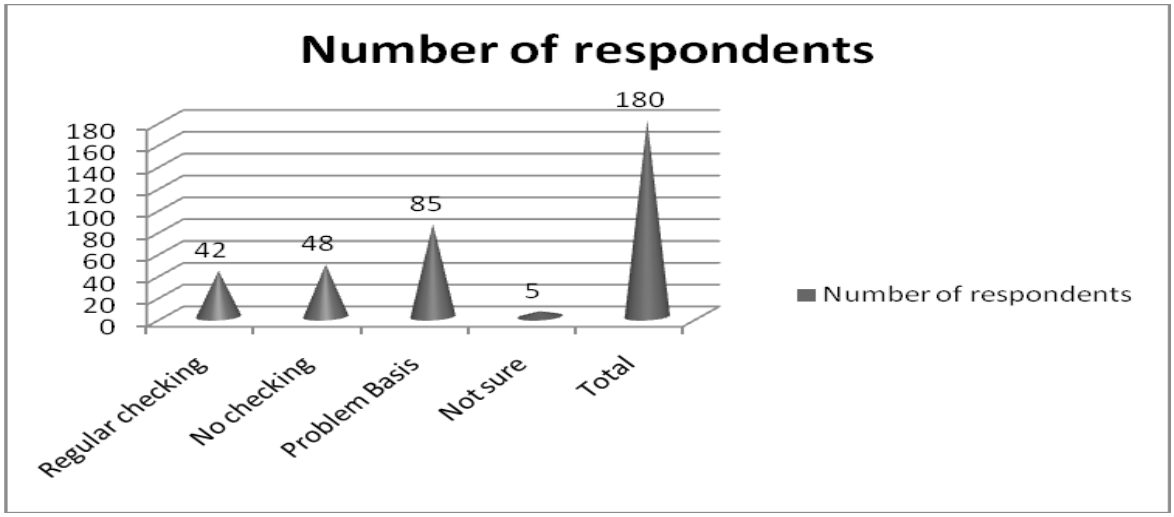

Fig. 1: Condition of Gas and Electricity line (Source: Field work, 2012)

Knowledge on Nearest Fire Station Number. During emergency situation fire station number is very important thing. Among the 180 respondents 27 (15%) said that they know nearest fire station number and also keep the number with them. Most of the respondents (85%) said they do not know the number. All the respondents who know the nearest fire station number worked in a higher position in the office. One of them said that though in his office they have no number of fire station but he personally keep the number for emergency.

Table 9: Knowledge on nearest fire station number

Personally keep fire station number	Number of respondent	Percentage
Yes	153	85
No	27	15
Total	180	100

Source: Field work, 2012

Visit from Fire Service. Respondents were asked whether any inspection team come from fire service. The figure shows that all of the respondents (100%) said that there is no regular visit from fire service in the building. They only come after the happening of fire accident.

Recomendations

Awareness at the Individual Level

1) Media is one of the most powerful sources for awareness generation. The electronic media as well as the newspapers could be an effective source to make people aware of fire hazards. Recently 'Fire Hazard Week' has been observed in many cities of Bangladesh and undoubtedly such initiatives are the great sources of generating awareness among the people.

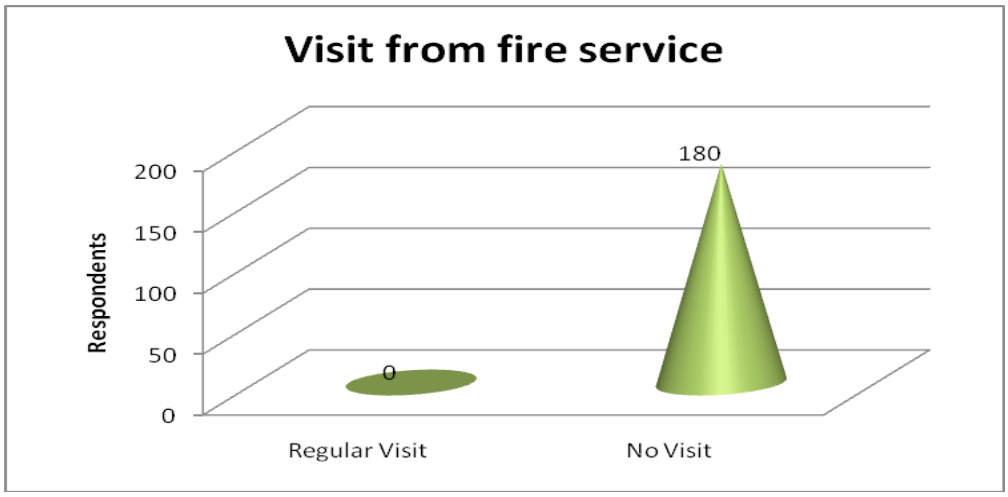

Fig. 2: Visit from fire service (Source: Field work, 2012)

2) At present BFSCDA arranges fire drills particularly in the garment factories and industries in a very limited scale, which requires to be strengthened. The provision of mandatory training should be arranged for the staff working in various residential and commercial buildings.
3) Some billboards could be put in the prominent locations, street intersections with some messages that are helpful to make people aware regarding fire safety. Also the emergency contact numbers of BFSCDA could be displayed in those billboards. Children at school should be taught about the fire safety and some drills can be arranged.
4) Electric short circuit and fire from burner are the two prominent causes of fire incidents in Dhaka City which could be reduced through motivation and generation and awareness of people at the individual level.

City Planning Perspective

1) The city authority should take necessary steps to preserve the natural water bodies. Already many water bodies of Dhaka City have been subjected to the encroachment. An urgent initiate is necessary to recover them.
2) In the unplanned areas, government may take necessary steps to widen the road. Community motivation for participation in this regard is highly encouraged.
3) The government should fix up appropriate land use zoning. Industrial activity and warehouses should not get permission in the residential areas. Proper enforcement of setback rules and FAR should be ensured in building construction. A long term planning is necessary so that the garments industries can be shifted from residential areas to the industrial zones.
4) The risky areas should be demarcated and necessary steps should be taken for remedy. Fire station can be established in the risky locations and in some cases street fire hydrants could be installed in limited scale.
5) Some special smaller sized vehicles can be added to the BFSCDA to provide the service in the locations with narrow road system. Government can allocate sufficient resources for the strengthening of the authority.

Institutional Strengthening
1) Ensure strict enforcement of the existing legal provisions. The manpower of the development control authority and BFSCDA could be increased gradually in order to proper monitoring of the law enforcement.
2) At present, each of the fire stations in Dhaka City is working beyond their capacity. BFSCDA have a future plan to construct 193 more stations all over Bangladesh. However, the stations should be constructed on the priority basis.
3) Modern training program should be provided for the staffs of BFSCDA. Experts should be appointed to demonstrate the efficient rescue service and the handling process of emergency situation. Also the quality of training on Medical First Responder (MFR) and Collapsed Structure Search and Rescue (CSR) should be improved.
4) The government should allocate more resources for purchasing modern firefighting equipment such as pump, ambulance, fire vehicles etc. The number of equipments should be increased in each station.
Risk allowance should be given to the staffs of fire service so that they can work with more dedication and interest.

Conclusions
In conclusion it can be said that fire fighting facilities have to increase in garments industries. Fire fighting equipments such as hydrant box, fire extinguishers are not available in every industry and most of the respondents do not know the use of fire extinguisher. Facilities like alarm bell, smoke detector, fire resistant door, sufficient number of fire exits, personal fire fighters are only available in some industries but the amount is minimum. Beside this for tackling fire situation under water reservoir or any extra source of water is not found in all the buildings and insufficient water supply still exists in the area. Considering to the height of the buildings enough number of lift and staircases are not available.

The important thing is that electricity lines are not regularly checked in most of the buildings. It is a matter of regret that though Dhaka city is now considering in a great risk of fire and urban spaces grows rapidly. Fire service is not taking any proper initiatives. In most of the study buildings no regular fire drill is occurred and there is hardly any visit from fire service for inspecting the condition of the fire facilities in the industries. Even the respondents do not know the nearest fire station number and they also have no idea about the existing law on fire drill. So steps should be taken to solve these problems. People have to give primary knowledge on fire fighting equipments and also have to show them how to tackle the emergency situation. Regular fire drill should be conducted under the guidance of fire service and for this everyone's participation has to ensure. Government has to take proper initiatives on this. They can ensure fire resistant door, emergency exit and separate water line in every garments industry and make people aware about fire hazard.

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GENDER, RELIGION, AND DISASTER SURVIVORS: A NARRATIVE INQUIRY

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Introduction

The Philippines is an archipelagic country that frequently experiences typhoons and torrential rains resulting in floods and landslides. Situated on the "Pacific Ring of Fire," earthquakes and tremors rock its islands from time to time. Through the years the destructions to the environment, properties, and human lives brought about by geohazards have been escalating. In the past three years, the Philippines was hit hard by three super typhoons—Sendong (international codename: Washi) in 2011; Pablo (international codename: Bopha) in 2012; and Yolanda (international codename: Haiyan) in 2013. Consequently, they put the country on the world's humanitarian map. This study explores personal issues in the narratives told by disaster survivors. It also attempts to forge pictures that would represent the meanings they bestowed on their lived experiences during the cataclysmic incidents and in the aftermath.

Methodology

Narratives are the simplest form of communication among people. Telling accounts of events and happenings comes so easily that narratives are ubiquitous in different societies and cultures. "When narrators tell a story, they give narrative form to experience. They position characters in space and time and, in a very broad sense, give order to and make sense of what happened—or what is imagined to have happened" (Bamberg, 2012, p.77).

Through narratives people make efforts to describe, clarify, explain, and normalize a happening, incident, or event. They present their recollected lived experiences and the subjective meanings they attach to them. In telling a story the narrator steps into the center-stage; takes control of the action, characters, setting, and conflict; and weaves these elements into something comprehensible to the listeners. Real or fictional, comic or tragic, a story always conveys a message or theme.

Narrative inquiry as a reformist or non-positivistic approach espouses that "evidence such as personal descriptions of life experiences can serve to issue knowledge about neglected, but significant areas, of the human realm"(Polkinghorne, 2007, p. 2). It can be a powerful instrument in surfacing information and knowledge which cannot be derived using numerical and statistical tools.

As a research methodology, narrative inquiry is non-threatening. It does not directly inquire into people's private lives; rather it simply invites them to share stories of events where they found themselves in. Central to this paper is the idea that the "human life is a storied one" (Flinders University, 2009, p.1). Thus, story-telling comes as second nature to humans.

Narratives and Explication

For this paper, excerpts from the life narratives of survivors in two large-scale disasters in the Philippines are selected. The Guinsaugon Rock Avalanche Tragedy in Saint Bernard, Southern Leyte in the Visayas in February 2006 was the third largest disaster in the world for that year (World Vision, 2008). More than a thousand people died in the landslide resulting from several days of rain. To date, Super Typhoon Pablo (international codename: Bopha) in December 2012 was the worst storm to ever hit the island of Mindanao. This category 5 typhoon claimed over 1,000 human lives and left thousands of inhabitants homeless, displaced, and uncertain of the future.

The main focus of this paper is not the disastrous events *per se*, but the meanings ascribed by the narrators (study participants) to their lived experiences during the cataclysmic incidents and thereafter. The first two narratives are from the Guinsaugon Rock Avalanche Tragedy (Carriedo, 2012) and the remaining two from Super Typhoon Pablo. In the presentation, the narrative data come first, followed by the explication.

Mara

Mara was about 20 years old, a slim, petite woman with curly hair, and dark complexion. She spoke Tagalog interspersed with Visayan words from time to time. This indicated that she was not a local or someone from any part of the Visayas. Her husband and two little daughters had died in the landslide. People at her evacuation center considered Mara a wild, problematic person. In her estimate, the money she received from both government and private donors amounted to about Php 50,000 (US$1,000 more or less). But instead of using it to start up a new livelihood, she wasted it all on alcohol and going to the discos.

My two little daughters and I were in our yard on the day of the disaster. Without any inkling, mud flood just engulfed us! It happened so fast! I lost consciousness! When I woke up, I was in the evacuation center. People informed me that my husband and two kids had all died in the landslide!

She sobbed, rubbed her eyes, and continued her story. In the course of her narrative, I found out that this young woman was an indigenous person from Luzon, which explained her speaking Tagalog.

When I was a child, both of my parents died and so I grew up living with relatives who maltreated me. When I became older, in my teens, I went to Manila seeking for a job. There I met my future husband, who was from Guinsaugon. After we married, we decided to leave Manila for Guinsaugon and raise our family here. My life changed for good. I got a loving husband and two adorable, little daughters.

She started to cry again. Overwhelmed by great sorrow, she uttered these words:

What did I do wrong? Why was the only man who loved me taken away from me? What kind of a mother was I? I wasn't able to save even one of my daughters!

Then she added:

I feel I no longer know myself. This wasn't me before. I wasn't really this bad at all!

From the above narrative, it is clear that Mara needs more than material help. The questions she asks are rhetorical questions. This type of question(s), a figure of speech, does not need or require an answer. Rhetorical questions are said or asked to help express or release strong emotions.

In Mara's rhetorical questions, two personal issues emerge: 1) worldview of disaster as divine punishment and 2) survivor guilt. Nader (2001, p. 1) describes *survivor guilt* as a type of "imagined guilt" with "an element of wishful thinking about one's ability to act." In Mara's case, her survivor guilt stems from her inability to rescue either of her daughters. As a mother and someone older, there is an unspoken gender role expected of her to perform: that of a protector and savior. But due to the velocity of the mud slide that sweeps them all away—estimated at 100-140 kilometers per hour (Lagmay, 2006)—she loses consciousness. Now she lives with the pain of being the sole survivor in her family. Why did her husband—the only person with whom she experienced true love and care—have to die, including their children, while she is left all alone to suffer grief and bear the guilt of failing to save even one of them?

Mara resorts to drinking and going to the discos as a way to drown her sorrows. The large amount of money she receives is only "helpful" in buying alcohol and going to loud, fast-beat dances to momentarily forget the pain of losing her family. Substance use, in Mara's case alcohol, is relatively common in people who experience disasters, lasting six to 12 months after the event (Ursano, Fullerton, & Norwood, n.d.). But in her sober moment, Mara is aware of the change in her personality. *I feel I no longer know myself. This wasn't me before. I wasn't really this bad at all!*

This case is an example of misused humanitarian assistance. The money is not spent on what it is intended—for livelihood or any productive endeavor. Donors and those who are in the administration of humanitarian assistance could learn from Mara's case. It is not enough to dole out money. The psycho-emotional condition of disaster survivors is a significant factor that has bearing on the success or failure of any well-meaning efforts to help them return to normalcy.

Disaster survivors need psycho-emotional support and services. Small (1990, p. 6) points out: [People in crisis] need to release the pent-up energies of rage and hurt that block clear thinking. And they need some reminders about who they really are beyond the current melodrama, grief, or fear they've gotten caught up in. They also need to be reminded of their strengths, as well as empathized with about the ways they've gotten hurt and off track.

The worldview of disaster as divine retribution exists not only in Philippine culture. Major religions such as Christianity, Judaism, Islam, Hinduism, primal religions, and other faith persuasions have teachings on cataclysmic events as God's punishment for people's sins and wrongdoings, or in the case of Hinduism and its related religions, karma (Ahmad, 1993; Gerstenfeld, 2000; Jayaram, 2000; Karmodi, 2011). However, there are religious people and non-believers who think otherwise. They attribute catastrophic phenomena to climate change or to processes taking place as part of the course of nature (Geller, 2011; Karmodi, 2011; Straw, 2011).

On Mara's part, it crosses her mind that losing her husband and children in the landslide can be God's punishment. And yet, she cannot readily point out the specific sin(s) she has committed to warrant such tragic, divine chastisement. This compounds her misery, feeling alienated from God.

The concept of "disaster as divine retribution" is a common, yet crucial issue, something to be dealt with caution. To sweepingly regard all cataclysmic events as divine retribution may blind people from the real, contextual factors that surround and contribute to the making of disasters such as environmental abuses. Besides

nailing survivors down with guilt, this worldview may also encourage passivity in people and prevent them from seeing that there are events which can be avoided by means of mitigation and preparedness. The 2005 Hurricane Mitch that hit Morolica in Honduras was perceived by many Catholics and Evangelicals as divine punishment. The location of the community on the two flood-prone plains was not taken into account. Only a few residents evacuated on time; logically, many perished for remaining in the place when danger was imminent (Reale, 2010).

Furthermore, not everyone can accept that disasters are God's punishment. Insisting that it is so can be divisive in times when social cohesion is needed most (Taylor, 1999). Both the good and the bad are affected by disasters. Even law-abiding and God-fearing people suffer and die as part of the course of events. For Fr. Kravtsov (Karmodi, 2011), to regard God as a mere judge and executioner is to create a false image of God, who is also a forgiving and loving God. So instead of condemning people, let us pray for the victims and help those who suffer. Disasters can become occasions for us to contemplate the brevity and fragility of human existence. Depending upon one's lived experience; disasters can spark faith, inspire more goodness, increase disbelief, snuff out waning faith, or even breed more apostasy and lawlessness.

Romeo

Romeo, early 20s, and his wife were walking down a road when suddenly mud flood just swept them away.

My wife and I went out together on the day of the disaster. We were walking down the road when rushing mud flood just suddenly appeared from nowhere. I tumbled and rolled! My wife and I were separated! Then I passed out!

Romeo was silent for some minutes, struggling with his feelings. He labored in silence, trying to get hold of himself. His breathing became uneven. He sighed. More silence. Moments later, he started talking again:

What if I did not pass out? I could have saved her.

He paused again and reflected. In a grieving voice, he added an afterthought:

Maybe not! What a flood! Super!

Romeo got emotional, tried to fight back his tears. More silence. Then he said:

There were small landslides before, but I never imagined the mountain could crumble down that way! It was raining as usual. But the mud flood, it never ever crossed our minds that such thing could happen!

Like Mara, Romeo also suffered from survivor guilt, from his inability as a husband to help and save his wife. However, unlike Mara who is stuck in her pain, in Romeo there is a movement toward acceptance of his limitation, thinking that it could be beyond his capacity to rescue his wife because it was a super mud flood. The end part of Romeo's narrative is revealing. Pocket landslides were common sights prior to the landslide, but were regarded as "common phenomena," instead of warnings of a forthcoming, serious geohazard. This shows lack of environmental education. Otherwise, he and his wife would not go out for a casual walk on the day of the landslide.

The Engineering Conferences International or ECI (2006, p. 1) defines *geohazards* as "events caused by geological features and processes that present severe threats to humans, property and the natural and built environments." Typical examples of these events are floods, earthquakes, avalanches, landslides, volcanic eruptions, and tsunamis. Take note: ECI only regards these phenomena as geohazards; they are threats to humans, but not necessarily disasters.

For Dr. Jörn Birkmann, scientific head of the *World Risk Index 2011* project, "Natural events do not necessarily cause disasters, because risk not only depends on the hazard, but is very much determined by social and economic factors" (IEHS, 2011, para. 3). Education and preparedness of the people are among the social factors that determine their capacity to face and cope with geohazards. These factors are absent in the couple walking ordinarily out in the rain.

Dan

Dan, late twenties, was a public elementary school teacher assigned in a remote area. The day before Typhoon Pablo made a landfall, he and his colleagues had received text-message advisories of an incoming typhoon. They did not take them seriously. The weather was fair, the sun shone so bright.

It was only toward the evening that the wind grew strong and began to howl. Rain started to pour hard. My wife and two little boys were frightened by the sound coming from our roof—from the GI sheets that the strong wind threatened to blow away. I gathered my boys in my arms, trying to comfort them. I was also afraid. I felt helpless and terrible as a father and husband who could not provide a durable dwelling for my family.

I thought that if we die, we would die together as a family. I pray to God to spare us. At my age, I never gave serious thoughts to dying before. Existence finitude became so real to me at that very moment. I was frightened, but needed to be strong for my family.

Looking back, I realize that my family matters most to me. Now, it's my foremost desire to build a house that is safe enough for my boys and wife to live. I'm also grateful to God that we are all alive. As a teacher, I want to protect my pupils like my own children by instructing them, as well as the community about disasters and how to prepare for such events. So many things to be done… I'm committing myself to this task.

In this account, it dawns on Dan that as a husband and father it is his role and responsibility to protect his family by providing them safe dwelling. Structural integrity—the amount of force a building or structure can hold or take before it breaks—does matter. Dan realizes this. Houses mostly made of light materials such as wood, thatches, GI sheets, cardboards, and the like can be easily blown away or toppled down by strong wind, heavily-pouring rain, and floods. Poverty as an economic factor contributes much in the making of disasters.

Location, in addition to structural integrity, plays a crucial role in disasters. Ericksen (2004) wants people to focus on "human use of an area" in ascertaining both *potential* hazards and *actual* disasters. By settling in places where extreme natural events do or are likely to happen, people are courting their own *potential* hazards; and consequently creating their own *actual* disasters. He prescribes land use planning as the most effective way to reduce hazards and losses brought about by extreme natural events. "Preventing disasters requires aiming our efforts not so much at controlling nature and relieving losses, but at the natural hazards that people are responsible for creating" (Ericksen, 2004, p. 1).

It is painful for Dan to see and admit his inadequacy to provide a decent house for his family, and yet this experience turns into a burning desire to construct a better dwelling. Nouwen (1979) reflects that when we realize that we do not have to run away from our pains, but instead use them to find meaning for living; they turn from manifestations of despair into promises of hope. Dan is able to transcend his unpleasant experience and find some enlightenment in his encounter with Typhoon Pablo. Besides constructing a decent house, he is powered-up to do more in his teaching, not only for his pupils, but including the community—that they be prepared for future catastrophic events.

Dan is also grateful for the second chance at life given to him and his family. He contemplates that life is not only about living, it is also about dying. This realization has spiritual implications, among which is to prepare for the life hereafter. In constructing the meaning of his lived experience with Typhoon Pablo, Dan comes up with an evolving story of himself that "integrates the reconstructed past, perceived present, and anticipated future" (MacAdams, 1996, p.301).

Julia

This girl was a vivacious teenager, age 16, who joined an inter-diocesan youth camp last April 2013. During the sharing of lived experiences, she gave this account.

I was at the house of my grandmother at the time of the typhoon. When it was still daytime, I learned from the radio and TV that there would be a coming typhoon. I got excited, I had never experienced typhoons before! I thought to myself, "How would it be like to have an actual experience of typhoon?" All I know about typhoons is what I saw on TV, in other places like Manila.

My excitement was mounting up. I was more excited than scared. At nighttime, the winds were blowing so strong It rained hard, too. You could hear people shouting outside. My feeling of excitement started to turn into fright. We prayed to be spared . . . it started to flood.

On the day that the youth campers would return home, Julia and a friend allegedly experienced something unusual in the room where they were staying. She recounted:

The door of our room just opened and closed by itself. I felt the presence of a "spirit." And there was this dead child whom I saw during the typhoon. The child opened her eyes and stared at me! She called me, "bad"! Days earlier, I wanted to tell the camp facilitators about this, but the child warned me not to. It would be bad of me to tell them! She'd be angry with me! I'm bad! Bad! Bad! The child re-appeared to me here in the camp not only once… She had already stopped visiting me before I came here. Now she's back, bothering me again! She was already dead! And yet her eyes opened suddenly! She looked at me with angry eyes, calling me bad! She's haunting me!

Julia's narrative belongs to the "ghost story" genre. Stories of spirits and the restless dead— especially those who experienced untimely deaths during accidents, calamities, and armed conflicts— abound in Asian cultures (Guillou, 2012). Although Philippine society is predominantly Catholic, animistic beliefs are pervasive. Whether Julia's story is real or just a product of her imagination, this is besides the point. The task of this narrative

inquiry is not to look for historical truth, but to uncover the significance of the narrative data (Kramp, 2004). How Julia construes her lived experience during Typhoon Pablo is what is of interest. Julia perceives herself as *bad*. She insists that the child was *already dead* during the typhoon and now is back to haunt her. This is another case of survivor guilt, Julia not able to do something for the child. Julia left the child behind in the flood, thinking she was dead. Somehow, in her subconscious, Julia entertains the possibility that the child could have been saved and still be alive now if she only extended help.

Guinsaugon after the Rock Avalanche Tragedy. (Photo credit: SM Carriedo)

White flags mark spots where dead bodies were recovered. (Photo credit: SM Carriedo)

A schoolboy surveys the damages left by Typhoon Pablo. (Photo credit: SM Carriedo)

The ghost story could be a projection of Julia's unspoken survivor guilt. She makes use of a belief (existence of restless spirits/souls) readily available in Philippine culture to articulate something that is gnawing at her conscience. This way, Julia is able to create a narrative that concretizes or gives form and sense to the psycho-emotional conflict raging inside her. Her ghost story is something anybody can understand though not everyone believes. The re-appearances of the dead child calling Julia "bad" and warning her not to tell anybody about the "visits" lest the former would be angry with her, are a form of self-inflicted punishment for her being "bad"—not

helping the child and feeling excited about the coming of a typhoon that eventually curtailed many lives. Her guilty mind would not let Julia rest. She sees flashbacks of the scene at the time of the flood where she saw the dead child. *She was already dead! And yet her eyes opened suddenly! She looked at me with angry eyes, calling me bad!* What is positive though in Julia's story is that she finally finds the courage to put an end to the "oppressive revenge" of the dead child. Julia tells others about her.

Although Julia's story may sound weird or unacceptable in different settings, still it is her story and deserves to be respected. What matters to me as a narrative researcher is the underlying meaning she attaches to it. There is possibility that Julia's relating of her ghost story may differ, depending on to whom she is talking, when and where she is. Even so, the concern of this narrative inquiry is not the verification of proof of reality, but the "verisimilitude—the appearance or likelihood that something 'could be' true or real." (Kramp , 2002, p.108).

In the movie, *Life of Pi* (2012), the main character Pi tells two stories/versions of what has happened to him after the ship he and his family boarded on the way to Canada capsized. One story is about him and the survivor-animals on a tugboat; and another of him, his mother, the nasty cook, and the vegetarian Buddhist. In both versions there are struggles for survival among the characters, killing, and dying. At the end of the film, the viewers are challenged which version to believe. Is the first story just hallucination? A symbolic way of informing Pi's listeners about himself? Is the second version the true one or merely contrived to accommodate what the realists want to hear?

The ghost story is Julia's creative, indirect way of telling us her lived experience during Super Typhoon Pablo. Through it we learn that behind her vivacious façade is a frightened teenager who is suffering from qualm of conscience, guilt feeling for her act of omission—not doing anything for a helpless child during the flood.

Apprehending the significance of a phenomenon under investigation can also be derived from alternative or other meanings presented, notwithstanding whether others accept them or not. Thus, as a co-interpreter of Julia's lived experience, I also attempt to make sense of her narrative data through my independent, personal lens. My take of her ghost story is different from what she sees and understands, and may also be different from those of the readers'. Hence, the explication of meanings is open-ended. This is not a limitation of this (qualitative) inquiry, but an opportunity to explore further enlightenments.

With all its scary nuances, Julia's ghost story offers us a glimpse of the inner struggle taking place inside someone who is battling with survivor guilt in the aftermath of a disaster. As a life narrative, her story resonates the point which Doan and Parry (1994, p.2) try to drive at, "The hearers of the story believed that it was true because it was meaningful, rather than it was meaningful because it was true."

Recommendations

Based on the findings, the following are recommended:

1. Provision of psycho-social-spiritual support and services to disaster survivors
2. Teaching of environmental education in schools as well as in communities
3. Trainings in disaster preparedness and mitigation for individuals and communities.

Transferability

The findings in this paper are contextually interpreted within specific cultural and interpersonal settings. As such, it is up to the audience or readers to identify similarities and differences between the context of the study and theirs; to choose and decide which elements are applicable and transferable to their respective realities.

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CLIMATE CHANGE VULNERABILITY AND AGRARIAN COMMUNITIES: INSIGHTS FROM THE COMPOSITE VULNERABILITY INDEX OF ANDHRA PRADESH AND KARNATAKA

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Abstract

Climate change is a main challenge for agriculture, food security and rural livelihoods for over a billion people in India. Agriculture is the sector most vulnerable to climate change due to its high dependence on climate and weather conditions. Among India's population of more than one billion people, about 68% are directly or indirectly involved in the agricultural sector. This sector is particularly vulnerable to present-day climate variability. In this context this paper examines the Socio-economic and climate analytical study of the vulnerability index in Andhra Pradesh and Karnataka states using secondary data; it examines the vulnerability through five different Sub-indicators of socio-demographic, agriculture, occupational, common property resource (CPR), and climate in respective states among different districts. The data was used in this paper was taken from different sources, like census in India 2011, Directorate of Economics and Statistics of respective states governments. Rainfall data was collected from the India Meteorological Department (IMD). In order to capture the vulnerability from two different states the composite vulnerability index (CVI) was developed and used. This indicates the vulnerability situation of different districts under two states. The study finds that Adilabed district in Andhra Pradesh and Chamarajanagar in Karnataka had highest level of vulnerability while Hyderabad and Bangalore in respective states have lower levels of vulnerability. Further, it also notices that the index was mapped using Geographical Information Systems (GIS) maps and it has been observed that almost similar districts from two states are found to be facing the highest vulnerability.

Keywords
Climate Change, Agriculture, Composite vulnerability index, GIS

Introduction

Climate change will have a profound impact on human and eco-systems during the coming decades through variations in global average temperature and rainfall (K N Ninan et al, 2012). A growing body of literature in the past two decades has identified climate change as the prime issue in global environment, analyzed the associated vulnerability and biodiversity loss (Fourth Assessment Report of the Intergovernmental Panel on Climate Change). Vulnerability is the degree to which a system is susceptible to or unable to cope with adverse effects of climate change including climate variability and extremes (IPCC, 2001a). According to Fussel (2007), climate related vulnerability assessments are based on the characteristics of the vulnerable system spanning over physical, economic and social factors. The Intergovernmental Panel on Climate Change (IPCC), in its second assessment report, defines vulnerability as "the extent to which climate change may damage or harm a system." It adds that vulnerability "depends not only on a system's sensitivity, but also on its ability to adapt to new climatic conditions" (IPCC,2001).

The lack of formal methodologies in the area of climate change - vulnerability relationship poses a big challenge and also an opportunity to continue research in this area. A study by Intergovernmental Panel on Climate Change (IPCC), links vulnerability with climatic change, and points out that the vulnerability of a region depends to a great extent on its wealth, and that poverty limits adaptive capabilities (IPCC, 2001). Further, they argue that socio-economic systems "typically are more vulnerable in developing countries where economic and institutional circumstances are less favourable". Also a common theme in the climate change impacts and vulnerability literature is the idea that countries, regions, economic sectors and social groups differ in their degree of vulnerability to climate change (Bohle et.al., 1994). This is due partly to the fact that changes in climatic patterns are uneven and are also not evenly distributed around the globe. Though vulnerability differs substantially across regions, it is recognized that "even within regions… impacts, adaptive capacity and vulnerability will vary" (IPCC, 2001). With respect to Africa, studies point out that climate change, mainly through increased extremes and temporal/spatial shifts, will worsen food security (IPCC, 2001). In the Indian scenario it is also likely that there will be an increase in the frequency of heavy rainfall events. Globally, the average temperature change is predicted to be in the range of 2.33° C to 4.78° C with a doubling in CO2 concentrations (Watson et.al, 1998). Vulnerability is often reflected in the condition of the economic system as well as the socioeconomic characteristics of the population living in that system. A study by Rao et al, (2013) presents the analysis of vulnerability of

agriculture to climate change and variability at the district level considering the fact that most of the development planning and programme implementation is done at the district level in India. Also, most of the non-climatic data that is integral to assessment of vulnerability to climate change and adaptation planning is also available at the district level. The analysis was done for the 572 rural districts as appearing in the 2001 Census of India. The study finds that looking at different indicators related to climatic projections also showed that some districts where the annual rainfall and the number of rainy days is likely to increase actually present some opportunities for harvesting more rain water which can be helpful in improving crop production and productivity. The study suggested that there is a need to redesign rainwater harvesting structures and strategies to handle higher runoff in a shorter period so that surplus water is harvested while preventing soil loss too. There are also some districts where the incidence of drought is projected to decline. Plans and strategies are therefore to be put in place to optimize crop yields and incomes from such improved situation. Such opportunities can be gainfully harnessed which in fact will be a significant step towards making Indian agriculture more climate resilient and smart.

A study by O'brien and Mileti (1992) on "Citizen Participation in Emergency Response Following the Loma Prieta Earthquake" examines the vulnerability to climate change and stated that in addition to economic well being and stability, being important in the resilience of populations to environmental shocks, the structure and health of the population may play a key role in determining vulnerability. Age is an important consideration as the elderly and young persons tend to be inherently more susceptible to environmental risks and hazards exposure. Generally populations with low dependency ratio and in good health are likely to have the widest coping ranges and thus be least vulnerable in the face of hazard exposure. Further, they also suggest that collective identification may be necessary but not a sufficient cause for collective action in response to disaster. Another interesting study by Handmer et al., (1999) examined the coping mechanisms to environmental shock or hazard brought about by biophysical vulnerability. The factors like institutional stability and strength of public infrastructure are crucial importance in determining the vulnerability to climate change. A well- connected population with appropriate public infrastructure will be able to deal with a hazard effectively and reduce the vulnerability. Such a society could be said to have low social vulnerability. If there is an absence of institutional capacity in terms of knowledge about the event and ability to deal with it, then such high vulnerability is likely to ensure that biophysical risk turns into an impact on the human population. Atkins, J., S.Mazzi, and C.Ramlogan, (1998) Studied on the Vulnerability of Developing and Island States: A Composite Index". They calculated the methodology for measurement of vulnerability and to construction of a suitable composite vulnerability index for developing countries and island states. The composite vulnerability indices were presented for a sample of 110 developing countries for which appropriate data was available. The index suggests that small states are especially prone to vulnerable when compared to large states. The small states, such as Cape Verde and Trinidad and Tobago are estimated to suffer relatively low levels of vulnerability and majority of the states estimated to experience relatively high vulnerability and the states like Tonga, Antigua and Barbedos being more vulnerable to external economic and environmental factors.

A study conducted by Chris Easter, (2000) "The Common Wealth Vulnerability Index. He estimates a vulnerability index for the commonwealth countries, which is based on two principles. First, the impact of external shocks over which the country has affected and second the resilience of a country to withstand and recover from such shocks. The analysis used a sample of 111 developing countries of which 37 small and 74 large for which relevant data were available. The results indicated that among the 50 most vulnerable countries, 33 were small states with in this 27 are least developed countries and 23 are islands. In the least vulnerable 50 countries, only two were small states. A study on assessing Indian cities for vulnerability to climate change by Kelkar et al (2011) critically evaluates the vulnerability of Indian cities to climate change in the context of sustainable development. City-scale indicators are developed for multiple dimensions of security and vulnerability. A factor analysis is employed to construct a vulnerability ranking of 46 major Indian cities. The study reveals that high aggregate levels of wealth do not necessarily make a city less vulnerable, and cities with diversified economic opportunities could adapt better to the new risks posed by climate change, than cities with unipolar opportunities. Finally, highly polluted cities are more vulnerable to the health impacts of climate change, and cities with severe groundwater depletion will find it difficult to cope with increased rainfall variability. The study also suggested that the policymaking by fostering greater appreciation of the multi-dimensional aspects of sustainability and vulnerability

A study conducted by Heltberg and Bonch-Osmolovskiy (2011) on mapping vulnerability to climate change develops a methodology for regional disaggregated estimation and mapping of the areas that are ex-ante the most vulnerable to the impacts of climate change and variability and applies it to Tajikistan, a mountainous country highly vulnerable to the impacts of climate change. They have constructed the vulnerability index as a function of exposure to climate variability and natural disasters, sensitivity to the impacts of that exposure, and capacity to adapt to ongoing and future climatic changes. The study found that vulnerability varies according to socio-economic and institutional development in ways that do not follow directly from exposure or elevation: in climate change, geography is not destiny. And also indicate that urban areas are by far the least vulnerable while RRS oblast, in particular its eastern mountainous areas, is the most vulnerable and the remote GBAO mountains rank in the middle. Most of the other studies try to measure the vulnerability of a region to specific events like sea level rise, changes in temperature, rainfall etc. The present study attempts to the Socio-economic and climate analytical study of the vulnerability index in Andhra Pradesh and Karnataka states. The analysis is carried out at the district level. The vulnerability of a particular district is measured by the frequency of occurrence of extreme events, in this case the occurrence of cyclones, storms and depressions. The study aims to build a vulnerability index and rank the various districts in the southern states of India namely Andhra Pradesh and Karnataka terms of their performance on the index. The index tries to capture a comprehensive scale of vulnerability by including many indicators that serve as proxies. Specifically, the study looks at two different sources of vulnerability:

viz., the demographic factors, agricultural factors, occupational factors, climatic & CPR factors. Based on this, a composite index has been created for the districts in the above mentioned southern states.

Data sources

Two states were selected for this study namely Andhra Pradesh and Karnataka. There are 21 indicators used for the construction of vulnerability indices at particular time period of 2011 for the 2 selected states of India. Out of the 21 indicators, 9 indicators are concerned with socio-demographic vulnerability, 4 indicators are related to occupational vulnerability, 4 indicators deal with agricultural vulnerability and the remaining 4 indicators represented the climate and CPR vulnerability component. The data pertaining to various socio-demographic, occupational, agricultural indicators were collected and compiled from different sources, like census in India 2011, Directorate of Economics and Statistics of respective states' governments. Rainfall data was collected from the India Meteorological Department (IMD). Vulnerability is very often reflected in the state of the economic system as well as the socio-economic features of the population living in the system. In order to understand this, we intend to compute vulnerability index covering socio-Demographic, occupational, agricultural, climatic and CPR dimensions across various districts and ecosystems in southern states of India. Based on these indicators we constructed a composite vulnerability index.

Methodology

There are several methods for evaluating the level of vulnerability but most of them are having their own limitations. A major limitation arises from the assumptions made about the vulnerability indicators themselves and their weightage in the aggregate index. Some of these methods for combining the effect of various indicators are presented here along with their limitations.

Limitations of Old Methods

Principal Component Analysis. Mostly the 'factor analysis' approach is used. The method is generally based on restrictive assumptions regarding the vulnerability indicators. It assumes that the variable indicators are linearly related. When non-linearity is present, the component analysis is not appropriate. Further, one cannot assign any special meaning to the transformed variables with respect to socio-economic vulnerability. They are artificial orthogonal variables not directly identifiable with a particular economic situation.

Multiple Factor Analysis. The main advantage of this method is that the 'factor loading' can be used as weights for combining the effect of various indicators. This method avoids, to some extent the arbitrariness in choosing weights. This method does not serve the purpose to arrive at a meaningful and comparable composite index of vulnerability when the indicators are presented in different scale of measurements.

Aggregation Method. Simple addition of the values of the vulnerability indicators is taken as composite index of vulnerability. The method is not suitable as the composite index of vulnerability obtained by use of the method depends on the unit in which the data is recorded.

Monetary Index. Vulnerability indicators are converted into monetary values and the total of these values is taken as the composite index of vulnerability. Monetary values of vulnerability indicators may change from place to place and from time to time. In this way this method affects the composite index adversely. One more difficulty may also come in this method because all the indicators cannot be converted into monetary values. Indicators like 'death rate', 'birth rate', 'sex ratio', literacy rate' etc. cannot be converted into monetary values.

Ranking Method. Each unit is allotted ranks based on different vulnerability indicators. Sum of ranks for all the indicators of the unit is taken as the composite index of vulnerability. The ranking procedure does not take into account the magnitude of differences between indicators and units.

Proposed Method of Estimation of Composite Index of vulnerability

Keeping in view the limitations of the above methods, the following estimation procedure of composite index is followed in this study.

Normalization of indicators using functional relationship. A normalization procedure was adopted for adjusting the indicator values to take the values between 0 and 1 using following formula;

Step 1: The dimension index for each of the indicator for each ecosystem (xi) is computed as

$$X_{ij} = \frac{X_{ij} - MinX_i}{MaxX_i - MinX_i} \qquad (1)$$

Whenever an indicator has negative relationship with vulnerability then the index is calculated as:

$$X_{ij} = \frac{Max\ X_i - X_{ij}}{MaxX_i - MinX_i} \qquad (2)$$

This is possible when, for example, higher literacy leads to lower vulnerability. Where, Xij is the normalized value of vulnerability indicator, X_{ij} is the value of ith vulnerability indicator in the jth block, 'Min Xi and 'Max Xi ' denote to the minimum and maximum value of the ith vulnerability indicator across district.

Step 2: Calculate an average index for each of the five sources of vulnerability viz. Socio-demographic, Climatic, Agricultural and Occupational, CPR vulnerability. This is done by taking a simple average of the indicators in each category.

Average Vulnerability Index $(AVI)_i$ = [Indicator 1 +……. + Indicator J] / J (3)

Step 3: Aggregate across all the sources of vulnerability by the following formula.

$$\text{Composite vulnerability index} = \frac{\left[\sum_{i=1}^{n}(AVI_i)^{\alpha}\right]^{1/\alpha}}{n} \quad (4)$$

where n is the number of sources of vulnerability and $\alpha = n$. The vulnerability indices can be worked out for each period of time and they can be compared to assess the changes in vulnerabilities over the period of time.

Functional Relationship of Indicators with Vulnerability. The table 1 shows the functional relationship between the indicators and vulnerability. In this study we used the following broadly classified categories namely, socio-economic & demographic, occupational, climatic, CPR and agricultural indicators. The density of population of the district was found to influence its demographic vulnerability and consequently the overall vulnerability to climate change. It was assumed to be positively related to the vulnerability to climate change, *i.e.,* with the increase in the number of persons per sq. km., the vulnerability would increase due to its direct impact on global warming.

Table: 1-Functional Relationship between Indicators and Vulnerability.

Components	**Indicators**	**Functional Relationship**
Socio-Demographic	a) Average HH Size b) Density of population (persons per sq. km) c) % of female d) Growth of Population e) % of SC Population f) % of ST Population g) % Literacy h) Sex ratio i) BPL	+ + + + + + - + +
Occupational	a) % of Marginal workers b) % of Non Workers c) % of cultivators d) % of agricultural workers	+ + - +
Agricultural	a) Cropping intensity b) % of irrigation area c) % of Fallow land d) % of net sowrn area	- - - -
Common Property Resources	% OF CPR to TGA % of animal live stock to CPR	- +
Climate change	a) Rain fall variation b) Drought area	+ +

Sources: Developed by authors.

The literacy rate, on the other hand, was presumed to have a negative functional relationship with demographic vulnerability and thereby, on the overall vulnerability. Literacy rate points out the adaptability of the population to both adverse impacts caused by shocks and the opportunities created. It also implies the proportion of expenditure on education in total public expenditure which indicates investment in human capital. Similarly, the percentage cropping intensities and the total cropped area and % of rice cultivation area in the district, each of these comprising the agricultural indicators, were also hypothesized to have a negative influence on the vulnerability to climate change. Climatic vulnerability was assumed to be positively related to the indicators such as variances in annual rainfall. This indicated that any increase in the variability of these climatic indicators would increase the vulnerability of the districts.

Results and discussions

Andhra Pradesh

The District-wise Vulnerability Indices of Andhra Pradesh have been worked out for different districts for socio-demographic and agricultural sector, occupational, climate and common property resources indictor. The districts have been ranked on the basis of vulnerability indices.

Table-2:District-wise Vulnerability Indices of Andhra Pradesh

District	Socio- Demo Vulnerability Index	Rank	Occupational Vulnerability Index	Rank	Agricultural Vulnerability Index	Rank	CPR Vulnerability Index	Rank	Climate Vulnerability Index	Rank
Adilabad	0.4679	2	0.4594	20	0.441	15	0.71200	6	0.67183	2
Anantapur	0.3651	13	0.5334	10	0.573	7	0.28654	23	0.40597	12
Chittoor	0.3337	18	0.4410	21	0.707	2	0.47809	16	0.39317	14
East Godavari	0.2768	21	0.5290	12	0.304	20	0.70780	7	0.51601	5
Guntur	0.3357	17	0.5561	7	0.349	19	0.62356	11	0.38333	15
Hyderabad	0.3765	12	0.3872	23	0.000	23	1.00000	1	0.15196	23
Karimnagar	0.3391	16	0.5156	13	0.350	18	0.54181	13	0.71911	1
Khammam	0.4223	5	0.5836	2	0.521	10	0.58297	12	0.56297	4
Krishna	0.2671	22	0.5652	4	0.290	21	0.70738	8	0.47573	8
Kurnool	0.4617	3	0.5646	5	0.420	16	0.51897	14	0.19293	22
Mahbubnagar	0.5201	1	0.4785	17	0.629	6	0.35188	22	0.50000	6
Medak	0.4607	4	0.4651	19	0.509	12	0.67104	10	0.40615	11
Nalgonda	0.3877	10	0.5416	9	0.467	13	0.44888	18	0.40444	13
Nizamabad	0.4071	7	0.4861	16	0.395	17	0.69511	9	0.47865	7
Prakasam	0.4029	8	0.5636	6	0.572	8	0.39330	19	0.47397	10
Rangareddy	0.4203	6	0.4002	22	0.824	1	0.74909	5	0.36123	16
SPSR Nellore	0.3783	11	0.5329	11	0.515	11	0.39024	20	0.29751	20
Srikakulam	0.3092	20	0.6482	1	0.563	9	0.76719	3	0.33073	18
Visakhapatnam	0.3237	19	0.4720	18	0.663	4	0.36782	21	0.47498	9
Vizianagaram	0.3473	14	0.5552	8	0.655	5	0.78557	2	0.25475	21
Warangal	0.3995	9	0.4867	15	0.450	14	0.51887	15	0.34248	17
West Godavari	0.2632	23	0.5750	3	0.183	22	0.75932	4	0.57565	3
Y.S.R.	0.3429	15	0.4960	14	0.680	3	0.47797	17	0.32714	19

Sources: 1. Census of India, 2011.
2. Directorate of economics and statistical organization of Andhra Pradesh.
3. Meteorology Departments of India.

The District-wise Vulnerability Indices of Andhra Pradesh along with the rank of the districts are given in Table 2. In case of socio- demographic indictor, Mahabubnagar was found to be the first place in vulnerability district in the State where as the district of West Godavari was on the last place. The vulnerability indices varied from 0.5201 to 0.2632. As regards overall occupational vulnerability, the district of Srikakulam was on the first place and the district of Hyderabad was on the last place. The vulnerability indices varied from 0.648 to 0.387. In case of agricultural indictor, Vizianagaram district is placed on the first position and Hyderabad is placed on the last position. The vulnerability indices varied from 0.655 to 0.00. With regards to common property resource indicator, the district of Hyderabad was found to have the first rank in the State whereas the district of Ananthapur was ranked at the last position. The vulnerability indices varied from 1.00 to 0.286. In case of overall climate vulnerability, the district of Karimnagar occupied the first place in the State and the district of Hyderabad was found to be at the last position. The composite indices vulnerability varied from 0.719 to 0.51.

Having looked at District-wise Vulnerability Indices of Andhra Pradesh, now we will turn to the composite indices of vulnerability have been worked out for different district' in Andhra Pradesh. The composite indices of vulnerability along with the district ranks are given in Table 3. The districts have been ranked on the basis of vulnerability indices. In the Table 3 shows that the rank 1 shows maximum vulnerable district and the vulnerability decreases as we go on increasing the rank. In Andhra Pradesh, Adilabad district is the most vulnerable district when we calculate the composite index of a few important indicators such as Socio- demographic and occupational, agricultural and climatic, CPR indicators. According to the composite vulnerability index, Hyderabad is the least vulnerable district of Andhra Pradesh. The composite indices of vulnerability varied from 0.538 to 0.00

Karnataka

The district wise indices of vulnerability have been worked out for different districts for socio- economic indicator, occupational indicators, agricultural sector, CPR, and climate change indicator. The districts have been ranked on the basis of vulnerability indices. The districts wise indices of vulnerability in Karnataka along with the rank of the district are given in Table 4. It may be seen from the table that in the case of socio- economic vulnerability index, the district of Yadgir is ranked first and the district of Dakshina Kannada is ranked last. The indices of vulnerability differ from 0.278 to 0.646. With respect to occupational indicators, the district of Bangalore Rural is found to occupy the first position and the district of Ramanagara is on the last place. The districts wise indices of vulnerability are different from 0.389to 0.747. As regards

agricultural indictors, the district of Yadgir is on the first place and Gulbarga is on the last place. The vulnerability indices vary from 0.323to 0.703. On the other hand, the district of Bangalore Rural is first place and Raichur district is last position under climate indictor. The vulnerability indices vary from 0.135 to 0.907. Finally, in the case of common property resources, the district of Bangalore is on the first position and Yadgir is on the last place. The district wise indices of vulnerability vary from 0.282 to 0.9470.

Table-3: Composite index of Vulnerability across Districts of Andhra Pradesh

District	Composite Vulnerability Index	Rank
Adilabad	0.53866	1
Khammam	0.53084	2
Rangareddy	0.51852	3
Medak	0.49494	4
Srikakulam	0.49127	5
Mahbubnagar	0.48753	6
Nizamabad	0.48192	7
Vizianagaram	0.47926	8
Prakasam	0.47508	9
Karimnagar	0.47379	10
Chittoor	0.45526	11
Y.S.R.	0.44823	12
Nalgonda	0.44682	13
Visakhapatnam	0.44622	14
East Godavari	0.43867	15
Guntur	0.43502	16
Warangal	0.43483	17
Krishna	0.43010	18
Anantapur	0.41950	19
West Godavari	0.41372	20
Nellore	0.41323	21
Kurnool	0.40539	22
Hyderabad	0.00000	23

Source: 1. Census of India, 2011.
2. Directorate of economics and statistical organization of Andhra Pradesh.
3. Meteorology Departments of India.

Apart from this, the district wise composite indices of vulnerability have been worked out for different districts for socio-economic indicator, occupational indicators, agricultural sector, CPR, and climate change indicator. Higher the districts index more will be a level of vulnerability. The districts have been ranked on the basis of vulnerability indices. The districts wise indices of vulnerability in Karnataka along with the rank of the district are given in Table 5. According to composite vulnerability index, the district of Chamarajanagar was to be placed on first position that of Belgaum district was placed on last position. The composite vulnerability index values differed from 0.633 to 370.

Conclusions

The broad conclusions emerging from the study are as follows:

- In case of socio- demographic indictor, Mahabubnagar was found to be the first place in vulnerability district in the State where as the district of West Godavari was on the last place in Andhra Pradesh while in Karnataka the district of Yadgir is ranked first and the district of Dakshina Kannada is ranked last.
- As regards overall occupational vulnerability, the district of Srikakulam was on the first place and the district of Hyderabad was on the last place in Andhra Pradesh. On the other hand, the district of Chitradurga is found to occupy the first position and the district of Bangalore is on the last place in Karnataka.
- In case of agricultural indictor, Vizianagaram district is placed on the first position and Hyderabad is placed on the last position in Andhra Pradesh. In the case of Karnataka, the district of Bagalkot is on the first place and Shimoga is on the last place.
- With regards to common property resource indicator, the district of Hyderabad was found to have the first rank in the State whereas the district of Ananthapur was ranked at the last position in Andhra Pradesh while The district of Udupi is on the first position and Yadgir is on the last place in Karnataka.

➢ In case of overall climate vulnerability, the district of Karimnagar occupied the first place in the State and the district of Hyderabad was found to be at the last position in Andhra pradesh. On the other hand, the district of Chamarajanagar is first place and Raichur district is last position in Karnataka.

➢ The study finds that Adilabed district in Andhra Pradesh and Chamarajanagar in Karnataka had highest level of vulnerability while Hyderabad and Bangalore in respective states have least level of vulnerability have been examined through composite vulnerability index.

Table-4: Districts wise indices of vulnerability in Karnataka

District	Socio-Demographic Vulnerability Index	Rank	Occupational Vulnerability Index	Rank	Agricultural Vulnerability Index	Rank	Climate Vulnerability Index	Rank	CPR Vulneralability Index	Rank
Bagalkot	0.4804	12	0.5147	17	0.6564	4	0.6607	4	0.5261	22
Bangalore	0.3788	24	0.4319	29	0.6090	7	0.2838	24	0.9470	1
Bangalore Rural	0.4147	17	0.7478	1	0.5571	13	0.9079	1	0.9079	3
Belgaum	0.4058	19	0.4662	22	0.4209	26	0.1971	29	0.4417	25
Bellary	0.5882	3	0.5268	14	0.5447	16	0.3552	19	0.4453	24
Bidar	0.5421	4	0.5293	13	0.5168	19	0.6534	5	0.6534	18
Bijapur	0.4783	13	0.4966	19	0.3828	28	0.2654	25	0.7031	15
Chamarajanagar	0.5266	7	0.6142	4	0.5540	15	0.7070	3	0.8060	7
Chikkaballapura	0.5046	9	0.6732	2	0.3347	29	0.6384	6	0.6384	19
Chikmagalur	0.3824	23	0.5194	16	0.5134	20	0.3016	23	0.7364	10
Chitradurga	0.5359	5	0.6055	5	0.5751	10	0.3917	13	0.3803	27
Dakshina Kannada	0.2786	30	0.4719	21	0.5245	18	0.5861	7	0.8114	6
Davanagere	0.4834	11	0.5252	15	0.4964	21	0.3029	22	0.6981	16
Dharwad	0.3764	25	0.4508	27	0.5370	17	0.3567	18	0.8248	5
Gadag	0.4275	15	0.5530	10	0.4331	24	0.2275	27	0.7812	9
Gulbarga	0.5254	8	0.5410	11	0.3236	30	0.4845	9	0.7081	14
Hassan	0.3910	21	0.4511	26	0.6063	8	0.5277	8	0.6265	20
Haveri	0.4222	16	0.5561	9	0.5957	9	0.3434	20	0.5504	21
Kodagu	0.3565	27	0.4931	20	0.6227	6	0.2600	26	0.7268	11
Kolar	0.4885	10	0.6384	3	0.6294	5	0.3723	17	0.3723	28
Koppal	0.5313	6	0.6041	6	0.5596	12	0.3811	16	0.7240	12
Mandya	0.3881	22	0.4611	23	0.6836	2	0.3882	15	0.6818	17
Mysore	0.4615	14	0.4606	24	0.4304	25	0.4523	11	0.5147	23
Raichur	0.6163	2	0.5827	7	0.5570	14	0.1353	30	0.4381	26
Ramanagara	0.3945	20	0.3896	30	0.4762	23	0.8032	2	0.8032	8
Shimoga	0.3675	26	0.4976	18	0.3967	27	0.3268	21	0.8337	4
Tumkur	0.4099	18	0.5353	12	0.5620	11	0.4381	12	0.3567	29
Udupi	0.3057	28	0.4341	28	0.4814	22	0.2038	28	0.9247	2
Uttara Kannada	0.2922	29	0.4548	25	0.6716	3	0.4829	10	0.7086	13
Yadgir	0.6463	1	0.5770	8	0.7030	1	0.3889	14	0.2829	30

Source: 1. Census of India, 2011.
2. Directorate of economics and statistical organization of Karnataka
3. Meteorology Departments of India.

Table-5: District-wise indices of composite vulnerability Index in Karnataka.

DISTRICTS	Composite Vulnerability Index	Rank
Chamarajanagar	0.6336	1
Bangalore Rural	0.5908	2
Bidar	0.5758	3
Bagalkot	0.5627	4
Koppal	0.5483	5
Chikkaballapura	0.5271	6
Kolar	0.5210	7
Hassan	0.5125	8
Dakshina Kannada	0.5049	9
Mandya	0.5036	10
Gulbarga	0.5010	11
Uttara Kannada	0.4977	12
Yadgir	0.4920	13
Chitradurga	0.4884	14
Dharwad	0.4849	15
Bangalore	0.4848	16
Bellary	0.4845	17
Davanagere	0.4843	18
Haveri	0.4836	19
Ramanagara	0.4835	20
Chikmagalur	0.4688	21
Mysore	0.4631	22
Kodagu	0.4604	23
Shimoga	0.4562	24
Tumkur	0.4539	25
Gadag	0.4487	26
Bijapur	0.4425	27
Udupi	0.4132	28
Raichur	0.4119	29
Belgaum	0.3700	30

Source: 1. Census of India, 2011.
2. Directorate of economics and statistical organization of Karnataka
3. Meteorology Departments of India.

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NATURAL DISASTERS AND UTTARAKHAND: AN OVERVIEW

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Introduction

Uttarakhand is one of the most bewitching and enchanting regions of northern India. Uttarakhand the land of gods, the home of the Himalayas and truly a paradise on earth, attracts everyone from everywhere. The fresh climate, the untainted water, the terrifying snow, the snow clad mountains, the picturesque beauty, the small villages, the simpler community and a tougher life style is what that distinguishes Uttarakhand from rest of the world. At the same Main Central Thrust (MCT), Main Boundary Thrust (MBT), Himalayan Fontal Thrust (HFT), Trans Himalayan Fault (THF), pressure of Indo-Australian plate, Delhi-Haridwar ridge, huge ranges of river, glaciers, evidence of recent movement (neotectonic adjustments) and continuing strain have been well recognized as the main characteristics that has made the Uttarakhand unstable, fragile and prone to different natural hazards and disasters.

Objectives

The objective of the study is not only to carry out an exploratory research but also emphasizes on action oriented research on disaster management by community participation. There are three distinct objectives as follow:

- First, to study the spatial pattern of hazards and disasters in Uttarakhand.
- Second, to study the approaches, components of CBDMP and provides a framework for an effective disaster management from CBDM perspective through case study.
- Third, to find the exposure, resistance, resilience, vulnerability, hazard and management status with the help of PRA (Participatory Rural Appraisal) tools.

Methodology

Primary and secondary both the data have been used by authors to make the work effective and significant:

- Collection of primary data by using PRA tools and conducting interviews for ground truth,
- Collection of secondary data for analyzing, explaining, and combining the information from the primary source with additional information.
- Ilwis 3.7, Surfer 9, Statistica 8 used for mapping and clustering and other purposes,

Study area

Uttarakhand is located in the northern part of India. Extending from 28° 43' N to 31° 27' N latitude and 77° 34' east to 81 ° 02' E longitudes, it is the 27th state of the Republic of India and was carved out of Uttar Pradesh on 9th Nov 2000. The state is bordering, Nepal in the East, Himachal Pradesh in the west, China in the North, Uttar Pradesh in the South. Uttarakhand comprises of 13 districts that are grouped into two divisions: Kumaon and Garhwal and has a total geographical area of 53,484 sq. km. The entire Uttarakhand state is highly prone to the geological and climate induced hazards. Both geological and climate factors in different combinations usually lead to disasters resulting from natural hazards like flash floods, earthquakes, draught, and landslides.

Different disasters

Landslides. In India there are two main regions which are most vulnerable to landslides: the Himalayas and the Western Ghats. Hill slopes in the Himalaya are known for their instability due to ongoing tectonic activity and younger geological formations subjected to severe seismic activity. Landslide and mass movements are chronic phenomena in Uttarakhand region. Their consequences, in recent times, have become more severe in terms of casualties and extensive damage to the roads, buildings, forests, plantation, and agriculture fields. In recent years, the intensive construction activity and destabilizing forces of nature combined have generated huge and complex problems. Implementation of number of hydro-electric schemes, large scale construction of dames, roads, tunnels, buildings, towers, ropeways, tanks and other public utility works as well as indiscriminate mining and quarrying have brought most of instability problems.

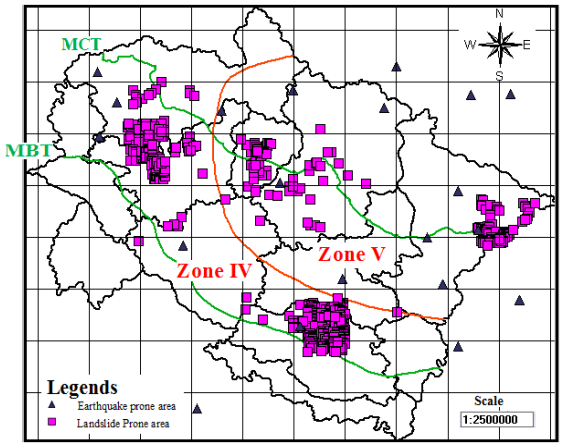

Fig.1. Landslides and earthquake epicenters

Table 1.0 Some major landslides in Uttarakhand

Year	Area	Triggered cause	Community related damage
8 Sept 1803	Srinagar, Pauri garhwal	Earthquake	Wiped out the whole Srinagar town
1857	Mandakini river	Cloud burst	Blocked the flow of the river
1868	Birahi ganga, Chamoli.	Slope failure, Flash flood	Blocked the Birahi river. It made a artificial lake. Suddenly lake burst and flood claimed the lives of 75 people
19 Sept **1880**	Sher-kaDanda, Nainital	Rainfall	151 killed, out of them 42 were Europeans
6th Sep1893	Birahi ganga, Chamoli	Rainfall	Blocked the Birahi river and a artificial lake, 'Gauna Tal' was formed.
Aug 1898	Balia, Nainital	Rainfall	29 killed in Kailakhan
20 July 1970	Belakuchi, Alaknanda river	Flash flood	55 people killed,142 animals perished, 101 village affected
14 Aug 1977	Tawaghat, Pithoragarh	Rainfall	44 people killed including 25 soldiers
14 Aug 1978	Rikhari, Bageshwar	-	4 people killed
6 Aug 1978	Bhagirathi, Gangnani	Flash flood	25 people were killed
1979	Khela, Dharchula	Rainfall	Destroyed area near Tawaghat
1979	Kontha village Chamoli	-	50 residents killed
23 Jun 1980	Gyansu, Uttarkashi	Flash flood	45 people dead
9 Sept 1980	Kanodia gad, Uttarkashi		15 government officials died
1983	Kurmi, Bageshwar	Cloud Burst	37 people killed
1984	Jagthana-Kanyalikot Bageshwar	Flash flood	9 people killed
1986	Jakholi, Tehri Garhwal	-	32 person killed
1990	Mahadev, Rishikesh.	-	100 pilgrims died
16 Aug 1991	Deor-khadura-Paduli-Koj-Pepalkoti	Rainfall	29 people killed
17 July 1996	Raintoli village in Pithoragarh	Cloud burst	18 people lost life and 20 were severely injured
11 Aug 1998	Ukhimath-Rudraprayag	Cloud burst	109 people were killed.
17 Aug **1998**	Malpa, Pithoragarh	Rainfall	207 persons died including 60 pilgrims, 10 house affected
29 Mar1999	Chamoli	Earthquake	Numerous small landslides in the region
20 Oct 1999	Uttarkashi	Earthquake	47 landslides, more than 100 people died and extensive damage to property
27 July 2001	Khetgaon, Pithoragarh	Cloud burst	5 people killed
16 July 2001	Phata- byung gad	Cloud burst	21 persons died & several houses damaged.
2001	Gohna	-	seven persons dead
10 Aug 2002	Balganga, Tehri Garhwal	Cloud burst	29 people died
12 July 2002	Khetgaon, Pithoragarh	Flash flood	5 members of a family died
8 Aug 2002	Bhatwari-Dunda, Uttarkashi	-	five persons died together with 26 cattle
7-9 July 2003	Didihat, Pithoragarh	Rainfall	4 people killed and 10 animals perished
2003	Gadoli, Almora	Rainfall	4 people killed
21-24 Aug 2003	Varunavat, Uttarkashi	Rainfall	affected numerous buildings, hotel and offices, affected 3,000 people and loss of approx 50 crore Rs.
23 Sept 2004	Amaparav, Nainital	Rainfall	3 people killed
2004	Sundardhunga, Bageshwar	Avalanches	5 people killed in the mountains while trekking
2004	Lambagar chatti, Chamoli	Cloud burst	7 killed together with another 9 missing
2004	Kalindi, Uttarkashi	Rainfall	6 people killed
2005	Govindghat, Chamoli	Cloud burst	11 people killed & heavy damage to property
2005	Agastyamuni, Rudraprayag	-	4 people killed
2007	Baram, Pithoragarh	Rainfall	15 fatalities and loss of livestock
8 Aug 2009	Jhakhla-Lah, Pithoragarh	Cloud burst	Wiped out two villages namely Jhakhla-Lah, claiming 43 lives.
19 Sep 2010	Bari- Devli, Almora	Cloud burst	18 people dead
2011	Different areas of Uttarakhand	Rainfall	15 people killed
5 July 2012	Chamoli	Cloud Burst	1 women dead and four people injured
4 Aug 2012	Gangori, Uttarakashi	Heavy Rainfall, Flash Flood	Thirty four people were killed including three jawans of fire services
14 June to 17 June 2013, Total 1604 Landslides	Different Parts of Uttarakhand (including Kedarnath)	Heavy Rainfall, Cloud Burst Flash Flood	13 district, 1603 villages were affected, estimated 70,000 pilgrims and tourists stranded, number of fatalities is close to 5000(Officials number), missing 4700, heavy damage to roads, bridges, houses, schools, administrative buildings, health centers etc. State loss of INR 30.000 Million, nearly 20,36,000

Source: Indo Asian News Service, The Times of India, Hindustan Times, Amar Ujala, The Indian Express, NRSC, NIDM.

Earthquakes. The history of earthquake in Uttarakhand is as old as the origin of Himalaya and the region is one of the seismically active regions of the world. There are several thrusts and faults in and around the region. Two main regional tectonic features in Uttarakhand, which have earthquake potential, are the Main Central Thrust (MCT) and the Main Boundary Thrust (MBT). As per the latest seismic zoning map of India, incorporated in Indian Standard Criteria for earthquake resistant design of structures IS 1893/ (Part I) 2002, entire Uttarakhand region has been assigned to two seismic zones - IV and V. Zone V registers Very High Damage Risk Zone (VHDRZ) and the zone IV registering High Damage Risk Zone (HDRZ).

Table 1.1 Some major earthquakes in Uttarakhand

Year	Area	Magnitude	Community related damage
01 Sep 1803	Kumaun-Garhwal	M>7.0	200 - 300 were killed and several villages were buried by landslides and rock falls.
26 May 1816	Gangotri	Ms 6.5	Affected surrounding the Badrinath peak
16 June 1902	Pokhra-Kainur	Mw 6.0	Affected whole south-east of Pauri
13 June 1906	Gangotri	Mw 6.1	Affected surrounding the Badrinath peak
27 July 1926	Near Changabang Peak	Mw 6.5	N.A.
04 June 1945	Near Nanda Devi Peak	Mw 6.5	N.A.
28 Dec 1958	Rameshwar-Devi Dhura	Mw 6.1	N.A.
27 June 1966	Athpali-Dhung	Mw 6.2	N.A.
29 July 1980	Bajhang-Ghoghda, Nepal	Mw 6.5	13 persons were killed in Pithoragarh and 40 were injured.
20 Oct 1991	Pilang-Bhatwari	Mw 6.6	768 people were killed, 5,000 injured and 18,000 buildings were destroyed in Uttarkashi-Chamoli region.
05 Jan 1997	Dharchula	Mw 5.6	Window panes were broken and Many people ran outdoors in panic
29 Mar 1999	Chamoli-Pipalkoti	Mw 6.8	115 people killed, 50,000 houses were damaged. Over 2000 villages were affected by the earthquake
30 Mar 1999	Chamoli-Pipalkoti	ML 4.9	50 people were injured, 24 houses collapsed while 96 developed cracks.
31 Mar 1999	Chamoli-Pipalkoti	Mb 3.0	1 person was killed and several injured in a house collapsed at Hat Pipalkot in Chamoli
27 May 2003	Bangina region	Mb 5.0	A moderate earthquake struck the Garhwal
08 Oct 2005	Kashmir-Kohistan, Pakistan-India	Mw 7.6	10 people died in north India (including 1 person in the Dehradun)
14 Dec 2005	Pokhri-Gopeshwar	Mb 5.0	Minor damage to property
05 Aug 2006	Thal	Mb 4.4	A light earthquake struck the Nepal-India border damage to property in parts of eastern Uttarakhand,
22 July 2007	Surka Ridge,	Mb 5.0	A moderate earthquake struck the Yamunotri region in Uttarkashi, few injuries and minor damage to property
23 June 2010	Ranchan Dhura, NW of Dharchula	Mb 5.1	Mild earthquake in Uttarakhand, no damage reported

Sources: Amateur Seismic Centre Uttarakhand, Daily news, Zee news, The Times of India, Hindustan Times, Amar Ujala

Forest Fire. Scientifically fire can be defined as exothermic chemical reaction between the fuel and atmospheric oxygen. Practically this process takes place in five stages. In the first stage the fuel gets heated up due to combustion of adjoining matter and temperature of the fuel is raised up to 100^{0}C, second stage is drying evaporation of moisture (free, capillary absorbed). Third stage consists of decomposition of wood with liberation of fuel gases and advent of carbonisation. It takes place between150-300^{0}C. In forth stage the process of chemical decomposition slows down within the carbonisation temperature (300-500^{0}C). Last stage is combo dioxide.
The central equation of fire fighting:

Fire = Fuel + Air + Heat

Forest fires are a common feature in Uttarakhand, especially between 1,000 to 1,800 m in fire adapted chir- pine forests. As per the National Remote Sensing Agency (NRSA), Hyderabad report, in one of the greatest forest fires in the region in 1999, around 22.64 per cent forest area was affected by the fires and 1,225 km2 forest area got severely burnt.

Drought. Uttarakhand has been severely affected by droughts over the past few years claiming many causalities and heavy loss. Annual precipitation in Uttarakhand is high. A large fraction of the rain falls during the monsoon months and drains out immediately. This rain is haphazardly distributed. The southern faces of the outer ranges and the high altitudes of the middle Himalayan belt receive heavy rainfall while many inner valleys and leeward slopes are drier. Several parts of Almora, Pithoragarh, Pauri Garhwal and Chamoli districts routinely experience periods of moisture stress every year. In 2006 Government of Uttarakhand submitted a memorandum and sought assistance from the Central Government for drought relief to the tune of Rs. 200.14 crore from NCCF. During the year 2008, state governments of Uttarakhand have declared 57 tehsils in 10 districts drought affected.

Avalanche. In Uttarakhand, a snow avalanche triggered from the Gomukh glacier area caused the death of one person and injured nine persons on 3 June 2008. Among the injured, one tourist was from the United Kingdom and three were from the United States. In another incident on 24 June 2008, an avalanche triggered by heavy precipitation near the Hemkund Sahib shrine in Rudraprayag district of Uttarakhand killed six pilgrims on the spot and injure Base hospital for treatment. In another event on 21 September 2008, three persons were killed in a snow storm and another 37 persons were rescued from Kalindi-Badrinath track in the Garhwal Himalaya, Uttarakhand.

Table 1.2 Five years (2007-2011) reported region wise forest fire incidents in Uttarakhand

REGIONWISE FOREST FIRE INCIDENTS IN UTTARAKHAND			
YEAR 2007			
Region	Total forest fire incidents	Total affected area (Ha)	Plantation affected(Ha)
Garhwal	300	1093.10	23.20
Kumaun	96	196.75	0.00
Wildlife	77	305.50	0.00
Total	473	1595.35	23.20
YEAR 2008			
Region	Total forest fire incidents	Total affected area (Ha)	Plantation affected(Ha)
Garhwal	436	1005.12	32.00
Kumaun	304	823.95	0.00
Wildlife	134	540.05	0.00
Total	874	2369.12	32.00
YEAR 2009			
Region	Total forest fire incidents	Total affected area (Ha)	Plantation affected(Ha)
Garhwal	990	2380.29	79.75
Kumaun	485	1314.71	3.00
Wildlife	133	420.50	1.50
Total	1608	4115.50	84.25
YEAR 2010			
Region	Total forest fire incidents	Total affected area (Ha)	Plantation affected(Ha)
Garhwal	362	31.50	40
Kumaun	313	13.15	304
Wildlife	114	0.00	0
Total	789	44.65	344
YEAR 2011			
Region	Total forest fire incidents	Total affected area (Ha)	Plantation affected(Ha)
Garhwal	90	0.00	0
Kumaun	47	7.00	0
Wildlife	13	0.00	0
Total	150	7.00	0

Source: Chief Conservator of Forest, Kumaun, Nainital.

CBDM concept

CBDM is described by the International Institute for Disaster Management as ´´an approach that involves direct participation of the people most likely to be exposed to hazards, in planning, decision making and operational activities at all levels of disaster management responsibility´´. In diminutive manner we can say that Community Based Disaster Management Planning (CBDMP), is an assertion which involves the local community perception and participation in disaster management planning. CBDMP involves communities in identifying, assessing and acting jointly to reduce disaster risks.

Components of CBDMP

The main key components of CBDMP in Uttarakhand are identifying the most vulnerable community, community participation, Risk reduction, Reorganization of coping mechanism and capacities, Linkage between disaster risk and development, Financial support level, Integrating disaster management with development planning, Capacity building, Planning for disaster management, Role clarity and unified command system, Trigger mechanism, Constitution of specialized task forces, Risk assessment and vulnerability reduction, Role of local government, Coordination, Communication system, Inventory of resources, Strengthening of infrastructure, Control room and emergency operation center, Environment protection, Disaster management in educational curriculum etc.

Case study from MCT UTTARAKHAND

Basic information of Pothing village. The extension of the Dewara village is 78°6'27.166"E longitude and 31°3'35.877"N latitude at Mori block, Uttarkashi district, Uttarakhand. Total population of the Dewara village is 2500 (source: Gram

Pradhan) wherein handicapped are 6 (2 females, 3 males and 1 children), number of households are 450, electricity level 50%, water related amenities depend natural resources. Total number of schools are 4 (1 is pre primary, 3 primaries). Main crops of the village are wheat, paddy, maduva, pulse etc

Hazard echelon. Frequency and Severity are very important element in Disaster Management Planning According to the Disaster Frequency author divided it into Very Frequency (V.F.), Frequency (F), Moderate Frequency (M.F.) and Occasional precinct and Disaster Severity divided it into Very Severity (V.S.), Severity(S), Moderate Severity (M.S.) and Low Severity (L.S) precinct. And in the table LS shows the Landslides, E shows the Earthquake, FF shows the Forest Fire, F shows the Flood, D shows the Drought, O shows the other disaster occurring in the village, Hazard score of Dewara village found 21.83. On the basis of observations and PRA data authors make a chart for village as follows:

Table 1.3 Hazard Frequency and severity in Dewara village

DEWARA VILLAGE				
FREQUENCY	**SEVERITY**			
	V.S.	**S**	**M.S.**	**L.S.**
V.F.				
F	**FF**	**E, LS**		
M.F.				
Occasional				**F, D, O**

Vulnerability echelon. Vulnerability has three main components and that are Exposure, Resistance, Resilience. With the help of PRA tool and ground truth collected data, authors give the data a weightage score and after having the score of different level author find the individual Exposure, Resistance and Resilience percentage, and then finally get the vulnerable level of village and make a table for vulnerability as follows:

Table 1.4 Exposure, Resistance, Resilience, and Vulnerability of Dewara village

VILLAGE NAME		**VULNERABILITY**		
	EXPOSURE	**RESISTENCE**	**RESILIACE**	**VULNERABILITY**
				((E+RS+RL)/3)
DEWARA	76.92	78.94	56.81	70.89

Management echelon. Management level is very poor in the village, villagers are not prepared for any disaster, There is no Hospital, Animal hospital, Shelter arrangement, Precaution, Open ground, Communication, Transportation. And after that we find the management score 10.

Disaster analysis

To examine the disaster risk analysis we need some aspects and that are Hazard, Vulnerability and Management. Getting the entire equation member, we put it into the Risk find formula like this:

R = (H*V)/ M ; where: R = Risk, **H =** Hazard, **V =** Vulnerability, **M =** Management

R = (21.83*70.89**)/** 10 = 154.75

Work done for CBDM

To keep in mind the main aim of Community Based Disaster Management Planning author visited the whole village; make a sketch map and basic information map.

Sketch map of Dewara village. This map shows the basic structure of the village which can easily understandable by common person to administrative person, this map shows the Population Centralization, Availability of resources, Shelter sources, water body, Schools, Temple, Road Networking, Shops etc. (Fig.1)

Basic information diagram. This Basic Information diagram shows the vital institutes, centers and their distance from the village. This will again help in every phase of disaster (Fig.2)

Results and Recommendations

The main failure of the above leveled plans for disaster mitigation is that the government machinery starts functioning after 48 hours. Time is an important factor in mobilizing resource and administrative machinery to meet immediate public health needs of affected population. Government machinery fails to function on time and the affected population goes through heavy loss. If we do this kind of community based disaster management planning instead of simple disaster management and involve local community in management based planning and programmes than the interaction level increases, got the correct past and present disaster based conditions, technology and traditional coping plans exchange and finally we get the effective management plan, because the ultimate aim of any study is community development. Main recommendations that can mitigate the hazards are Basic disaster Education, Awareness, assumption of the Responsibility, assessment community vulnerabilities and Capacities, Viable methodology.

Conclusions

Uttarakhand has always been prone to many disasters but over the past few decades, there was an exponential increase in human and material losses because of disaster events like landslides, earthquake, forest fire, flash flood, cloud burst,

avalanches are very common phenomena for the Uttarakhand. Recent disasters (Kedarnath, Ukhimath) indicate that nature is beyond the human control and we cannot stop the natural calamities but positively we can minimize the damages by improved management and planning. The progress should be done according to the scientific facts and natural law. Communities are the only issue that differentiates the hazard and disaster, hazard has the potential to create the loss but it called disaster only when it affects the communities directly or indirectly, If the basic backdrop is communities behind the disaster than we can assume how important role of communities in disaster management.

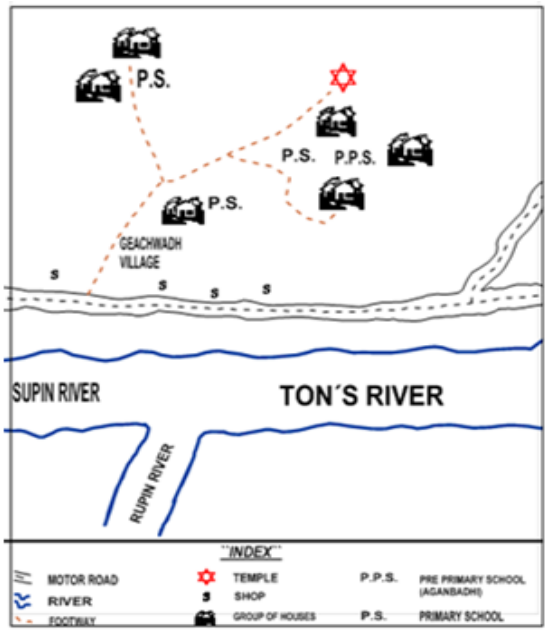

Fig.1 Sketch map of Dewara village

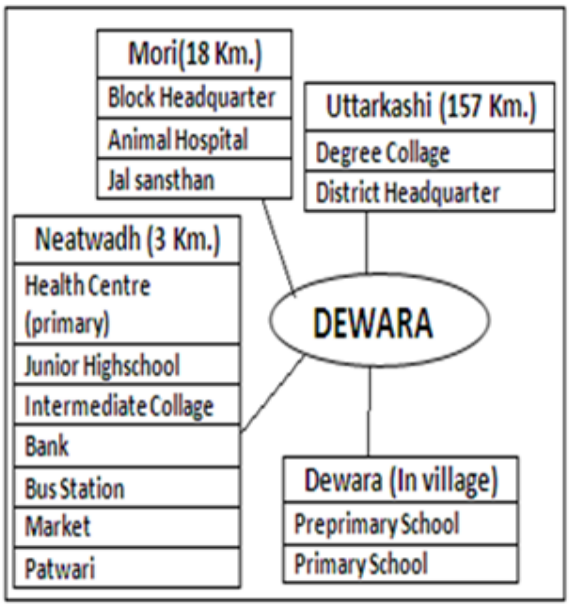

Fig.2 Basic information diagram of Dewara village

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FLASH FLOOD EARLY WARNING SYSTEM: ALGORITHM AND ARCHITECTURE

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Abstract

The flash flood is one of the most lethal forms of natural hazards and every year damages colossal properties and causes human deaths. An early flash flood detection and warning system can provide an effective solution to this problem by giving people sufficient time to evacuate and protect their life and property. On the other hand, presently Wireless Sensor Network (WSN) based systems are widely used as an effective warning system against different hazard scenarios e.g.; fire, tsunami etc. Such WSN based system can also be design to generate an early warning against the Flash Flood and such system is high on demand. This system will be having sensor nodes, processing unit and warning unit etc, for successful prediction and warning generation. Under present work, a WSN based indigenously designed, low cost, accurate and automated Flash Flood Early Warning (FFEW) system has been proposed and studied with technical details. The algorithm of the central processing unit/block for the proposed system has been implemented with MATLAB Simulink and also hardware implemented with PIC microcontroller. Experimental outcomes show that such system will be very much effective to generate a valuable early warning against the devastating flash floods and will be helpful in preventing huge collateral damage.

Keywords

Flash Flood, WSN, Microcontroller, RF Transmitter-Receiver, Rain Gauge sensor

1. Introduction

According to World Meteorological Organization (WMO), a flash flood is generally defined as a rapid onset flood of short duration with a relatively high peak discharge [1]. The flash floods are one of the most lethal form of natural hazard (based upon the ratio of fatalities to people affected), and cause millions of dollars in property damage every year [1]. Flash floods can be triggered by a variety of events including intense rainfall, failure of a natural (e.g., glacial lake debris) or manmade (e.g., dam, levee) structure that is impounding water, or the sudden impoundment of water upstream of a river ice jam [1]. Along with the whole world India is also vastly affected by such catastrophic events in long and recent past [2]. In recent time, Flash floods has killed 250 people on October 8 2009 at Andhra Pradesh, 103 people on 6th August 2010 at Ladakh, 31 people on 3rd August 2012 at Uttarkashi, 24 people on 23rd September at Northan Sikim (death) and left several people injured as well as coasted huge property loss [2]. Few months back on 18th June, 2013 the biggest flash flood event has occurred in Indian history, at Kedarnath (Uttarakhand), which has killed more than 10,000 people according to the latest Govt. report [2].

Flash flood, its deadly consequences and relevant safety measures are the burning issues to the researchers, scientists, engineers and domestic and international policy makers throughout the world [3-5]. Successful prediction of flash flood and generating an effective early warning, are under active research especially in remote and inhospitable forest mountain regions where flash floods are highly unpredictable and deadly [6]. Design and successful implementation of such forecasting and warning system can protect life and property loss [7-8]. Such issues can be significantly addressed with the design and implementation of fully automated Wireless Sensor Network system based Flash Flood Early Warning (FFEW) system. Now-a-days Wireless Sensor Networks (WSN) are vastly implemented as healthcare, defence and security, environmental monitoring and building/structural health monitoring system [9]. Such type of WSN based indigenously designed, low cost, accurate and automated **FFEW** system is highly on demand in India as well as around the world.

Present work has been devoted to develop an effective architectural algorithm for such FFEW system. Along with the algorithm, the technical specifications and functionality of the different blocks of the proposed system has been discussed elaborately. Under present study, the core algorithm of FFEW system has been simulated with MATLAB Simulink and simulation outcome has been analyzed. Being hindered by the financial issue, only the central processor block of the proposed system, has been programmed, designed and implemented with PIC microcontroller. Using the designed software and hardware model, proposed FFEWS system algorithm has been verified experimentally.

2. System Architecture

Under the architecture of the proposed WSN system, a group of end point sensor nodes which will serve as primary nodes. The primary nodes will be connected to a particular number of secondary nodes and those secondary nodes will be connected to a base station. Number of end point sensor nodes or primary node and gate way nodes or secondary node can be varied based on the range of the application but there will be a single base station in a particular locality which will generate some warning signal as well as can be linked with concerned public office through GPS [9].

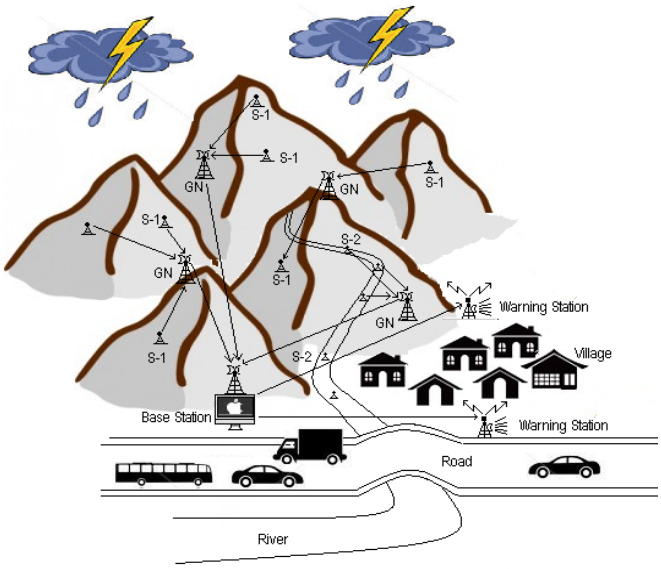


Fig. 1: A picture showing the functioning of an FFEW system. Sensors; S1: Rain-gauge or some similar sensors, S2: Water level/flow measuring sensor, GN: Gate-way-Node

The whole FFEW system can be divided into different blocks and sub blocks as explained bellow.

2.1. Primary Block. This block will consist mainly three sub-blocks e.g.; sensor, transmitter and power source. Sensor is a very important issue related with the proposed project since it needs to be small, reliable, highly sensitive, cost effective and easily installable. Under the proposed project rain gauge or similar types of sensor (S1) will continuously monitor rain fall in the mountain regions. For the proposed system RG-11 Rain Sensor can be used which includes a DIP switch that allows it to be set up for the mode of operation that best matches the application. It's robust, easy to use and it is remarkably inexpensive which make it useful for the proposed system. Similarly, another type of sensor (S2) can be mounted on mountain river bed to measure sudden increase in water level and flow which can be considered as an indication of flash flood. Transmitter part will be as simple as possible which will generate a signal to be transmitted to the secondary node. For less complexity it will be a unidirectional unit.

2.2. Secondary Block. This block will be having mainly three sub blocks e.g.; a transmitter and a receiver with bidirectional communication ability and a signal processor unit which will filter the incoming signal for a specific frequency and amplitude.

2.3 Central Processing Block. The Central Processing Block (CPB) or base station will be having three sub blocks e.g.; a core processor, transmitter-receiver block and a warning signal generating block. The CPB will be mounted in some secure place and will be having a GPS transmitter and a local warning system (an audio visual unit).

3. Central processing block

The functioning algorithm of CPB has been both software and hardware implemented with MATLAB Simulink and PIC Microcontroller respectively.

3.1. CPB Simulation Model. To establish the algorithm of the proposed system, a scalable mathematical relationship has to be formed between input parameters and Output Warning Signal (OWS). Under present analysis input parameters have been considered are Rain Time (RT), Rain Intensity (RI), Local Geography (LG) and Flood History (FH) of that location [3]. Along with the rain time and intensity the favorable geography and history of flash flood at a particular location can also play a dominating role in flash flood prediction [5]. First two parameters will be the outcome of the sensor S1 and second two will be coming from the saved data of CPB memory. Every parameter will be assigned a weight in percentage based on its predicted impact on OWS generation. The considered weight for each parameters for OWS calculation are; RT=50%, RL=30%, LG and FH are 10%, respectively. Again, each parameter will be categorized into three sub-parameters based on its value e.g.;

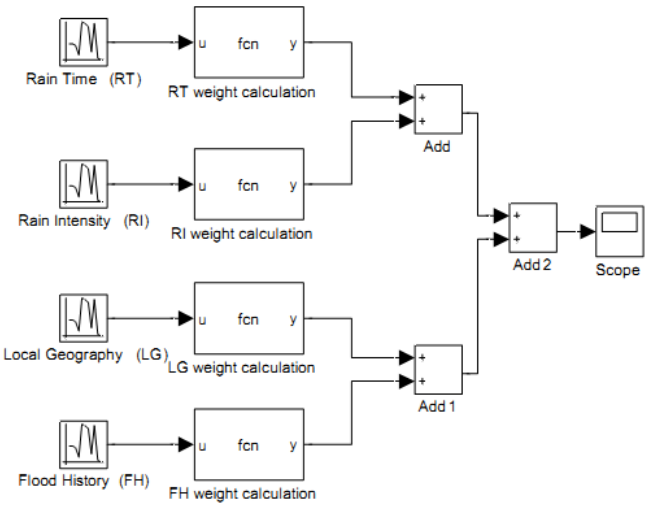
For, RT, long time rain detection will be defined as RTH (Rain Time High) and will be having 50% weight of total RT, medium rain time will be defined as RTM (Rain Time Medium) with weight percentage 30 of total RT and low rain time will be defined as RTL (Rain Time Low) with weight percentage 20 of total RT.
Similarly for other parameters corresponding sub-parameters will be categorized as;

RI: RIH (Rain Intensity High) 50%, RIM (Rain Intensity Medium) 30%, RIL (Rain Intensity Low) 20% of total RI respectively.
LG: ULG (Unsafe Local Geography) 50%, MLG (Moderate Local Geography) 30%, SLG (Safe Local Geography) 20% of total LG respectively.

FH: FFH (Frequent Flood History) 50%, MFH (Medium Flood History) 30%, LFH (Less Flood History) 20% of total FH respectively.
At any particular time, only one sub-parameter will be active and corresponding parameter value will be calculated based on the weight assigned to that particular sub-parameter and overall OWS will be calculated based on weight assigned to all the parameters. The formulated equation of input parameters and OWS will be;

$$OWS = \frac{(RTH \vee RTM \vee RTL) * 50}{100} + \frac{(RIH \vee RIM \vee RIL) * 30}{100} + \frac{(ULG \vee MLG \vee SLG) * 10}{100} + (FFH \vee MFH \vee LFH) * 10/100 \quad (1)$$

Like input parameters, OWS will be also categorized High (OWSH), Medium (OWSM) or Low (OWSL) based output warning signal strength.



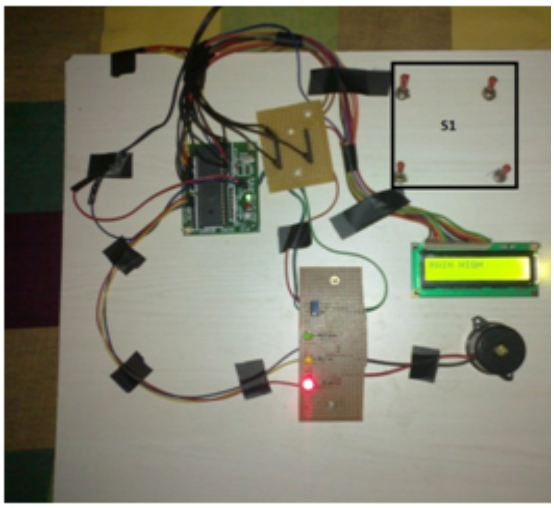


Fig. 2: Matlab Simulink model of proposed FFWS algorithm **Fig. 3:** Hardware implementation of FFWS CPB algorithm

All though, the number of parameters and their actual impact on overall output signal generation is a subject of practical field study but those adjustments can be incorporated effectively with little or moderate modification of proposed simulation model.

3.2. CPB Hardware Model. The algorithm for FFWS CPB has been hardware implemented with four switches (considered as sensor S1), LEDs, LCD, Buzzer and microcontroller (PIC16F877A) etc. as shown in Fig. 3. To maintain the simplicity, the present system hardwire has been designed in such a way that at a time only one parameter and its impact on OWS can be analyzed. When RT is considered as input: if more then 3 switches are on then RT is considered as RTH, if 2 or more than 2 switches are on then RT is RTM and if 1 or no switch is on then RT is RTL, respectively. The red, green and blue LEDs have been used to implicate output conditions OWSH, OWSM and OWSL, respectively and the output signal will be also displayed on LCD screen. The buzzer will create warning sound with red LED and "Output Warning Signal High" on the LCD display at OWSH condition. The whole code for the algorithm has been written with "micro-c" and successfully burned in PIC microcontroller.

4. Results and discussion
Under the present study, the algorithm for the CPB of the proposed system has been developed and implemented with MATLAB Simulink and PIC microcontroller. For simplicity inputs from the sensor S1 has been considered only. In simulation model, input parameters are generated randomly and how different combinations of input parameters will generate subsequent OWS are shown with time scale in Fig. 4 to Fig. 8. In the presented results, all the weight percentage of input parameters and OWS have been converted in a scale of 0 to 5. Input parameters are randomly generated from -5 to +5 with a dc offset bias value +2.5. Randomly generated negative value for any input parameter can be considered as a representation of physical noise. When OWS value is less than 3 it will be considered as OWSL (e.g.; time range 6.8 to 7) and if between range 3 to 4 it will be considered OWSM (e.g., time range 1.2 to 1.4) and more than 4 will be OWSH (e.g., the time range 3.6 to 3.8) as shown in the Fig. 4 and corresponding input parameters can be visible from Fig. 5 to Fig. 8, respectively.

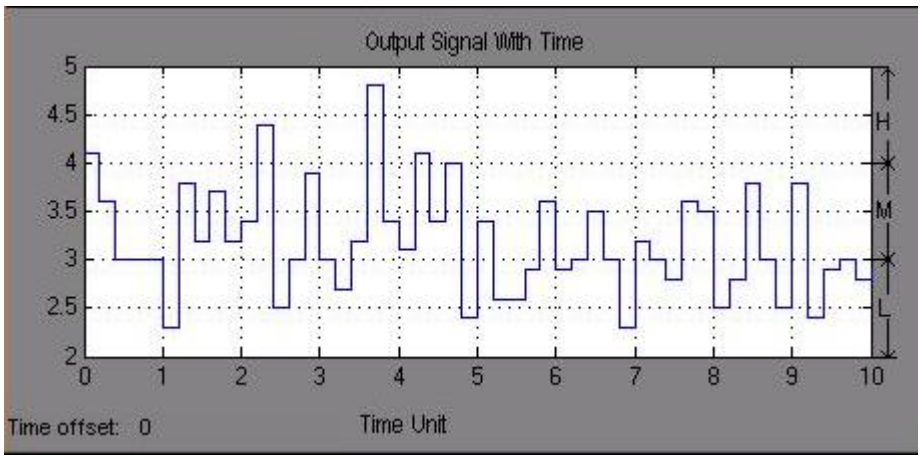


Fig. 4. OWS with time. High, Medium and Low ranges have been shown in a scale of maximum 5 from 0.

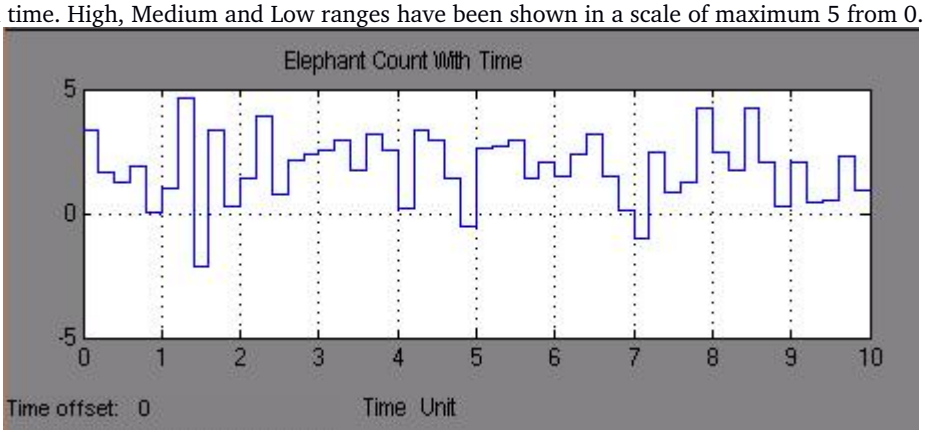


Fig. 5. Randomly generated RT values with time. Value: 0-2 will be RTL, 2-3 will be RTM, and 3-5 will be RTH. Any generated value of less than zero can be considered as noise for this and all the other graphs.

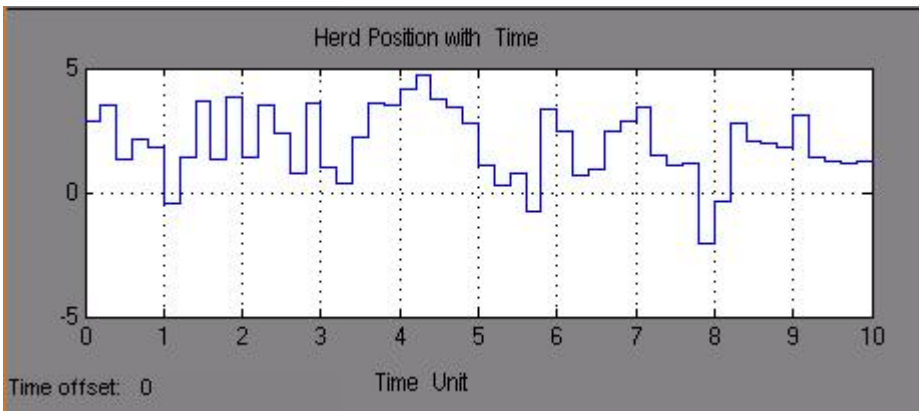


Fig. 6. Randomly generated RI values with time. Value: 0-2 will be RIL, 2-3 will be RIM, 3-5 will be RIH.

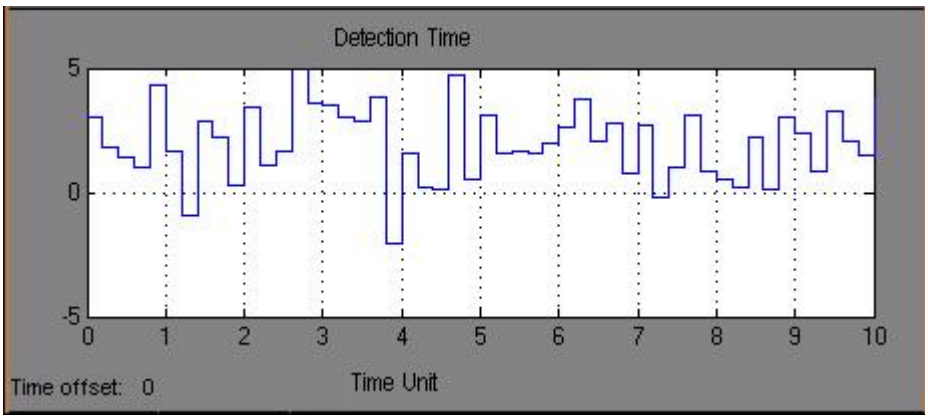


Fig. 7. Randomly generated LG values with time. Value: 0-2 will be SLG, 2-3 will be MLG, 3-5 will be ULG.

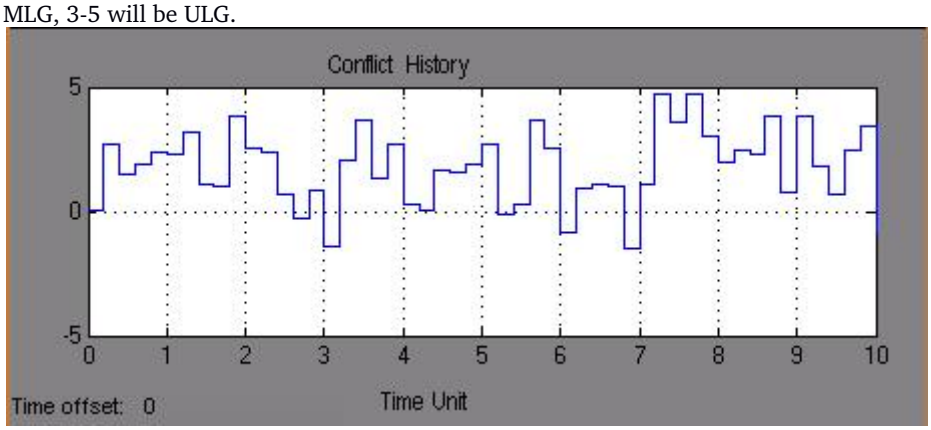


Fig. 8. Randomly generated FH values with time. Value: 0-2 will be LFH, 2-3 will be MFH, 3-5 will be FFH.

5. Conclusion

Under present study, algorithm and architecture for an effective flash flood early warning system has been presented with technical details. Proposed FFEW system has been divided into different functional blocks and sub blocks. The software as well as the hardware for the central processing block, has been successfully designed and implemented with MATLAB Simulink and PIC microcontroller. The central processing block, designed under present study can be successfully integrated with other peripheral blocks and sub blocks and the complete FFWE system can be effectively designed and implemented. Although there are considerable of scope for conceptual and technical improvements, the design and successful realization of such system will generate effective warning against the flash flood and thus will be able to save massive life and property loss throughout the world.

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CLASSIFICATION OF NATURAL RECHARGING SITES IN VETTIKAVLA BLOCK, KOLLAM DISTRICT, SOUTH KERALA, INDIA: A GIS-BASED APPROACH

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Abstract

Groundwater plays an indispensable position in most projects undertaken by humans. The water table of an aquifer is unswervingly influenced by the pluviometric conditions in its environment and shows everlasting variations that regulate the state of its inflows and its drainage possibilities. Groundwater level fluctuation data coupled with soil infiltration rate, sand percentage and soil thickness in GIS platform is used for the factual delineation of natural recharging sites, thereby appropriate artificial recharging methods can be tailored to amend the water environment. Numerical weighted parameter rating (WPR) was used in the identification of natural recharging sites. Safe sites united with site specific methods for recharging make the system sustainable. Hence identifying natural recharging sites in this semi critical block is decisive for conniving fitting management practice for rainwater harvesting and artificial recharging.

Keywords

Groundwater, weighted parameter rating, natural recharge

Introduction

With the increasing use of groundwater for agricultural, municipal and industrial needs, the annual extractions of groundwater are far in excess of net average recharge from natural sources. Consequently, groundwater is being withdrawn from storage and water levels are declining, resulting in crop failures, adverse salt balance, and sea water intrusion in coastal aquifers and land subsidence in areas where drafts result in compaction of sediments (Gilli E et.al 2013). Thus a quantitative evaluation of spatial distribution of groundwater recharging site, is a pre requisite for utilizing groundwater resource in one of the semi critical block, Vettikavala. Over use of water in an area for any purposes will lower the water table in that region. Apart from that this will also deteriorate the quality of groundwater confined to the shallow aquifer (Binoj Kumar R.B. and Divya M.P, 2011). The present study intends to identify the natural recharging sites in Vettikavala block by integrating convinced parameters, using Arc GIS 9.1 software. Rise in groundwater level immediately after the first phase of monsoon is taken as the prime parameter for the identification of natural recharging sites (Rajesh Reghunath, 2011). The basic requirement for recharging the groundwater reservoir include the availability of non committed surplus monsoon runoff of suitable quality in space and time and identification of suitable hydrogeological sites for augmenting groundwater through cost effective artificial recharging techniques. At the same time the infiltration of water into the soil or weathered zone can deliver unwanted result too.

Study area

Vettikavala, is semi-critical block in Kollam district, South Kerala and which was opted for the present study (**Fig 1**). The areal extension is 204 km^2 and consists of six panchayats namely Ummanoor, Vettikavala, Mylom, Melila, Kulakkada and Pavithreswaram. Geology of the area is relatively homogeneous mostly comprising of Precambrian crystallines. Among the crystallines the charnockites, biotite-gneissess and other unclassified gneisses cover major portions with laterites capping. Nearly 90% of the area is characterized by lateritic soil. These are mostly reddish brown to yellowish. Laterite forms the major phreatic aquifer in this region. Groundwater extracted from these aquifers is the main source of water supply for drinking, domestic and agriculture purposes.

Data used and methodology

In the present study Survey of India topographical maps of 58C/12, 58C/16 and 58D/13, on 1:50,000 scales were used for doing comprehensive filed work. For identifying the natural recharging sites of Vettikavala block, 82 locations were selected for water table monitoring and soil thickness was also measured inside the wells. Observation wells were fixed at an interval of 1 km to ensure uniform spatial distribution. Soil samples were collected near the observation well and textural analysis was carried out to determine percentage of sand. Infiltration rate of the area was studied using double ring infiltrometer test. Infiltration test was carried out at 35 locations in different parts of the study area. Spatial variation maps of water table fluctuation, sand percentage, soil thickness and soil infiltration rate were prepared with the help of Arc GIS 9.1 software. Numerical weighted parameter rating (WPR) was used for accurate identification of natural recharging sites.

Results and discussion

Water table fluctuation. Rise of water level is an important factor in determining the suitable sites of natural recharging of aquifer (Todd D.K, 1980). The depth to water table (below ground level, BGL) measured in a systematic network of

observation wells just before the starting of the initial spell of monsoon and just after the first intense spell can used to delineate the natural recharging zones (Rajesh Reghunath, 2011). Well data was collected from the observation wells during, May 2011 and June 2011. During May, the water table will be lowered to the deepest level owed to the extreme summer season and over extraction by anthropogenic means (Walton, W.C, 1970). Lowest depth of water table below the ground level (bgl) was obtained from a place called Vanchimuk (18.1m). SW monsoon started at the end of May 2009 and intensified in the month of June 2009. After the heavy downpour in the initial 3-4 weeks, water level measurements were taken in June 2011. Fluctuation of water table is shown in (**Table 1).**

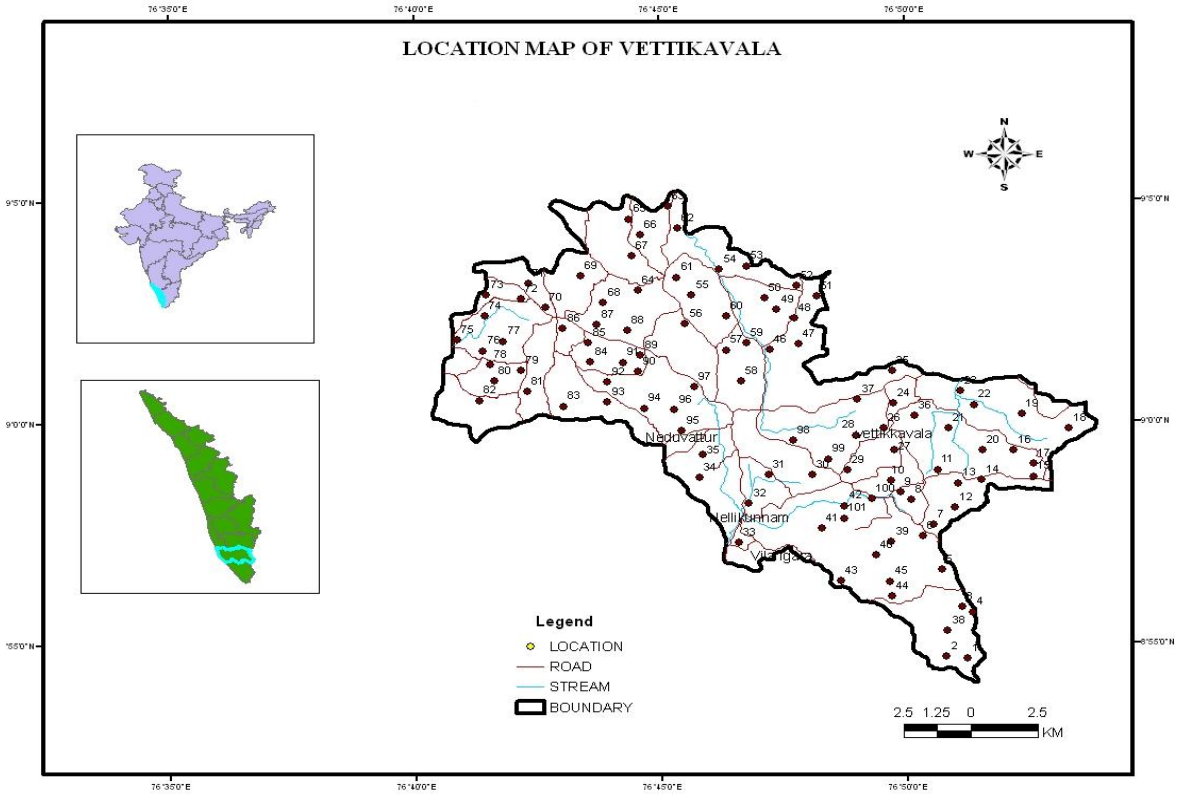

Fig 1. Location map

Table 1 Water table fluctuation from May 2009 to June 2009

Location	Location Name	Difference in Depth to water table from May to June (m)
1	Kulanji	0.97
2	Agamon	0.19
3	Vaikal	0.4
4	Valakam	0.01
5	Kaipallymuk	1.19
6	Chirattakonam	1.02
7	Thalachira	1.5
8	Vaidhyashala junction	1.15
9	Kokkadu	1.19
10	Kokkadu	1.77
11	Mudakuzhi	0.37
12	Kottavatom	0.25
13	Chakkuvaikal	0.41
14	Thazhattu	0.62
15	Villur	1.45
16	Cheathady	0.39

17	Changamanad	0.52
18	Vettikavala	1.2
19	Muttavilla	1.01
20	Uliyanadu	0.55
21	Sadhanandapuram	1.21
22	Thavayikod	1.26
23	Plapally	1.55
24	Nellikunnam	1.24
25	Chungathara	1.71
26	Velamkonam	1.49
27	Neleswaram	0.95
28	Padinjaraetheruvu	2.01
29	Kizhekkaetheruvu	0.11
30	Kumbamkodu	0.45
31	Mulliyil	0.58
32	Ambalakara	0.59
33	Perumba	1.5
34	Ummanoor	0.41
35	Andur	1.1
36	Mylom	0.15
37	Muttabalam	0.52
38	Mylom market jun	0.26
39	Varikaveli	1.69
40	Tamarakudi	0.35
41	Neadiyankala jn	0.27
42	Kalayapuram	1.24
43	Kalayapuram market jnt	1
44	Puvatoor east	0.53
45	Varanpuzha	1.7
46	Perumkulam	0.57
47	Maveli muk	1.08
48	Reashenkada jnt	1.88
49	Inchakadu	1.52
50	Kulakkada,pe	0.62
51	Erattukulakada	0.35
52	Ennat	0.9
53	Kulakkada	0.07
54	Kulakkada thazhet	1.3
55	Eruvelikkal	1.64
56	Mavadi	1.18
57	Mailamkulam	1.1
58	Mailamkulam putor	1
59	Putor	0.25
60	Pazhavara	0.77
61	Karikal	0.08
62	Karikal pally	0.87
63	Cherupoika	1.22
64	Cherupoika 2	0

65	Cherupoika ,neadiyavila	1.07
66	Pawitreswaram	1.36
67	Vanchimuk	1.1
68	Edavattom	0.21
69	Kaithakodu	0.38
70	E.maranad	1.4
71	Thevalapuram	0.75
72	Puttor	1.3
73	Veandar	0.56
74	Manaikara kav,veandar	1
75	Kottathala,moozhikod	0.96
76	Panayil jn	0.58
77	Kurumbaloor	0.27
78	Anakotur	0.67
79	Neaduvatoor	1.15
80	Avannur	1.25
81	Karikam	0.82
82	Iranur	1.48

From the chart it is evident that immediately after the first spell of monsoon considerable increase in water table was observed only in certain locations. On the contrary in some other locations even lowering of water table was also observed. The locations where more than 1m rise in water table obtained can be considered as the natural recharging sites **(Fig 2)**. Out of the 82 observation wells only half of the locations show more than one meter rise of water table.

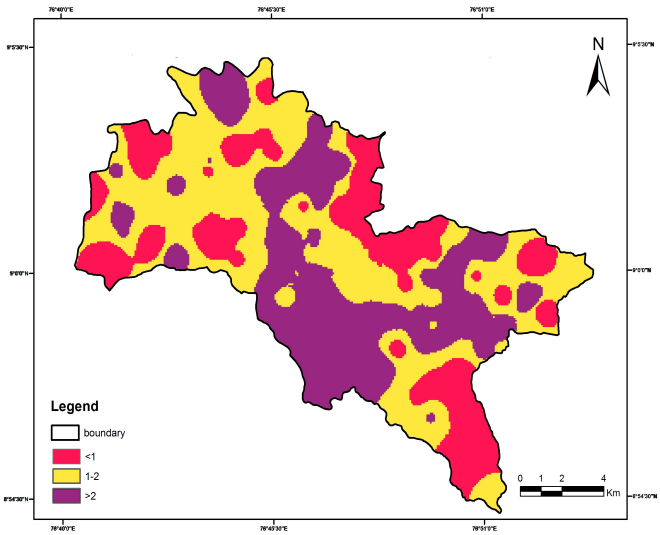

Fig 2. Water table fluctuation from May to June.

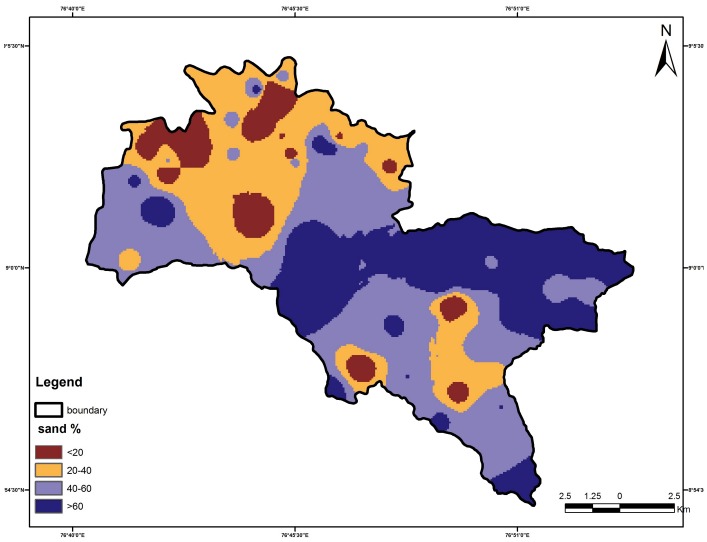

Fig 3 : Percentage of sand in the study area

Soil texture. The texture of a soil is defined by the relative proportions of sand, silt and clay present in the particle size analysis. Soil texture analysis was carried out by wet sieving and pipette analysis and percentage of sand, silt and clay were calculated. The key factor which controls the recharge of aquifer is the sand percentage. Hence the spatial variation map **(Fig 3)** for sand percentage was considered as one of the key parameter to find out the natural recharging site. The sand percentage (**Table 2**) is relatively less in highland areas and most part of the area shows sandy texture with loam or clay.

Soil properties and rate of infiltration. Soil is a mixture of mineral, organic materials, water and air. The content of soil varies in different locations and constantly undergoes changes. The soils in the study area are generally porous in nature.

The relative amount of recharge and runoff rates varies with the soil type present in the area and it depends up on soil properties such as depth, texture and permeability.

Table 2. Sand percentage in the study area

location	Name	sand%
1	Kulanji	82.15
2	Agamon	57.54
3	Vaikal	66.63
4	Valakam	52.86
5	Kaipallymuk	63.06
6	Chirattakonam	55.24
7	Thalachira	68.43
8	Vaidhyashala Junction	82.22
9	Kokkadu	70.47
10	Kokkadu	57.77
11	Mudakuzhi	64.20
12	Kottavattom	73.91
13	Thazhatu	73.69
14	Villur	74.072
15	Chethady	74.25
16	Vettikavala	82.05
17	Muttavila	81.42
18	Eliyanadu	12.06
19	Sadhananthapuram	59.12
20	Thavayikod	70.07
21	Plapally	65.39
22	Chungathara	75.98
23	Velamkonam	28.4
24	Neleswaram	81.64
25	Padinjaraetheruvu	63.76
26	Kizhekketheruvu	82.52
27	Kumbakode	66.69
28	Perumba	36.38
29	Ummanoor	70.037
30	Andur	61.84
31	Mylom Market Junction	64.48
32	Varikaveli	41.42
33	Tamarakudi	50.73
34	Neadiyankala Jun	56.79
35	Kalayapuram	42.14
36	Kalayapuram Market Jun	71.72
37	Puvatoor East	36.66
38	Varanpuzha	46.69
39	Mavelimukk	61.22
40	Reashenkada Jun	76.07
41	Inchakadu	62.44
42	Kulakkada,Pe	31.89
43	Erattukulakkada	5.69
44	Ennat	59.69
45	Kulakada	45.1
46	Kulukkada Thazeth	71.76
47	Eruvelikal	62.28
48	Mailam Kulam	59.46
49	Mailamkulam Putur	41.88
50	Putor	32.33
51	Pazhavara	57.0
52	Karikal	25.58
53	Karikal Pally	39.57
54	Cherupoika	69.15
55	Cherupoika 2	87.22
56	Neadiyavila	64.1
57	Kaithakodu	54.68
58	E.Maranadu	61.09
59	Thevalapuram	47.10
60	Puttor	53.68
61	Veandar	48.80
62	Kottathala	30.39
63	Avannur	79.33

Infiltration is the process by which water on the ground surface enters the soil. Infiltration rate in soil science is the measure of the rate at which soil is able to absorb rainfall or irrigation. As the soil saturation increases the rate of absorption gradually decrease and at one stage there will not be any further absorption. The rate of infiltration is affected by soil characteristics including ease of entry, storage capacity and transmission rate through the soil. The soil texture, structure, vegetation types, water content of the soil, soil temperature and rainfall intensity all play important role in

controlling infiltration rate (Rama Krishna, 1988). Once water has percolated in to the soil it remains in the soil, infiltrate down to the water table and become part of groundwater. The maximum rate at which the soil in any given condition is capable of absorbing water is called infiltration capacity. Infiltration often begins at a high rate and decreases for a fairly steady rate and it is known as basic infiltration rate. The Booker Agriculture International Limited (Landon. J.R, 1984) has classified the basic infiltration rate and the result is shown in (**Table 3**).

Table 3. Soil infiltration rate in Vettikavala block

Category	Basin infiltration rate (cm/hr)	No of locations
Very slow	<0.1	NIL
Slow	0.1-2	NIL
Moderately slow	0.5-2	2
Moderate	2-6	11
Moderately rapid	6-12.5	6
Rapid	12.5-25	9
Very rapid	>25	7

In practice the rate of inflow diminishes with time and experiment is terminated when the rate becomes constant and this relative constant value is considered as basic infiltration rate. From the spatial variation map **(Fig 4)** it is clear that, the locations which are showing high infiltration rate is positively considered as suitable for recharging (Fetter C.W 1990).

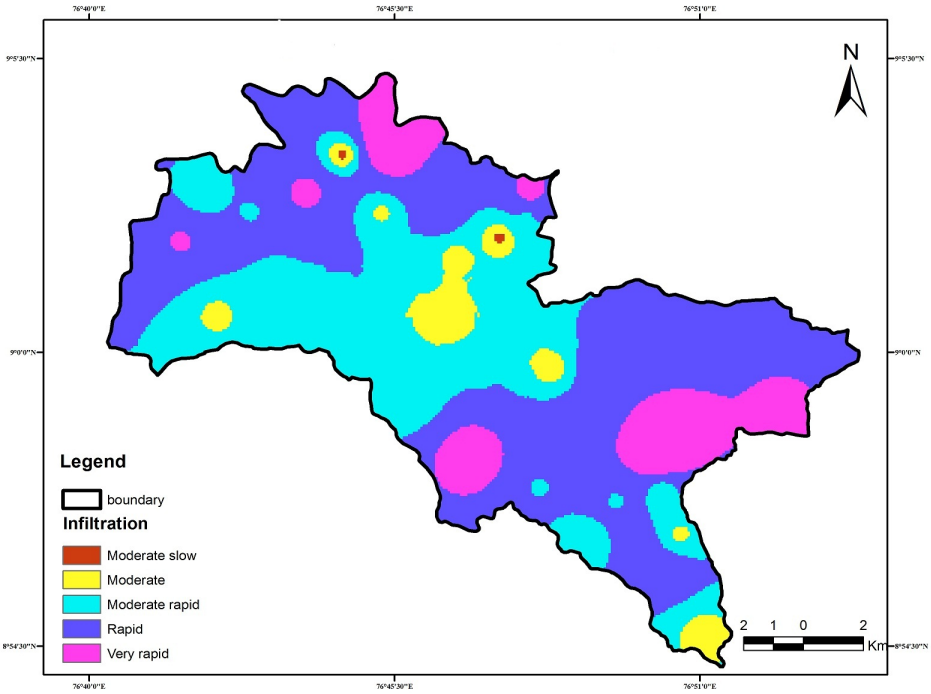

Fig 4: Diversity in infiltration

Soil thickness. The soil thickness varies considerably in the study area. In this study soil thickness was measured from the well cuttings and road cuttings. More the soil thickness the recharging will be more. In the study area, at certain locations the thickness of soil was found to be less than 1m (**Table 4**). Majority of the area shows soil thickness between 1and 1.5. Soil thickness variation map is prepared **(Fig 5)** and soil thickness more than 1m is considered as favorable sites for recharging in this area.

Table 4. Soil thickness of the study area

Location No:	Location Name	Soil thickness
1	Kulanji	0.58
2	Agamon	0.85
3	Vaikal	0
4	Valakam	0
5	Kaipallymuk	1.71
6	Chirattakonam	1.75
7	Thalachira	0.73
8	Vaidhyashala junction	1.06
9	Kokkadu	1.21
10	Kokkadu	0.87
11	Mudakuzhi	1.21
12	Kottavatom	0
13	Chakkuvaikal	0.54
14	Thazhattu	1.12
15	Villur	0.81
16	Cheathady	0
17	Changamanad	1.2
18	Vettikavala	2.34
19	Muttavilla	2.15
20	Uliyanadu	0
21	Sadhanandapuram	1.61
22	Thavayikod	2.75
23	Plapally	0.99
24	Nellikunnam	0.03
25	Chungathara	1.04
26	Velamkonam	2.8
27	Neleswaram	0.22
28	Padinjaraetheruvu	2.07
29	Kizhekkaetheruvu	1.61
30	Kumbamkodu	1.6
31	Mulliyil	0
32	Ambalakara	0
33	Perumba	0
34	Ummanoor	0
35	Andur	1.24
36	Mylom	1.45
37	Muttabalam	0
38	Mylom market jun	0
39	Varikaveli	0.67
40	Tamarakudi	0.87
41	Neadiyankala jn	1.46
42	Kalayapuram	0
43	Kalayapuram market jnt	0
44	Puvatoor east	0.71
45	Varanpuzha	0.5

46	Perumkulam	1.23
47	Maveli muk	0.73
48	Reashenkada jnt	2.01
49	Inchakadu	1.71
50	Kulakkada,pe	0.13
51	Erattukulakada	0.74
52	Ennat	1.17
53	Kulakkada	0
54	Kulakkada thazhet	1.55
55	Eruvelikkal	1.94
56	Mavadi	1.22
57	Mailamkulam	1.18
58	Mailamkulam putor	0.88
59	Putor	1.55
60	Pazhavara	1.62
61	Karikal	0.98
62	Karikal pally	1.47
63	Cherupoika	1.18
64	Cherupoika 2	1.18
65	Cherupoika ,neadiyavila	0.44
66	Pawitreswaram	1.55
67	Vanchimuk	2.06
68	Edavattom	1.76
69	Kaithakodu	0
70	E.maranad	0
71	Thevalapuram	1.3
72	Puttor	2.1
73	Veandar	1.48
74	Manaikara kav,veandar	1.4
75	Kottathala,moozhikod	1.37
76	Panayil jn	0.51
77	Kurumbaloor	0
78	Anakotur	0
79	Neaduvatoor	0
80	Avannur	0
81	Karikam	0
82	Iranur	0

Table 5 Weighted parameter rating for natural recharging site

Parameters	Class	Rank	Weightage	Index (Rank x weightage)
Rise in water table	<1	1	50	50
	1-2	2		100
	>2	3		150
Soil infiltration rate	<2	1	10	10
	2-6	2		20
	6-12.5	3		30
	12.5-25	4		40
	>25	5		50
Sand percentage	<20	1	30	30
	20-40	2		60
	40-60	3		90
	>60	4		120
Soil thickness	<0.5	1	10	10
	0.5-1	2		20
	1-1.5	3		30
	>1.5	4		40

Data integration in GIS platform. To identify the natural recharging site, zonation maps were prepared by giving rank and weightage to all the parameters. In this study groundwater table rise after first spell of monsoon is considered as the key parameter for natural recharging and hence maximum weightage was assigned to water level rise. Sand percentage is the second important parameter, since it controls the water percolation through soil. However soil infiltration rate and soil thickness was assigned equal weightage because both are equally dependant factors. Weighted parameter rating (WPR) for natural recharging site is summarized in (**Table 5**). The natural recharging sites zonation map **(Fig 6)** shows that 62% of study area falls in the moderate category, 20% falls under very good category and18 % falls in poor category.

Conclusions

The amplitude of water level variation changes radically, depending on the nature of the aquifer and consequently it can echo a rise in the water table during periods of surplus rainfall. The methodology used in this study will unquestionably make possible to categorize the natural recharging sites in any area. Application of geospatial technology is principally imperative in the preparation of zonation map, by overlaying individual layers, assigning suitable rank and weightages to pertinent parameters, which do have unambiguous control on the natural recharge, which helps to decipher the natural recharging sites. The map reveals that 62% of study area falls in the moderate category, 20% in very good category and the rest 18 % falls in poor category. It can be concluded that a greater part of the study area falls under moderate category which needs augmentation. Groundwater tapping needs to be managed suitably so that source remains sustainable. All necessary and requisite procedures may be undertaken so that sustainability might be reached through watershed development.

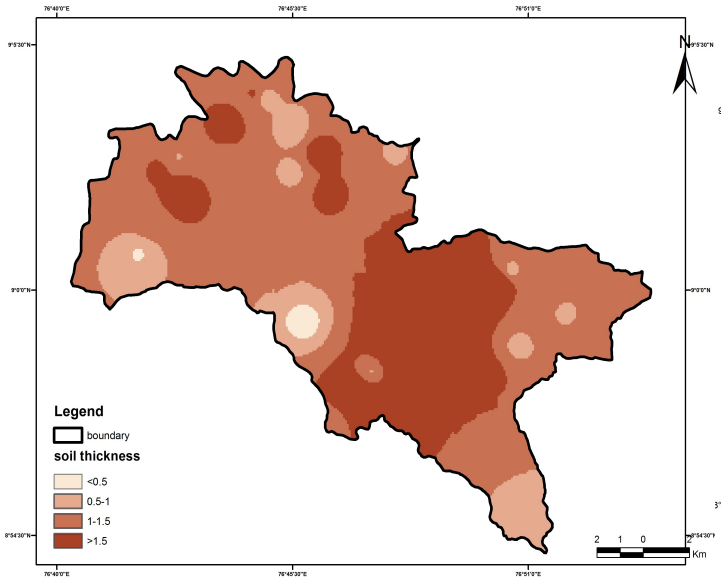

Fig 5: Variation in soil thickness

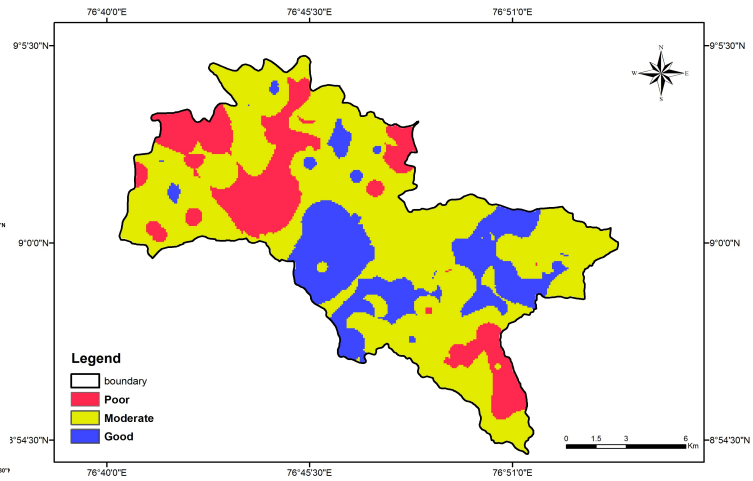

Fig 6: Suitable sites for natural recharging

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LANDSLIDE HAZARD ZONATION USING GEOSPATIAL TECHNOLOGY IN PARTS OF KODAIKANAL HILL REGION, TAMILNADU, INDIA

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Abstract

A methodology for landslide hazard zonation mapping using an integrated remote sensing and GIS approach is presented. Landslides often affect Kodaikanal, a well-known tourist hill resort in south India, The hills in Kodaikanal have a fairly thick weathered overburden that tend to slide during heavy rainfall. Therefore the frequency of landslides in these areas is higher. This study represents the causative factors of the Kodaikanal landslides. Here the landslide inventory map shows that, during the past 10 years, out of 66 landslide incidences, 35 incidences were fallen along the Vatlagundu-Kodaikanal-Palani Ghat roads. Secondly thematic maps were prepared on the various causative factors that is geosystem parameters like geology, lineaments/faults, geomorphology, land use/land cover, drainage system, slope, etc. High resolution Geo-eye satellite data, LANDSAT-TM and ASTER images have been used to generate a few of these thematic maps. To identify the vulnerable areas, the above-mentioned parameters were analyzed in a GIS by assigning appropriate ranks and weights. The result is a landslide hazard zonation map showing regions with varying degrees of vulnerability to landslides. Detailed landslide vulnerability analysis along road corridor. This prepared hazard zonation map will enable to propose and implement suitable mitigating measures, thus preventing loss of life and property in the Kodaikanal hills. An additional study made over landslide vulnerability analysis along road corridor region, using lineament and drainage maps. Though the heavy rainfall is triggering landslides in western-Ghat region, the other causative factors in inducing landslides are anthropogenic activities, geosystemparameters like structure, geomorphology, land use practices, drainage system, etc.

1 Introduction

1.1 Landslides and their significance

Landslide is a major geological hazard, which poses serious threat to human population and various other infrastructures like highways, rail routes and civil structures like dams, buildings and other structures. Basically, it is almost impossible to prevent the occurrence of landslides. However, it is possible to reduce the impact of landslides. Thus, regional landslide hazard assessment is becoming an important task for government at local and national level together with the community in order to realize the optimum protection to the community and social assets, economy and environment from possible disasters.

1.2 Role of geospatial technology

The Landslide Susceptibility Maps identifies the vulnerability of an area to landslide. They form the basis for the landslide hazard assessment. Such maps are prepare with the help of Remote Sensing and GIS. The feature extraction of some of these factors can be done from the interpretation of satellite images. With the increase in efficient digital computing facilities, the digital remote sensing data and their analysis have gained enormous importance. Then the spatial and temporal thematic in formations derived from remote sensing and ground based information need to be integrated for data analysis. With the help of GIS, it is possible to integrate the spatial data of different layers to determine the influence of the parameters on landslide occurrence. Most importantly greatly aid in the prediction of future landslides occurrences, which is very important to those who reside in areas surrounded by unstable slope. The remote sensing data products such as IRS LISS III and PAN merged are used to extract terrain information and landslides area as also marked in the images. Different thematic maps such as land use/land cover, Lineament, Geomorphology and drainage map can be prepared from the digitally processed remote sensing data.

2 Study area

Kodaikanal is a city in the hills of the taluk division of the Dindigul district in the state of Tamilnadu, India. kodaikanal is referred to as the "Princess of hill stations". It was established in 1845 as a refuge from the high temperatures and tropical diseases of the plains. The town sits on a plateau above the southern escarpment of the upper Palni hills at 2,133 meters (6,998 ft), between the Parappar and Gundar valleys. The Average Summer Temperature remains 19.8 °C (67.6 °F), The Average Winter Temperature remains 8.3 °C (46.9 °F) and has Average Rainfall of 1650 mm.

2.1 Ghat road

The Kodaikanal Ghat Road has been designated by the Tamil Nadu State Highway Department as SH-156. It begins at 10°9′10″N 77°41′30″E on the Grand Southern Trunk Road (NH-45), about 8 kilometers west of Batlagundu and ends at

Kodaikanal with a length of 56.8 kilometers. Palani Ghat Road starts at Kodaikanal and ends at palani with a length of 65 kms. The road was strengthened at a cost of 6 crore in 2009. A retention wall was later built due to a landslide. In 2010, the road was completely blocked after a major landslide occurred due to heavy rainfall.

2.2 Location of the study area

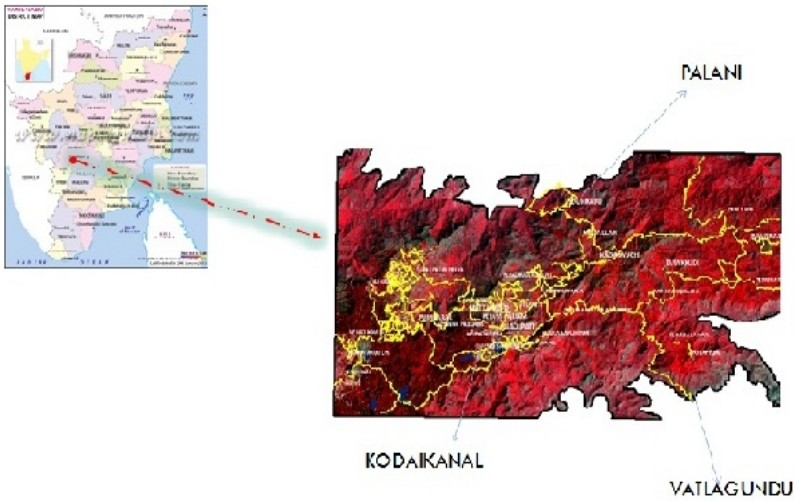
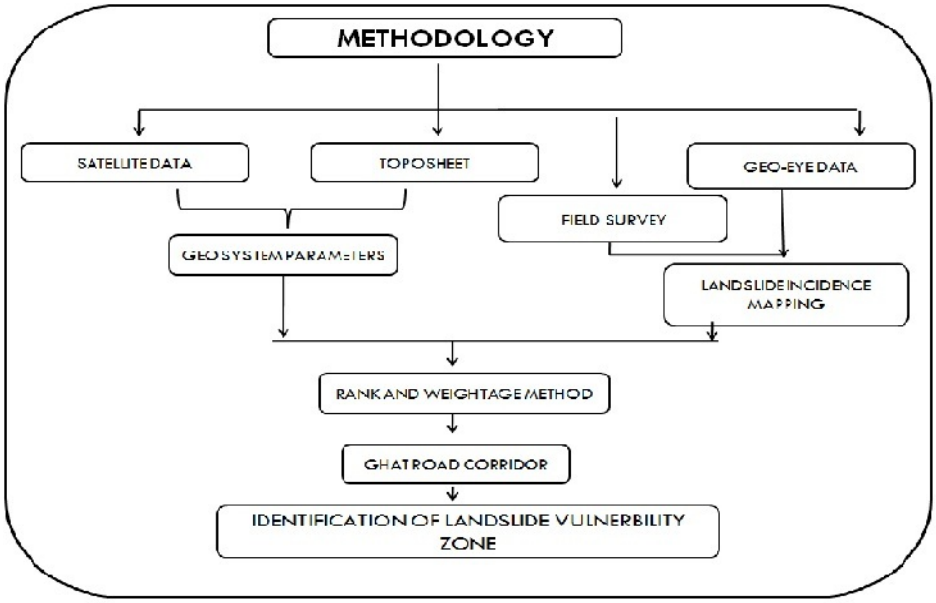


Fig.1 Study area

3. Methodology and materials
3.1 Methodology



Flowchart.1 Methodology adopted

3.1.1 Materials
3.1.2 Field data collection and database generation. Landslide incidences were identified on the field based on landslide remarks and local people's information. And the spatial co-ordinates about landslide incidence was recorded and landslide pictures also taken and to create the database.
3.1.3 Landslide incidence mapping through Geoeye data. The Landslide incidences were mapped through interpretation of Multidated geo eye data by identifying the landslide scars in-between the period of 2004 -2012. There were 34 evident incidences marked and mapped through the comparison of multidated Geoeye data.

Fig.2 Field evidences

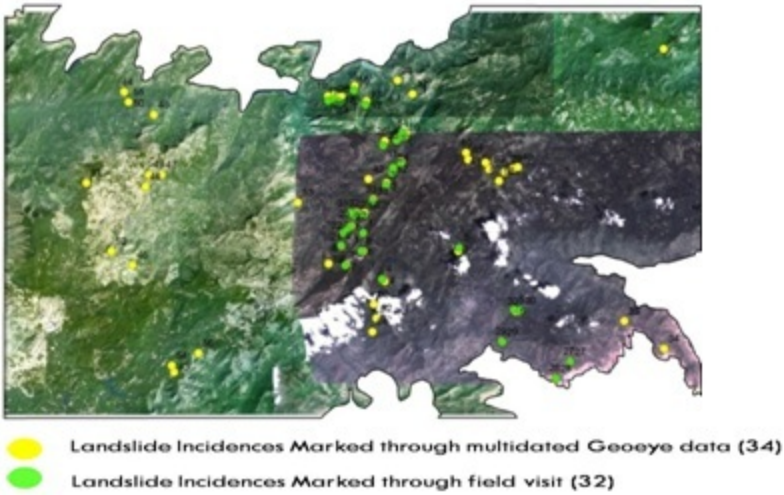


Fig.3 Geoeye-data

4 Preparation of thematic maps

The following thematic maps were prepared for the study area: drainage, lineament, geomorphology, landuse and landcover, lithology, soil, slope, drainage density, lineament density

5 Weightages given to thematic maps based on landslide incidences

Weightages were given to the geosystem parameters based on number of evident landslide occurred in the features of geosystem parameters. Features with high landslide occurrences is given as highest Weightages, similarly remaining features were weighted.

GEOMORPHOLOGICAL FEATURES	LANDSLIDE INCIDENCES
DISSECTED PLATEAU	3
HIGHLY DISSECTED PLATEAU	0
MESA	0
BUTTE	0
ESCARPMENT	1
DEBRIS SLOPE	53
BARREN SLOPE	4
BROAD VALLEY FILLED	1
FILLED VALLEY	4
BARREN VALLEY	0
LANDUSE/LANDCOVER FEATURES	**LANDSLIDE INCIDENCES**
DECIDUOUS FOREST	23
URBAN	0
RURAL	0
PLANTATION	23
SCRUB FOREST	0
EVERGREEN FOREST	10
GRASS LAND	1
BARREN LAND	9
BARREN VALLEY	0
WASTE LAND	0
WATER BODIES	0
SLOPE MAP FEATURES	**LANDSLIDE INCIDENCES**
VERY STEEP SLOPE	59
STEEP SLOPE	5
MODERATE STEEP SLOPE	2
GENTLE SLOPE	0
SOIL FEATURES	**LANDSLIDE INCIDENCE**
CLAYEY SOIL ON STEEP SLOPE	42
LOAMY SOIL ON STEEP SLOPE	13
LOAMY SOIL ON GENTLY SLOPE	11
CALCAREOUS CLAYEY SOIL	0
CLAY SOIL ON MODERATELY SLOPING	0
MODERATELY DEEP CLAYEY SOIL ON UNDULATING LANDS	0
DRAINAGE DENSITY CLASS	**LANDSLIDE INCIDENCE**
MODERATE(0-628.06)	11
HIGH(628.06-1025.84)	22
VERY HIGH(1025.84-2669.29)	33
LINEAMENT DENSITY CLASS	**LANDSLIDE INCIDENCE**
VERY HIGH	22
HIGH	16
MODERATE	12
LOW	11
VERY LOW	5

5.1 NDVI and wetness

NDVI VALUE	LANDSLIDEINCIDENCE	NDVI CLASS
-0.391 – 0.315	7	LOW
0.315 – 0.441	22	HIGH
0.441 – 0.549	27	VERY HIGH
0.549 – 0.757	10	MODERATE
WETNESS VALUE	**LANDSLIDE INCIDENCE**	**WETNESS CLASS**
44.163 – 105.277	5	LOW
105.277 – 123.695	25	VERY HIGH
123.695 – 141.275	22	HIGH
141.275 – 257.643	14	MODERATE

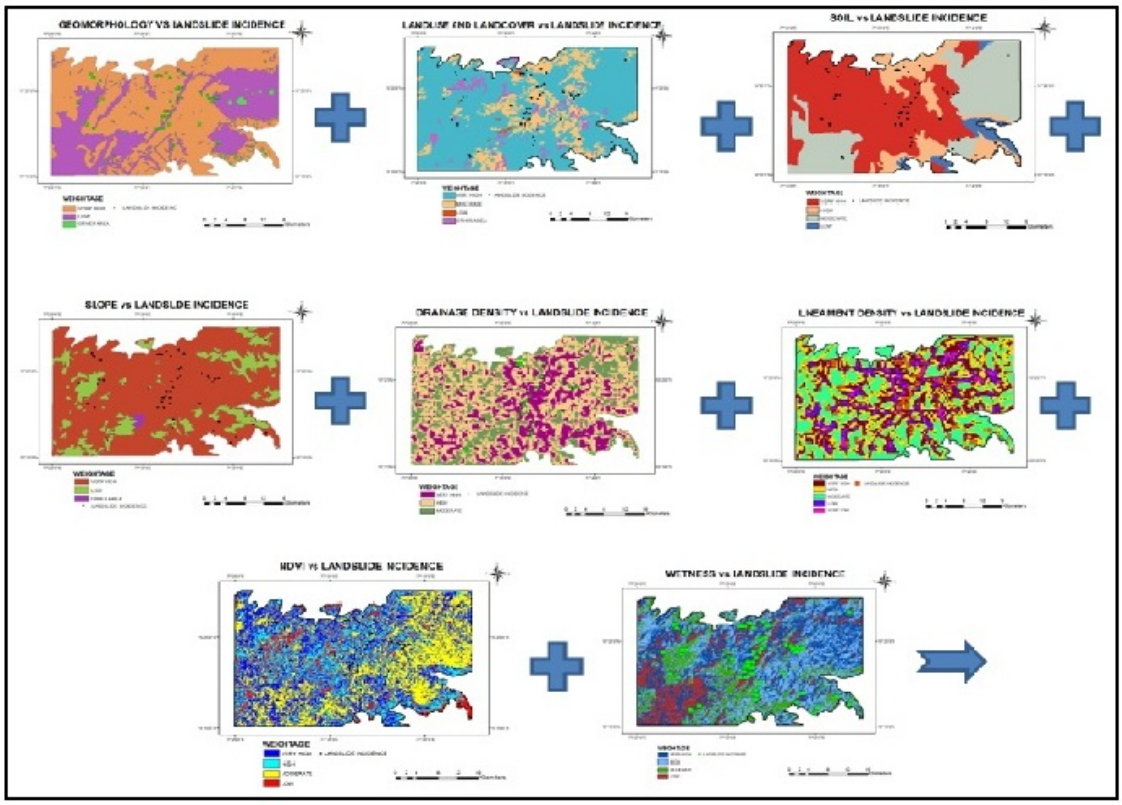


Fig.4 Integration of weightage maps

5.2 Landslide hazard zonation mapping

Using raster calculator in GIS environment , the above all weighted maps were integrated and landslide hazard zonation were identified.

6 Detailed landslide vulnerability analysis along road corridor

For detailed study of landslide vulnerability, we analyzed along the ghat road section. We buffered out 1000 m along the road side for our detailed analysis. Among 66 evident landslides, 35 landslides fall under the ghat road buffer zone. Even though the entire buffer zone is vulnerable area, only some places are subjected to landslides, the reason behind this is major lineaments and major drainages are crossing the ghat road section. Some of the landslides occur along the lineament zone.

6.1 Method and map used

Constructing the road in vulnerable zones, Failure associated with soil and rock mass, Linear features of fold, fracture, crack, joints and Drainages are the most important inducing factor for landslide occurrence alone ghat road session. The map indicates the vulnerable zones with and without landslide incidences. Though most of the region are of vulnerable, only some areas are affected and these areas were identified by 3D surface analysis(using ArcScene) with Lineament and Drainage intersection. Still in some vulnerable zones and these lineament and drainages were intersecting and these areas

identified as most prone zones for future landslide occurrences.

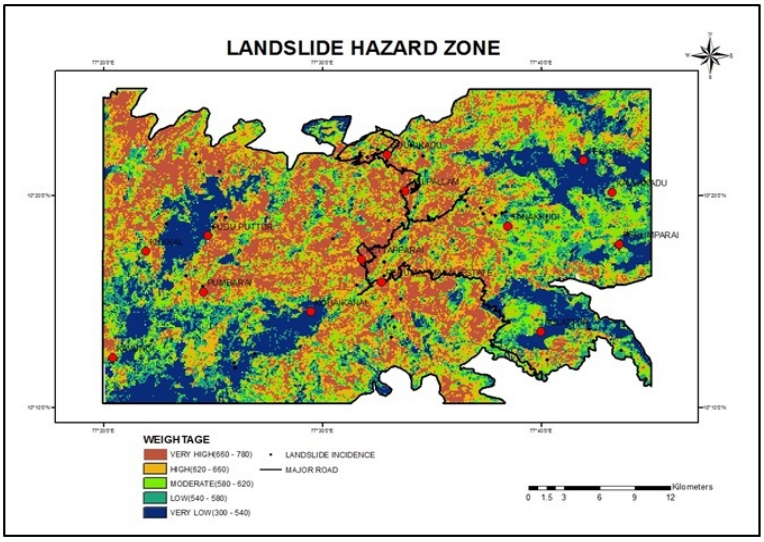


Fig.5 Landslide hazard zonation map

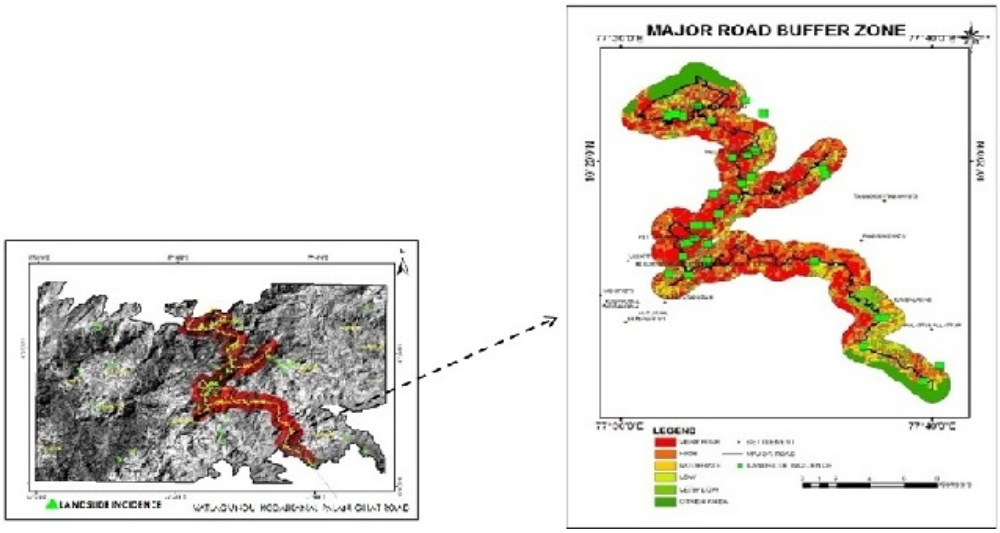


Fig.6 LHZ in ghat-road

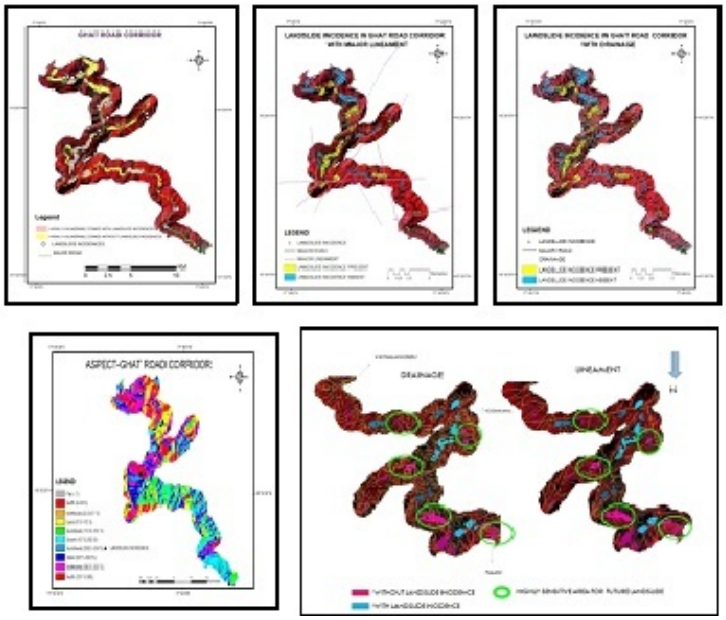


Fig.7 Future landslide sensitive zones

7 Result and discussion

Landslide is one of the major disasters in hilly region. As far as India is concerned, Himalayan region in the extra peninsular India and Eastern and Western Ghats region in Peninsular India are more prone for landslide. The tectonic movements are generally attributed to Himalayan landslide and at the same time landslides occurring at Eastern and Western Ghat region are due to the improper developmental activities. The most of the landslides are occurring in Western Ghat region during the monsoon period. From that it can be said that the rainfall is the major triggering parameters in this region. Though the heavy rainfall is triggering landslides in western Ghat region, the other causative factors in inducing landslides are anthropogenic activities, geosystem parameters like structure, geomorphology, land use practices, drainage system, etc. Under the above backdrop, the present study is aimed to identify the what are the various causative factors behind the landslides in parts of Western Ghat region especially in Kodaikanal region.

7.1 Conclusion

At first, detailed landslide inventory mapping was done through the field work and interpreting the high resolution Geo-eye satellite data. The landslide inventory map shows that, during the past 10 years, out of 66 landslide incidences, 35 incidences were fallen along the Batlagundu-Kodaikanal-Palani Ghat roads. Secondly thematic maps were prepared on the various causative factors that is geosystem parameters like geology, lineaments/faults, geomorphology, land use/land cover, drainage system, slope, etc. Then the landslide incidences were analysed in conjunction with various geosystem parameters and according rank and Weightages were assigned to various sub parameters. The weighted maps on the causative factors were integrated under the GIS environments and from the same landslide hazard zones were identified.

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CORPORATE SECTOR IN DISASTER MANAGEMENT IN INDIA

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Abstract

Disasters due to natural hazards have increasingly devastating impacts on the development prospects of most countries. Unlike the bounty of nature, its fury is a great leveller. Natural disasters affect everyone alike although the nature of impact varies from region to region and sector to sector with the coping capacity of an individual sector being the differentiating factor. The catastrophic fallout of natural disasters on the community and the people is very well documented by now. At the same time, it is their impact on the existence, survival and viability of the economic muscle of a nation, community and region, i.e. the corporate sector, which also merits equally focused attention. India's geo-climatic conditions as well as its high degree of socio-economic vulnerability, makes it one of the most disaster-prone countries in the world. Traditionally, India had been 'reactive' in its approach towards disasters – with precious resources being spent on relief, rehabilitation and reconstruction efforts. Today, after considerable and meticulous planning and a concerted effort, a paradigm shift in the approach of the Government departments and agencies as well as of other stakeholders including the community, the corporate sector and others has been brought about for building holistic capabilities for disaster management. This article highlights the role of Corporate Sector in Disaster Management in India.

Keywords

Disaster management, Institutional and policy framework, Role of corporate sector, corporate disaster resource network

Introduction

India is one of the oldest civilizations in the world with variety and rich cultural heritage. It covers an area of 3,287,590 sq. km, extending from the snow-covered Himalayan heights to the tropical rain forests of the south. As the 7th largest country in the world, India stands apart from the rest of Asia, marked off as it is by mountains and the sea, which give the country a distinct geographical entity. Bounded by the Great Himalayas in the north, it stretches southwards and at the Tropic of Cancer, tapers off into the Indian Ocean between the Bay of Bengal on the east and the Arabian Sea on the west. India's population, as on 1 March 2011 stood at 1,210,193,422 were 623.7 million males and 586.4 million females and considered as the second-most populous country in the world.

The Indian subcontinent is among the world's most disaster-prone areas due to its unique geo-climatic conditions. Floods, droughts, cyclones, earthquakes and landslides have happened in different parts of the country. Almost 85% of India's area is vulnerable to one or multiple hazards. Of the 28 states and 7 union territories, 22 are disaster-prone. It is vulnerable to wind storms spawned in the Bay of Bengal and the Arabian Sea, earthquakes caused by active crustal movement in the Himalayan mountains, floods brought by monsoons, and droughts in the country's arid and semi-arid areas. Almost 57% of the land is vulnerable to earthquake (high seismic zones III–V), 68% to drought, 8% to cyclones and 12% to floods. India has also become much more vulnerable to tsunamis since the 2004 Indian Ocean tsunami. In view of India's high vulnerability profile, the recurrent phenomena of a range of geophysical as well as hydro-meteorological hazards impact millions across the country leaving behind a trail of heavy loss of lives, property and livelihoods. In many areas of the country, disaster losses tend to outweigh the development gains. The economic and social costs on account of losses caused by natural disasters continue to mount year-after-year as disasters occur with unfailing regularity encompassing every segment of national life including the industrial and corporate sector.

Traditionally, India had been 'reactive' in its approach towards disasters – with precious resources being spent on relief, rehabilitation and reconstruction efforts. Today, after considerable and meticulous planning and a concerted effort, a paradigm shift in the approach of the Government departments and agencies as well as of other stakeholders including the community, the corporate sector and others has been brought about for building holistic capabilities for disaster management. The focus has shifted to a balanced approach including pre-disaster aspects such as disaster prevention, mitigation and preparedness since it is felt that appropriate mitigation measures can substantially, if not wholly, reduce the heavy toll of lives and property, the dissipation of developmental, industrial and infrastructural gains and the hard-earned socio-economic infrastructure.

In keeping with the paradigm shift in its approach to disaster management brought by the Government of India and the recurring phenomenon of natural disasters impacting all sectors of socio-economic life, including the corporate sector and inflicting heavy economic losses, focussed attention has been given to risk mitigation endeavours to systematically reduce the vulnerabilities. The involvement and association of the corporate sector with national risk reduction and risk management initiatives and with dissemination of appropriate and practical structural and non-structural disaster prevention and mitigation measures necessary for their safe and disaster-free functioning has been accorded priority as part of a strategy to systematically mainstream holistic disaster management into the functioning of

the corporate sector. Recognizing the importance of integrating the corporate sector and their nodal organizations in disaster prevention, mitigation and preparedness agenda, the National Disaster Management Framework drawn up by the Ministry of Home Affairs, Government of India envisages "involvement of corporate sector in awareness generation and disaster preparedness and mitigation planning" through sensitization, training and co-opting of the corporate sector and their nodal bodies in planning process and response mechanisms.

Institutional and policy framework

The institutional and policy mechanisms for carrying out response, relief and rehabilitation have been well-established since Independence. These mechanisms have proved to be robust and effective insofar as response, relief and rehabilitation are concerned. At the national level, the Ministry of Home Affairs is the nodal Ministry for all matters concerning disaster management. The Central Relief Commissioner (CRC) in the Ministry of Home Affairs is the nodal officer to coordinate relief operations for natural disasters. The CRC receives information relating to forecasting/warning of a natural calamity from India Meteorological Department (IMD) or from Central Water Commission of Ministry of Water Resources on a continuing basis. The Ministries/Departments/Organizations concerned with the primary and secondary functions relating to the management of disasters include: India Meteorological Department, Central Water Commission, Ministry of Home Affairs, Ministry of Defence, Ministry of Finance, Ministry of Rural Development, Ministry of Urban Development, Department of Communications, Ministry of Health, Ministry of Water Resources, Ministry of Petroleum, Department of Agriculture & Cooperation. Ministry of Power, Department of Civil Supplies, Ministry of Railways, Ministry of Information and Broadcasting, Planning Commission, Cabinet Secretariat, Department of Surface Transport, Ministry of Social Justice, Department of Women and Child Development, Ministry of Environment and Forest, Department of Food. Each Ministry/Department/Organization nominates their nodal officer to the Crisis Management Group chaired by Central Relief Commissioner. The nodal officer is responsible for preparing sectoral Action Plan/Emergency Support Function Plan for managing disasters.

The role of corporate sector

The high vulnerability profile of India also enhances the susceptibility of the corporate sector to multiple disasters. The expanding human and economic infrastructure over the last few decades has been accompanied by rising abruptness, ferocity and magnitude of natural disasters. The only way of safeguarding the precious physical infrastructure is to integrate disaster prevention, mitigation and preparedness measures into planning behind them. While hazards belong to nature and cannot be wished away, the risks and vulnerabilities can definitely be minimized. This is the only way to sustainable development.

The World Summit on Sustainable Development (WSSD) defines sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

To many business executives, the concept of sustainable development and business remain abstract and quite simply do not go together. But the perception is now rapidly changing and it is now being widely accepted with the recognition of linkages between protecting a corporates capital base and the natural resources. Sustainable development for corporates would mean adopting and implementing business approaches which meet the needs of the industry and its stakeholders while at the same time protecting, sustaining and enhancing the human and natural resources for the future.

Business organizations are increasingly recognizing that there is an umbilical bond between sustainable development and disaster risk management. Sustainable development envisions integration of economic and social development with environment protection as interdependent and mutually reinforcing pillars. The development philosophy must seek to minimize the expenditure on rehabilitation and reconstruction so the precious developmental resources are preserved and help interweave a culture of safety and preparedness. There is need to bring about a change in perception, attitude and mindset of the corporate sector about the way things should be approached now.

The new approach stems from the premise that development in any sector, more so in the corporate world, cannot be sustainable and viable unless risk reduction and mitigation measures are built into the development processes and that investments in mitigation are much more cost-effective than expenditure on relief, rehabilitation and reconstruction. The corporates in every country have always played a major role in post-disaster relief, rehabilitation and reconstruction efforts in the affected regions. In India, the contribution of the corporate sector has been notable especially in the aftermath of the devastating super-cyclone in Orissa in 1999 and the Bhuj earthquake (Gujarat) in 2001. The industrial and corporate organizations like the Confederation of Indian Industry (CII), the Federation of Indian Chambers of Commerce and Industry (FICCI), the PHD Chambers of Commerce and Industry and other industry and area-specific manufacturers and traders associations have been in the forefront of providing much-needed succour to the affected populace for ameliorating their sufferings. Some notable contribution of corporate sector in disasters management listed below:

1. The contribution of the Corporate Sector has been notable especially in the aftermath of the devastating Super-Cyclone in Orissa in 1999 and the Bhuj Earthquake in 2001.
2. During Kosi Floods and Andhra Pradesh & Karnataka Floods in 2008 & 2009 respectively, the Corporate Sector came forward in providing relief in a big way.
3. As an inalienable part of its Corporate Social Responsibility (CSR), the corporate sector can play an essential role in leading and supporting the community in comprehensive risk management activities and in mobilizing human and financial resources.

Potential Areas for the Corporate Sector

1. Common inventory (public-private-public) of disaster response resources so that one could easily find a machine or a specialist in the aftermath of a disaster.
2. Alternating and cost-effective technologies for hazard-resistant housing and infrastructure.
3. Research and development in hazard prevention and mitigation.
4. Supporting and popularizing traditional and indigenous disaster mitigation methods which are time-tested and effective.
5. Corporate Sector can also play a useful role before the crisis by supporting disaster-prevention and preparedness activities, by filling gaps between emergency relief and long term development programs.
6. Initiatives and supporting-initiatives aimed at disaster- prevention or preparedness so that communities regularly hit by floods, earthquakes and other disasters can develop disaster plans raise public awareness about disaster preparedness, and train local disaster response teams for the next emergency.

Initiatives undertaken by National Disaster Management Authority (NDMA)

1. Identified areas of priorities where corporates can provide assistance for disaster management and how they can dovetail their commitments/ assistance to meet the existing gaps.
2. Developed an Institutional framework for coordinating the receipt of such assistance.
3. NDMA is working with state governments to take adequate precautions in the regulatory framework to ensure that all projects undertaken by the Private Sector are made disaster resilient.
4. Written to important Central Ministries, State Governments, PSUs and Private Sector Groups.
5. Conducted National Level Conferences with various Corporate Houses on how to develop partnerships in disaster management not only for relief measures but also in mitigation and preparedness.
6. Developed scoping exercise on the involvement of the Corporate Sector in Disaster Management – in coordination with IIM Ahmedabad.
7. Developing an institutional framework in the Corporate Sector, State Governments, District Level, NDMA and Ministries for coordinating the activities of the Corporate Sector in DM and mobilization of assistance, and to continue this engagement and take the agenda forward.
8. Planning by the Government through the SDMP and DDMP to factor in assistance of resources and inventory, CSR and PPP activities.
9. Planning by Corporate bodies for identification and matching of areas, priorities, sectors, in which corporate sector can initiate projects and schemes, as part of their CSR, or partner with government through PPP initiatives, or provide assistance for disaster management.
10. Ensure that on-site and off-site disaster management plans are developed by industries, compliance to be ensured.
11. Conduct mock drills on a regular basis in collaboration with the corporate units.

Corporate sector involvement in disasters in India have focused largely, if not totally, on disaster response. Recent high impact disasters saw considerable corporate responses in the form of food and medicines aid, cash aid, medical camp, tents, construction materials etc. While this is commendable, it is also important that pre-disaster preparedness and mitigation activities are also taken up. It is only by enhancing the resilience of the communities before disaster strikes that the risk of disasters can be reduced and the business continuity can be maintained.

Corporate disaster resource network (CDRN)

Corporate Disaster Resource Network (CDRN) is a web based supply chain management system that helps relief agencies, response agencies and local government's access and feed in real time information on products and services required for emergency humanitarian relief. Thereby enabling an efficient logistics, administrative and financial resources based emergency preparedness, response and rehabilitation tool. Joining the CDRN gives immediate access of resources at disposal. As the system is all-inclusive in nature, a large community of relief agencies, governments and corporate partners offer collective knowledge of best practices and practical solutions. The setting-up of CDRN aims to facilitate an efficient real-time supply chain management system for effective deployment of resources - financial, material, volunteers and skilled professionals for preparedness, response and rehabilitation in times of emergency.

NGOs

Through this platform, NGOs could respond swiftly during disasters. They could:

1. Interact with a wider pool of suppliers/ donors
2. List the needs for preparedness, response and rehabilitation
3. Have access to volunteers
4. Interact and partner with various agencies for co-ordinated response
5. Develop partnerships with leading members of the corporate sector, relief agencies and government
6. Highlight required volunteer skills

Corporates

Through this platform corporates could:

1. Provide gifts in kind or financial donations
2. Provide products/service at discounted pricing

3. Build cross–sector partnerships
4. Track donations with transparency
5. Encourage employee-giving and volunteering
6. Volunteer organisational skills

Individuals

As an individual one can use CDRN to view and post relevant information. Individuals can donate or volunteer based on their interests and share information with peers and organisations. This helps individuals collectively make a larger, direct impact on disaster relief operations. Individuals can

1. Provide gifts in kind or financial donations
2. Volunteer skills and time
3. Collaborate with other providers to maximise impact
4. Spread awareness on CDRN.

Conclusions

The ever-increasing role of civil society has started to put pressure on corporate to act in an economically, socially and environmentally sustainable way. The companies are facing increased pressure for transparency and accountability, being placed on them by their employees, customers, shareholders, media and civil society. There is an umbilical bond between sustainable development and disaster-risk-reduction and the business organizations are recognizing it so. Integration of risk management measures has to be an all-pervasive activity by the corporate across the industrial spectrum and must not remain a one-off activity. It would seek minimization of expenditure on rehabilitation and reconstruction to obviate dissipation of precious developmental resources and help interweave a culture of safety and preparedness in every walk of national life and more so in the corporate sector so that the development efforts are socially safe, commercially viable and sustainable.

Business does not operate in isolation and there is today, an increased realization that not only can companies affect society at large, but they are also in a unique position to influence society and make positive impact. The corporate perceptions, attitudes, pre-conceived notions and mindsets about the way the things are approached towards risk reduction, disaster preparedness and management is changing in a positive direction which would definitely bring in more economic prosperity along with safe, sustainable and continuous business.

Disaster Management being an all-encompassing and multi-disciplinary activity spanning across all sectors of development, a coordinated action in conjunction with all stakeholders including the corporate sector is a sine qua non for overcoming the vulnerabilities and minimizing the risks. It will not only help pooling of resources but would also facilitate exchange of information and expertise across sectors, learn from each others' experience and best practices.

The objective of disaster management initiatives is to consciously move towards strengthening the national capabilities in accordance with the status acquired by India as a self-sufficient and self respecting nation well-positioned to mount an effective and substantive disaster response and to take care of the concerns vis-a-vis disaster management across different sectors.

However, effective disaster management is a long-drawn battle against the formidable forces of nature and necessitates devising a comprehensive strategy and work-plan based on the lessons learned and experiences gained from every disaster. The shortcomings and gaps need to be addressed and successes built upon.

The Government of India as well as other stakeholders including the corporate sector has reaffirmed their commitment and resolve to achieve the objective of moving towards a disaster resilient and safe nation. The task is arduous and the challenge ominous. However, the roadmap is well-defined and clear. No effort will be spared and no constraint would be allowed to impede the progress towards creating a safe and disaster-free nation and the challenge thrown by successive disasters will be converted into an opportunity for further strengthening disaster risk management measures.

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DISASTER MANAGEMENT EDUCATION IN INDIA: ISSUES AND CHALLENGES

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Abstract

India is one of the most disaster prone countries in the world. Over 55% of its land area is vulnerable to earthquakes. 70% of the land under cultivation is prone to draught, 12% to floods and 8% to cyclones. A huge amount is spent by our government as well as aid agencies in relief and rehabilitation measures every year. It has now become increasingly evident that an investment in disaster preparedness can save thousands of lives, vital economic assets, livelihoods and reduce the cost of overall relief assistance. Further, disaster mitigation is a step forward in attempting to conserve development gains before a disaster strikes. As we all know that Prevention is better than cure, the strategies of the agencies involved in disaster management activities should be to prevent the damages caused by disasters. Prevention starts with information. As schools are the best venue for sowing collective values, school students and teachers can serve as vehicles for building a culture of prevention. Students are an integral part of community, and have an important role to play in being prepared. Hence it is imperative that they should be prepared adequately to prevent, face and respond to disasters. History has shown that where communities have been prepared to face disasters, lesser lives have been lost, less significant damage to the environment has occurred, and property has been better conserved. According to the latest government survey there are 1,124,033 schools in India in which about one-third of the population study. With nearly 85% of the land area prone to disaster it is high time the 34% of the country's future generation has been prepared to combat future disasters. This number will be much higher if institutions of higher education, distance education etc. too is included in this population. Educational Institutions can contribute towards the generation of knowledge in the area of disasters, develop expertise in specific types of disaster and impart training in different fields. This paper attempts to provide a description of present status of disaster management education in India along with various issues and challenges. This paper focuses on the fact that though some of vital steps taken by Indian government are proving a lot helpful in disaster preparedness; there are still miles to go. Overall, it will highlight the importance of disaster management education in India and will focus on how disaster management education could help in disaster mitigation and could save a number of lives along with assets.

Keywords
Disaster management, preparedness, mitigation, education, schools

Introduction

India as a nation is prone to various hazards due to its unique geo-climatic conditions. Flood, drought, cyclone, earthquake and landslide have been frequent phenomena. About 60% of the landmass is prone to earthquakes of various intensities; over 40 million hectares is prone to floods; about 8% of the total area is prone to cyclones and 68% of the area is susceptible to drought. Experience and knowledge of the past shows that when attention has been given to adequate preparedness measures, the loss of life and property has considerably reduced. Therefore, wisdom dictates that the warning to prepare should come at a time and season conducive to preparation. And when it comes to disaster risk reduction activities one of the best available options is that of incorporating disaster management education in educational institutes – be it in formal schooling curriculum or in non formal education. So, India as a nation is strongly adhering to incorporate the culture of timely preparedness and mitigation activities in its endeavour by giving strong emphasis on its institutional and policy framework for Disaster Risk Reduction.

During the last thirty years' time span the country has been hit by 431 major disasters resulting into enormous loss to life and property. According to the Prevention Web statistics, 143039 people were killed and about 150 crore were affected by various disasters in the country during these three decades. The disasters caused huge loss to property and other infrastructures costing more than US $ 4800 crore. The table show the date of India's Deadliest Disaster which had caused enormous loss of life and infrastructures.

What is disaster?

According to CBSE (2009) Textbook in Geography for class XI, A disaster is a result from the combination of hazard, vulnerability and insufficient capacity or measures to reduce the potential chances of risk. A disaster happens when a hazard impacts on the vulnerable population and causes damage, casualties and disruption. Therefore, we need to understand the three major components namely hazard, vulnerability and capacity with suitable examples to have a basic understanding of disaster management.

Table 1. India's Deadliest Disasters

Sl No.	Name of Event	Year	Country and Region	Fatalities
01	Earthquake	1618	Mumbai, Maharashtra	2,000 deaths
02	Bengal Earthquake	1737	Bengal	300, 000 deaths
03	Cyclone	1864	Kolkata, West Bengal	60,000 deaths
04	The Great Famine	1876-78	Southern India	58.5 million people affected 5.5 million deaths due to starvation
05	Cyclone	1882	Bombay, Maharashtra	100,000 deaths
06	The Indian famine	1896-1897	Whole India	1.25 million to 10 million deaths
07	Earthquake	1934	Bihar	6,000 deaths
08	Bhola Cyclone	1970	West Bengal	500,000 deaths (including Hindu Kush Himalayas and surrounding areas)
09	Drought	1972	Large Part of Country	200 million people affected
10	Drought	1987	Haryana	300 million people affected
In the Last Century				
01	Earthquake	1905	Kangra, Himachal Pradesh	20,000 deaths
02	Cyclone	1977	Andhra Pradesh	10,000 deaths hundreds of thousands homeless 40,000 cattle deaths. Destroyed 40% of India's food grains
03	Latur Earthquake	1993	Latur, Marthawada, region of the Maharashtra	7,928 people died and another 30,000 were injured
04	Orissa Super Cyclone	1999	Orissa	10,000 deaths
05	Gujarat Earthquake	2001	Bhuj, Bachau, Anjar, Ahmedabad, and Surat in Gujarat State	25,000 deaths 6.3 million people affected
06	Tsunami	2004	coastline of Tamil Nadu, Kerala, Andhra Pradesh and Pondicherry, as well as the Andaman and Nicobar Islands of India	10,749 deaths 5,640 persons missing 2.79 million people affected 11,827 hectares of crops damaged 300,000 fisher folk lost their livelihoods
07	Maharashtra floods	July 2005	Maharashtra State	1094 deaths 167 Injured 54 Missing
08	Kashmir Earthquake	2005	Kashmir State	86000 deaths (includes Kashmir & surrounding Himalayan region)
09	Kosi Floods	2008	North Bihar	527 Deaths 19323 Livestock perished 222754 Houses damaged 3329423 persons affected
10	Cyclone Nisha	2008	Tamil Nadu	204 deaths $800 million worth damages
*11	Cloud Brust (Flood)	2013	Uttarakhand	5700 deaths(approx) 4200 village affected

Source:"EM-DAT: The OFDA/CRED International Disaster Database, www.emdat.be - Université catholique de Louvain - Brussels – Belgium" * http://en.wikipedia.org/wiki/2013_North_India_floods

(a) Components of Disaster:-

(b) What is a Hazard? How is it Classified?

According to CBSE (2009) Textbook in Geography for class XI, Hazard may be defined as "a dangerous condition or event, that threat or have the potential for causing injury to life or damage to property or the environment." Hazards can be grouped into two broad categories namely natural and manmade.

(i) **Natural Hazards** are hazards which are caused because of natural phenomena (hazards with meteorological, geological or even biological origin). Examples of natural hazards are cyclones, tsunamis, earthquake and volcanic eruption which are exclusively of natural origin. Landslides, floods, drought, fires are socio-natural hazards since their causes are both natural and manmade. For example flooding may be caused because of heavy rains, landslide or blocking of drains with human waste.

(ii) **Manmade Hazards** are hazards which are due to human negligence. Manmade hazards are associated with industries or energy generation facilities and include explosions, leakage of toxic waste, pollution, dam failure, wars or civil strife etc. The list of hazards is very long. Many occur frequently while others take place occasionally. However, on the basis of their genesis, they can be categorized as follows:

(c) **Classification of Hazards** (Source- CBSE (2009) Textbook in Geography for class XI)

Types	Hazards	
Geological Hazards	1. Earthquake 2. Tsunami 3. Volcanic eruption	4. Landslide 5. Dam burst 6. Mine Fire
Water & Climatic Hazards	1. Tropical Cyclone 2. Tornado and Hurricane 3. Floods 4. Drought 5. Hailstorm	6. Cloudburst 7. Landslide 8. Heat & Cold wave 9. Snow Avalanche 10.Sea erosion
Environmental Hazards **Biological** **Chemical, Industrial and Nuclear Accidents**	1. Environmental pollutions 2. Deforestation	3. Desertification 4. Pest Infection
	1. Human/Animal Epidemics 2. Pest attacks	3. Food poisoning 4. Weapons of Mass Destruction
	1. Chemical 2. Industrial	3. Oil spills/Fires 4. Nuclear disasters
Accident related	1. Boat / Road / Train accidents / air crash, Rural / Urban fires, Bomb /serial bomb blasts 2. Forest fires	3. Building collapse 4. Electric Accidents 5. Festival related disasters 6. Mine flooding

(d) What is Vulnerability?

According to CBSE (2009) Textbook in Geography for class XI, Vulnerability may be defined as "The extent to which a community, structure, services or geographic area is likely to be damaged or disrupted by the impact of particular hazard, on account of their nature, construction and proximity to hazardous terrains or a disaster prone area."

(i) **Physical Vulnerability**: It includes notions of **who** and **what** may be damaged or destroyed by natural hazard such as earthquakes or floods. It is based on the physical condition of people and elements at risk, such as buildings, infrastructure etc; and their proximity, location and nature of the hazard.

(ii) **Socio-economic Vulnerability**: The socio-economic condition of the people also determines the intensity of the impact. For example, people who are poor and living in the sea coast don't have the money to construct strong concrete houses. They are generally at risk and lose their shelters whenever there is strong wind or cyclone.

(e) What is Capacity?

According to CBSE (2009) Textbook in Geography for class XI, Capacity can be defined as "resources, means and strengths which exist in households and communities and which enable them to cope with, withstand, prepare for, prevent, mitigate or quickly recover from a disaster". Capacities could be:

(i) **Physical Capacity**: People whose houses have been destroyed by the cyclone or crops have been destroyed by the flood can salvage things from their homes and from their farms. Some family members have skills, which enable them to find employment if they migrate, either temporarily or permanently.

(ii) **Socio-economic Capacity**: In most of the disasters, people suffer their greatest losses in the physical and material realm. Rich people have the capacity to recover soon because of their wealth.

(f) What is Risk?

According to CBSE (2009) Textbook in Geography for class XI, Risk is a "measure of the expected losses due to a hazard event occurring in a given area over a specific time period. Risk is a function of the probability of particular hazardous event and the losses each would cause." The level of risk depends upon:

- Nature of the hazard
- Vulnerability of the elements which are affected
- Economic value of those elements

A community/locality is said to be at 'risk' when it is exposed to hazards and is likely to be adversely affected by its impact. Disaster risk management includes all measures which reduce disaster related losses of life, property or assets by either reducing the hazard or vulnerability of the elements at risk.

Disaster risk reduction

According to CBSE (2009) Textbook in Geography for class XI, Disaster risk reduction will happen in the following ways:-

Preparedness. This protective process embraces measures which enable governments, communities and individuals to respond rapidly to disaster situations to cope with them effectively. Preparedness includes the formulation of viable emergency plans, the development of warning systems, the maintenance of inventories and the training of personnel. It may also embrace search and rescue measures as well as evacuation plans for areas that may be at risk from a recurring disaster. ***Mitigation.*** Mitigation embraces measures taken to reduce both the effect of the hazard and the vulnerable conditions to it in order to reduce the scale of a future disaster. Therefore mitigation activities can be focused on the

hazard itself or the elements exposed to the threat. Examples of mitigation measures which are hazard specific include water management in drought prone areas, relocating people away from the hazard prone areas and by strengthening structures to reduce damage when a hazard occurs.

Disaster management cycle

According to CBSE (2009) Textbook in Geography for class XI, Disaster Risk Management includes sum total of all activities, programmes and measures which can be taken up before, during and after a disaster with the purpose to avoid a disaster, reduce its impact or recover from its losses. The three key stages of activities that are taken up within disaster risk management are:

(i) **Before a Disaster (Pre-Disaster)**

These are activities taken to reduce human and property losses caused by a potential hazard for example carrying out awareness campaigns, strengthening the existing weak structures, preparation of the disaster management plans at household and community level etc. Such risk reduction measures taken under this stage are termed as mitigation and preparedness activities.

(ii) **During a Disaster (Disaster Occurrence)**

Initiatives taken to ensure that the needs and provisions of victims are met and suffering is minimized. Activities taken under this stage are called emergency response activities.

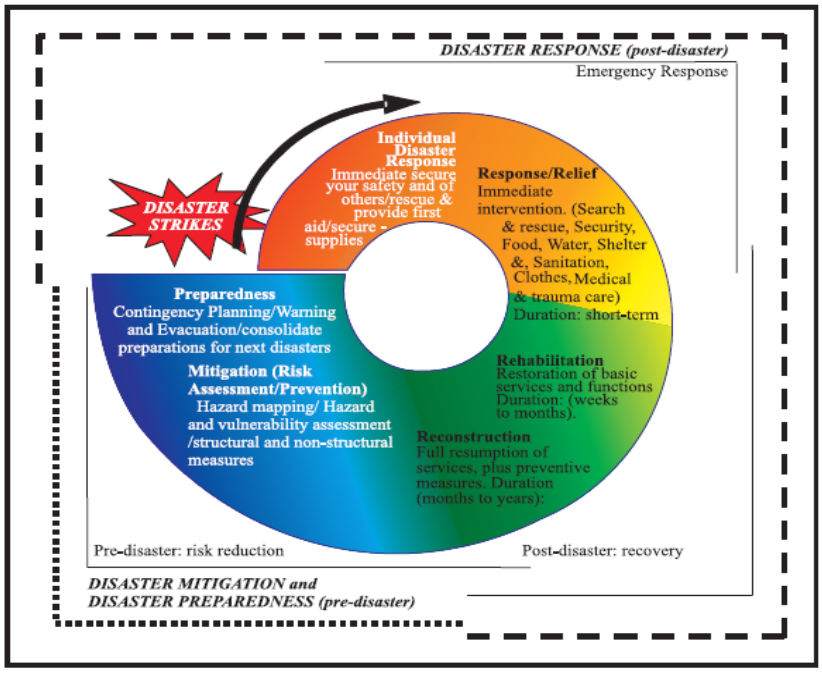
(iii) **After a Disaster (Post-Disaster)**

Initiatives taken in response to a disaster with a purpose to achieve early recovery and rehabilitation of affected communities, immediately after a disaster strikes. These are called as response and recovery activities.

Source- CBSE (2009) Textbook in Geography for class XI, page-8)

Why disaster management education?

According to India UNCRD (2008) project , In India there are various different types of school system - the Central Board of Secondary Education, State Education Boards, the Council for Indian School Certificate Examinations (CISCE), National Open School and International Schools. According to the latest government survey there are 1,124,033 schools in India in which about one-third of the population study. With nearly 85% of the land area prone to disaster it is high time the 34% of the country's future generation has been prepared to combat future disasters. GOI, Ministry of Human Resource



Development has recommended the different school boards to incorporate Disaster Management in the school curriculum. Apart from Schools, there is huge scope for Disaster education in our colleges and universities. With the advancement in the field of information and technology, there is also great potential of online and Distance Learning education in our country. Every country is at the risk of exposure to some type of disaster, whether natural or man-made. In order for each country to prepare for any kind of disaster, it must inform its citizens about the different types of disasters. The local residents must also be aware of how they can effectively participate in preparing for a disaster, mitigating potential impacts of a disaster and the recovery process after a disaster. One of the most effective mechanisms for a country to prepare for a disaster is by conducting education and public awareness programmes at the local community level. Public awareness in disaster management is a process of educating and empowering the population through sharing knowledge and information about the various types of disasters and their potential risks as widely as possible so that people act appropriately when a disaster happens

Status of formal education: India

(i) Central Board of Secondary Education

According to India UNCRD (2008) project, in a first attempt by an educational institution in the country the Central Board of Secondary Education (CBSE) has integrated a short course on Disaster Management in the school curriculum. Around 7300 schools in the country follow CBSE curriculum and almost 900,000 children are enrolled with it. Apart from India the board has its schools in the gulf and some neighbouring countries such as Nepal, Bangladesh and in the Far East African countries. A brief outline of the course content is:

- Class VIII focuses on preparedness measures to be taken by students and teachers for various disasters.
- Class IX focuses on mitigation measures.
- Class X focuses on the role of government and other agencies in disaster management, role of science and technology in disaster management and initiating the concept of volunteerism among the children.
- Class XI (Sociology) focuses on gender and child rights in disaster management, role of community in disaster management.
- Class XI (Geography) focuses on the concept of various hazards.

(ii) State Education Boards

As recommended by the Government of India Ministry of Home Affairs, various State Governments are in the process of introducing disaster management in the school education. The status of disaster education in various states under the State Education Boards as compiled by the Ministry of Home Affairs is given below:

I. Tamil Nadu State: Course curriculum has been drafted and will be incorporated soon.
II. Orissa State: *"bipati biparjayao surakhya"* or *"Disaster Risk Safety"* was launched by Orissa State Disaster Mitigation Authority (OSDMA) for students. The Orissa Board of Secondary Education has included a chapter on Disaster Management in the class VIII geography syllabus.
III. Maharashtra State: Education Ministry has initiated the process of incorporating Disaster Management in school curriculum.
IV. Bihar State: Disaster Management has been carried forward through Sarva Shiksha Abhiyan. The Government of Bihar has incorporated Disaster Management in course curriculum from class V onwards in Social Science and the text book is being developed.
V. Gujarat State: Text books on disaster management for classes VII, VIII and IX have been drafted.
VI. West Bengal State: The Kolkata Municipal Corporation is in the process to introduce disaster management course in the schools run by the civic body.
VII. Jharkhand State: The state government of Jharkhand had included a text book on disaster management in the class IX syllabus as part of the social sciences subject.

Non-formal education

According to India UNCRD (2008) project, in India disaster management training has been included in the defence training of student cadets under various schemes such as NCC (National Cadet Corps), NSS (National Service Scheme), Scouts and Guides, National Yuva Kendras (NYKs), Civil Defence, Sainik Board etc. the initiatives taken by some of the states are as follows:-

i. Tamil Nadu State: Project Officers of National Service Scheme were identified as Master Trainers from Cuddalore District and were sensitized on Disaster Management. The Master Trainers in-turn planned sensitization training program for all the NSS Program officers in the district and they inturn organized the sensitization program for the NSS volunteers in their respective schools in Cuddalore District. A Group of NSS, NCC, Scout & Guides Project Officers from vulnerable districts in Tamil Nadu were trained at Anna Institute of Management Chennai about Disaster Management during the month of February 2006.
ii. Gujarat State: Gujarat State Disaster Management Authority (GSDMA) has successfully completed a two year project, Gujarat School Safety Initiative-I (GSSI-I) to promote culture of disaster safety in selected 150 schools in association with SEEDS in the districts of Ahmedabad, Vadodara and Jamnagar. Training of 500 NCC Girl cadets on first aid, search and rescue, and Ham radio was organized in Jasani hospital, Ahmedabad.
iii. Maharashtra State: An essay competition was organized in Dhule district of Maharashtra to create awareness among students. Nearly 180 students participated in the competition.
iv. Uttranchal State: NSS volunteers in secondary and senior secondary school levels are being trained on first aid, search and rescue and preparing contingency plan.
v. Assam State: In Nagaon district, 1800 NCC cadets were sensitized on DRM activities in association with the Commandant of 8th Assam Battalion.
vi. Kerala State: Nearly 170 volunteers – 120 from National Service Scheme and 50 from Nehru Yuvak Kendra Sangham (NYKS) were sensitized in two separate programs in Kozhikode on Disaster Management, including first aid and search and rescue concepts, vulnerability profile of the country, the national initiative and the need for the preparedness.
vii. Tripura State: Training of 250 NSS officers and volunteers in the city of Agartala has been initiated.
viii. Himachal Pradesh State: Under the SESIS (School Earthquake Safety Initiative Shimla) programme, students from 20 schools were given awareness on earthquake risk and were trained in first aid, fire safety, search and rescue etc., under a project implemented by SEEDS with the support of European Commission & Christian Aid.

Role of universities in disaster management

According to Joshi PC (2009), the increased incidences of disasters in the recent decades as well as increase in the awareness of disasters and related phenomena have likewise generated the need to produce systematic knowledge on all aspects of disasters. Since the last two decades, the need and importance of scientifically validated knowledge on disasters have been felt. It is also a fact that Universities, as citadel of knowledge are the right places where such scientific knowledge can be cumulatively and fruitfully generated. Intensive courses on anthropological, sociological, economic, psychological, public health, educational and sundry other areas are not available to the students and researchers. While comparing the situation in other countries, we find that USA and UK have emerged as the destinations offering intensive courses in all aspects of disasters. It is felt that our regulatory bodies like the UGC, AICTU, RCI and MCI should specially focus on funding non-structural high end courses on disasters for filling the existing gap in demand for generating such knowledge.

Role of open learning and distance education in disaster management

Open Distance Learning system is gaining currency to cater to variety of needs of different segments of the society. It has been recognized as one of the most effective tools of reaching to a large number of clientele. It does not bind learners with the constraints of time and place. ODL system is required to be extensively used for paving the way for educating the clientele and imparting required knowledge and skills to them.

According to Sahni P (2009) Disaster management education through ODL system shall aim at:

- Wider dissemination of need based knowledge;
- Financial viability;
- Flexible mode of learning;
- Optimum utilization of Information and Communication Technologies;
- Vast reach and accessibility;
- Capacity building in new and multi-disciplinary areas like disaster management;
- Use of multi-media approach; etc.

Though at present, besides Indira Gandhi National Open University, the distance education programmes are offered by 14 State Open Universities and 230 Departments of Distance Education in different universities in India, yet the number of universities offering education programmes in the area of disaster management in India is far too less than required.

Education and employment in disaster management

It is evident from the facts presented above that disasters are the most uncertain things and can occur in many forms. Trained manpower is necessary to deal with the situation before, during and after the disasters. The trained manpower helps in quick rehabilitation of the disaster affected people, understands their psychological conditions and helps in their post disaster settlement. In the planning and policy making, trained and experienced personnel are highly required to give better suggestions.

In our country, Ministry of Home Affairs is the nodal agency which monitors and manages the disasters. Other ministries/departments like agriculture, chemical, civil aviation, railways, road transport, environment and forest, health and atomic energy are responsible for their respective areas.

(i) Education in Disaster Management

According to Kumar A(2014), Trained manpower is the first requirement for mitigation, monitoring and management of disasters. There are number of universities and institutes offering certificate, Post Graduate Diploma, Master's and Research degree. The basic requirement for certificate and bachelor course is 10+2 and for P.G. diploma and Master's Degree, bachelor's degree (B.A./B.Sc./B.Com.) with 55% marks. For Ph.D. degree, Master degree with 55% marks is required. However, the entrance qualifications vary from university to university. The course in disaster management is suitable to all subjects' students but for sociology, social work, economics, public administration, psychology, geography, geology, meteorology and agriculture students, it is most suitable. Following universities/institutes are offering courses in disaster management in India (Kumar A (2014)):

i. **Mahatma Gandhi University, Kottayam, Kerala (http://www.sesmgu.org/)**
ii. MSc in Env Sci and Disaster Management – Full time; MPhil & PhD
iii. PG Diploma in GIS (3 months) with option for Disaster Mgt specialization
iv. **Indira Gandhi National Open University, New Delhi (www.ignou.ac.in)**
   - P.G.Diploma in Disaster Management
   - Certificate in Disaster Management
v. **Sikkim Manipal University of Health, Medical and Technological Sciences, Gangtok (www.smu.ac.in)**
   - M.Sc. in Disaster Mitigation (Distance education)
vi. **Indian Institute of Ecology and Environment, New Delhi (www.ecology.edu)**
   - M.Sc. in Disaster Mitigation (Distance education)
vii. **Annamalai University, Annamalai Nagar, Tamil Nadu (www.annamalaiuniversity.ac.in)**
   - M.A. in Disaster Management (Distance education)
viii. **Panjab University, Chandigarh (www.pu.ac.in)**
   - M.A. in Disaster Management
ix. **Vardhman Mahaveer Open University, Kota (www.vmou. ac.in)**
   - Certificate in Disaster Management P.G. Diploma in Disaster Management

x. **Gurvind Singh Indraprastha University, Delhi (www.ipu. ac.in)**
   - Centre for Disaster Management
   - MBA (Disaster Management) Weekend Programme.

xi. **National Institute of Disaster Management (NIDM), Indraprastha Estate, Ring Road, New Delhi (www.nidm.gov.in)**
   - Short-term specialized training programmes in campus and online.

xii. **Madras University, Chennai (www.uom.ac.in)**
   - International Centre of Madras University, Chennai
   - P.G. Diploma in Disaster Management

xiii. **The Global Open University, Kohima, Nagaland**
   - B.A. in Disaster Management
   - M.A. in Disaster Management
   - M.Phil. in Disaster Management

xiv. **Indian Institute of Techno-logy, Roorkee (www.iitr.ac.in)**
   - Centre of Excellence in Disaster Mitigation and Management
   - P.G. Diploma in Disaster Management

xv. **Tripura University, Suryam-aninagar, Tripura (www.tripura university.in)**
   - Department of Geography and Disaster Management
   - M.A. Disaster Management

xvi. **Indian Institute of Remote Sensing, Dehradun (www.iirs-nrsc.gov.in)**
   - Certificate/Awareness in Geo-hazards
   - P.G.Diploma in Geohazards
   - M.Sc. Geohazards

xvii. **North Bengal University, Darjeeling, West Bengal (www.nbu.ac.in)**

xviii. **Centre for Civil Defence College, Nagpur**
   - Degree/P.G. Diploma in Fire Engineering and Safety

xix. **Environment Protection Training and Research Institute, Hyderabad**

xx. **Disaster Mitigation Institute, Ahmedabad**
   - Research and training programmes

xxi. **Centre for Disaster Management, Pune**
   - Research and training programmes

xxii. **Amity Institute of Disaster Management, Noida**
   - M.Sc. and Ph.D. in Disaster Management

xxiii. **Nalanda Open University, Patna**

xxiv. **Rajrshi Tandon Open University, Allahabad**

xxv. **Indian Institute of Technology, Kanpur (www.iitk. ac.in)**
   - Department of Earthquake Engineering
   - M.Tech. (Earthquake Engineering) and Ph.D

xxvi. **Tata Institute of Social Sciences, Mumbai (www.tiss.edu)**
   - Jamsetji Tata Centre for Disaster Management
   - M.A./ M.Sc. in Disaster Management

xxvii. **Disaster Management Institute, Paryavaran Parisar, Arera Colony, Bhopal**
   - Training and Research in Disaster Management

xxviii. **National Institute of Rural Development, Rajendranagar, Hyderabad**
   - Centre for Agrarian Studies and Disaster Mitigation
   - Research and Training in Disaster Management
   - (Note- the list is indicative only)

(ii) Higher Study – Ph.D And Post-Doctoral Research

There are number of universities and institutes conducting research programmes/facilitating in disaster management in the country like the Mahatma Gandhi University, Kottayam, Kerala; Centre of Excellence of Disaster Management in Indian Institute of Technology, Roorkee; Department of Earthquake Engineering in Indian Institute of Technology, Roorkee; Centre of Earthquake Engineering in Indian Institute of Technology, Kanpur; National Institute of Disaster Management, New Delhi; Centre of Disaster Management, Guru Govind Singh Indraprastha University, Delhi; Department of Geography, Punjab University; Indira Gandhi National Open University, New Delhi; SAARC Disaster Management Centre, New Delhi; India Meteorology Department, Lodhi Road, New Delhi; Indian Agricultural Research Institute, New Delhi; Natural Resources Data Management System (NRDMS) Division, Department of Science and Technology, Govt. of India, New Delhi; Council of Scientific and Industrial Research (CSIR), New Delhi; National Institute of Ocean Technology, Chennai. The fellowship varies from Rs.12000/- plus HRA to Rs. 23,000/-plus HRA depending on the qualification and experience of the candidate. In foreign countries, there is good number of fellowships available for Ph.D. degree and Post-Doctoral research. After completing the research, there is good scope of employment in universities, institutes, NGOs, policy and planning organizations within country and abroad.

(iii) Job Opportunities

There are good employment opportunities in disaster management in government as well as in private organizations. The work profile varies like teaching, research, consultancy, documentation, training organizer, field training and mock driller expert. Name of some organizations having likely employment opportunities are as follows:

1. National-Centre for Earth Science Studies (N-CESS), DST, Trivandrum
2. Hazard Risk and Vulnerability Analysis (HVRA) Cell, Dept of Revenue, Govt of Kerala, Trivandrum
3. Institute of Land and Disaster Management, Dept of Revenue, Govt of Kerala, Trivandrum
4. Kerala State Disaster Management Authority, Dept of Revenue, Govt of Kerala, Trivandrum
5. National Institute of Disaster Management (NIDM), Ministry of Home Affairs, Govt. of India, New Delhi.
6. SAARC Disaster Management Centre, NIDM Building, New Delhi.
7. National Disaster Management Authority, Near Indira Gandhi International Airport, New Delhi.
8. Indian Institute of Public Administration (IIPA), Indraprastha Estate, Ring Road, New Delhi.
9. India Meteorological Department, Lodhi Road, New Delhi.
10. Centre of Disaster Management, HCMRIPA, JLN Marg, Jaipur.
11. Haryana Institute of Public Administration (HIPA), Gurgaon.
12. Ambedkar Institute of Public Administration, Chandigarh.
13. Shri Krishna Institute of Public Administration, Ranchi.
14. G.B.Pant Institute of Himalayan Environment and Development, Nainital, Uttarakhand.
15. Disaster Management Centre, Bhopal.
16. Disaster Mitigation Institute, Ahmedabad.
17. Centre for Disaster Management, Guru Govind Singh Indraprastha University, Kashmeri Gate, Delhi.
18. Indian Agriculture Research Institute (ICAR), New Delhi.
19. Indian Red Cross Society, New Delhi and States Units.
20. States Revenue and Disaster Management Ministry/Department.
21. State Government's Institute of Public Administration.
22. National Remote Sensing Centre, Department of Space, Govt. of India, Hyderabad.
23. Space Applications Centre, Department of Space, Govt. of India, Ahmedabad.
24. Indian Institute of Remote Sensing, Department of Space, Govt. of India, Dehradun.
25. National Institute of Ocean Technology, Chennai.
26. United Nations Development Programme (UNDP) of national level and State Units.
27. Faculty and research positions in universities/institutes and in foreign countries.
28. Organizations providing fellowships for Disaster Prevention and Management Study.
29. Indian and international level Non-Governmental Organizations (NGO) working in the field of Disasters Management.
30. State Remote Sensing Applications Centers.
31. International organizations having research and job opportunities.

(Note- the list is indicative only)

From the employment generation point of view too disaster management education is having a lot to offer. Also it is quite obvious form the list that there is a good amount of opportunities are available for the trained manpower as a number of national as well as international organizations are offering jobs in various arena of disaster management.

Conclusion

Prevention is better than cure, is a novel saying which is extremely useful and applicable in the context of disaster management. It is evident from the facts that mitigation and investment in disaster preparedness can save thousands of lives, vital economic assets, livelihoods and reduce the cost of overall disaster relief. It is at this juncture that the role of education and schools in disaster risk reduction becomes extremely important. The importance of education in promoting and enabling Disaster Risk Reduction (DRR) has already been identified by researchers and policy makers throughout the world. In doing so, there is a renewed focus on disaster risk education in primary and secondary schools. Mainstreaming DRR into school curricula aims to raise awareness and provide a better understanding of disaster management for children, teachers and communities. Now with many universities are offering courses in Disaster Management and also with the openings of employment opportunities in various institutions it is high time that more and more students are motivated to join these courses and in turn make their career in the fields which is highly challenging and socially extremely rewarding. From the point of view of Education there is still a lot of room for improvement in higher education and research related activities which ultimately lead to Disaster risk reductions.

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FOREST FIRE RISK ANALYSIS USING GEO-INFORMATION TECHNOLOGY: A STUDY OF PEPPARA WILDLIFE SANCTUARY, THIRUVANANTHAPURAM, KERALA, INDIA

DRVC2014
2nd Disaster Risk & Vulnerability Conference

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Abstract

Forest fire is a common problem in the Western Ghats regions of Kerala. Therefore forest fire risk analysis is necessary for forest management. The present study area is also prone to forest fires. The present study deals with the identification of fire risk zones in Peppara Wildlife Sanctuary, Western Ghats mountain region, Kerala using GIS and Remote Sensing techniques. The forest fires are caused due to environmental and human related factors. This study considered 5 factors namely, land use/land cover, slope, elevation, distance from road, and distance from human settlements. Relevant thematic layer maps representing these factors that are related to forest fire occurrence have been prepared by using Geographic Information System (GIS) and Remote Sensing (RS) software tools. A multi parametric weighted index model was used to prepare the fire risk zone map using ArcGIS and ERDAS Imagine software tools. The forest fire risk zones were segmented into four, viz., low, moderate, high and very high risk zones. Forest fire risk maps are useful tools for the efficient planning and management of forest in the Western Ghats mountain region.

Keywords

Western Ghats, human related factors, multi parametric weighted index, fire risk zones

1. Introduction

The fire in most accepted manner can be defined as that it is uncontained and freely spreading combustion which consumes the natural fuels of a forest i.e. duff, litter, grass, dead branch, wood, snags, logs, stumps, weeds, brush, foliage and to some extent green trees (Brown and Davis, 1959). Fire hazard is physical event of certain magnitude in a given area and at a given time, which has the potential to disrupt the functionality of a society, its economy and its environment (Boonchut, 2005). Forest fire is the most common hazard in forest. The causes of forest fires can be divided into two broad categories. The first one is the '*Environmental',* which are beyond control and the second, '*Human related',* which are controllable. Forest fires of Environmental origin are largely related to climatic conditions such as temperature, wind speed and direction, level of moisture in soil and atmosphere and duration of dry spells. The friction of bamboos swaying due to high wind velocity and rolling stones that result in sparks setting off fires in highly inflammable leaf litter on the forest floor can also result in Environmental forest fire. Human related fires result from human activity as well as methods of forest management. It can be intentional or unintentional. The centuries old practice of shifting cultivation (especially in the North-Eastern region of India and in parts of the States of Orissa and Andhra Pradesh), the use of fires by villagers to ward off wild animals, fires lit intentionally by people living around forests for recreation, fires started accidentally by careless visitors to forests who discard cigarette butts, etc can result in forest fire. The causes of forest fire have been increasing rapidly. This situation has been accentuated by the increasing human and cattle population. People depends forests ever more frequently to graze cattle, collect fuel wood, timber and other minor forest products. Forest fires can result in forest degradation and have wide ranging adverse ecological, economic and social impacts. The adverse effects of forest fires are loss of valuable timber resources, loss of biodiversity and extinction of plants and animals, loss of wildlife habitat and depletion of wildlife, loss of natural regeneration and reduction in forest cover, loss of livelihood for tribal people and the rural poor, as approximately 300 million people are directly dependent upon collection of non-timber forest products from forest areas for their livelihood. The residual chemical effects are also deleterious for the soil (Brown and Davis, 1959). Fire serves an important function in maintaining the health of certain ecosystems, but as a result of changes in climate and in human use and misuse of fire, fires have become a threat to many forests and their biodiversity (Dennis and Meijaard, 2001). Damage to seed bank, seedlings, and saplings hinders the recovery of original species (Woods, 1989). The loss of key organisms in forest ecosystem, such as invertebrates, pollinators and decomposers will slow the recovery rate of forest (Boer, 1989).

It has been estimated that 90% of forest fires in India are human induced. The normal fire season in India is from the month of February to mid June. India witnessed the most severe forest fires during the summer of 1995 in the hills of Uttar Pradesh and Himachal Pradesh. The fires were very severe and attracted the attention of whole nation. An

area of 677,700 ha was affected by the fire. The Forest Survey of India (FSI) data on forest fire attribute around 50% of the forest areas as fire prone. This result doesn't mean 50% area of India is affected by fires annually. Very high, high and frequent forest fire damages are noticed only around 0.8%, 0.14% and 5.16% of the forest areas respectively. Thus only 6.17% of the forests are prone to severe fire damage, i.e., out of the 63 million ha of forests, an area of 3.73 million ha can be presumed to be affected by fires annually. The forests of Kerala falls in two bio-geographic provinces, viz., the Western Ghats and the Western Coast are rich in biodiversity and vital for environmental protection and considered to be a repository of rare and endangered flora and fauna. Even though the land area of Kerala is only 1.2 percent of India, the forest cover is 2.30 percent of the national average. In Kerala, the area burnt in forest fires has been increasing in recent years. The peak was during the year 2003-2004, when more than 15500 hectares caught fire.

Tanaka et al. (1983) used Landsat Multi Spectral Scanner (MSS) data for the classification, mapping and area estimation of devastated land in Japan. Karteris and Kritikos (1992) applied non-supervised and supervised classifications for assessing forest fire damages in the Holy Mount Athos (Greece). Matson and Stephens (1987) proposed a method for regional and global fire detection using NOAA-AVHRR images. Malingreau (1984) and Malingreau et al. (1985) used the vegetation index (AVHRR data band 1 and band 2) for evaluating the extension and damage of fires. Chuvieco and Congalton (1989) combined GIS and Remote Sensing techniques to prepare a fire hazard map. Antoninetti et al. (1993) integrated topographical and satellite data for the identification of fire hazard areas. Tahir Malik et al. (2013) used Remote Sensing and GIS techniques to delineate forest fire risk zones in Kansrao forest range of Rajaji National Park, Uttarakhand. They combined fuel type, elevation, slope, aspect, accessibility and settlement maps to prepare the risk zone map. In this study an attempt has been made to identify fire risk zones in Peppara Wildlife Sanctuary, Thiruvananthapuram district, Kerala using Geo-information technology. The parameters such as slope, elevation, land use/land cover (LU/LC), distance from roads, and distance from human settlements are used for the present study.

1.1. Study Area

The present study area is located between longitudes of 77˚6'50" E and 77˚14'5" E and latitudes of 8˚34'30" N and 8˚41'25" N. The total area of the Peppara Wildlife Sanctuary is 53 sq. km. It consists of part of the Palode reserve forest (24 Sq. km) and Kottoor reserve forest (29 sq. km). The area is hilly. The major peaks in the sanctuary are Chemmunjimottai, Athirumalai, Arumukhamkunnu, Kovilthérimalai, and Nachiyadikunnu. The Annual average rainfall is 2500 mm. The major river flowing through the sanctuary is Karamana River and its tributaries. The Peppara reservoir of 5.82 sq. km area is located within the sanctuary. The common tree species in the sanctuary are Terminalia paniculata, Terminalia bellerica, Pterocarpus marsupium, Palaquium ellipticum, Mesua ferrea, Hopea parviflora, Bombax ceiba, Lagerstroemia lanceolata, Albizia procera, Alstonia scholaris, etc. 43 species of mammals, 233 species of birds, 46 species of reptiles, 13 species of amphibians and 27 species of fishes are reported from the sanctuary. The common mammals found are Tiger, Leopard, Sloth bear, Elephant, Sambar barking Deer, Bonnet Macaque, Nilgiri langur, Nilgiri tahr, etc.

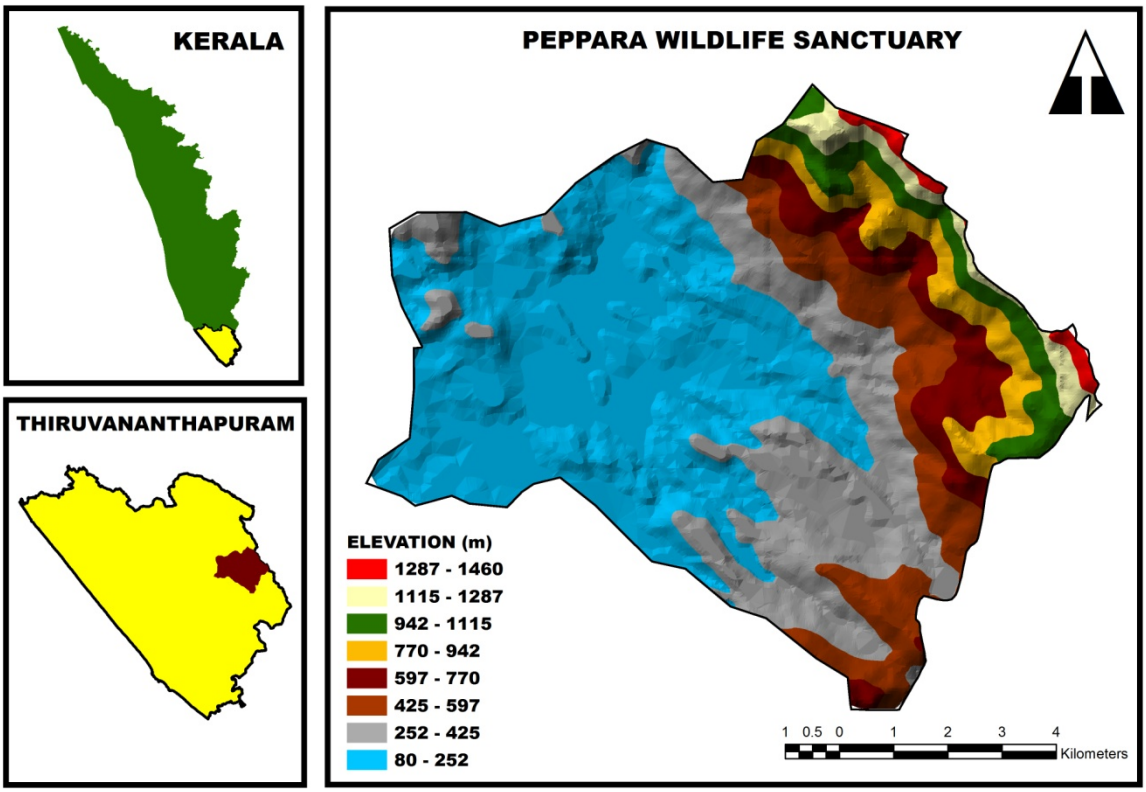

Figure 1: Location map of the Study area

2. MATERIALS AND METHODS

2.1. Data Used

- Survey of India Topographic map of scale 1:50,000
- Cartosat -1 DEM of 30 m resolution
- Landsat ETM+ satellite imagery of 30 m resolution

2.2. Software Used

- ArcGIS 9.3
- ERDAS Imagine 9.2

2.3. Methods

The present study area, Peppara Wildlife Sanctuary was delineated from the SOI toposheet numbered; 58 H/2. Landsat ETM+ image was used to prepare the land use/land cover (LU/LC) map. The image was classified by using ERDAS Imagine software tools. The supervised classification method was used to prepare the LU/LC map. The Cartosat DEM was used to prepare the slope and elevation map using ArcGIS spatial analyst and 3D analyst tools. The road networks and settlements were digitized from the SOI toposheets by using ArcGIS tools. The Google Earth was used to modify the road networks and settlements. Distance from road map and distance from settlement map was prepared by using ArcGIS spatial analyst tool. A multi parametric weighted index model was used for the study. The thematic layers were reclassified using Natural breaks (Jenks) method. Ranks were assigned to these thematic layers and weights were assigned to each class of these thematic layers according to their sensitivity to fire or their fire inducing capability. The index was derived from the ranks and weights (Index = Rank x Weight). The forest fire risk map of the study area was created by overlaying the index maps using ArcGIS spatial analyst tool. Finally the prepared map was validated with the fire inventory points.

3. Results and discussions

The forest fire risk zones for the study area were generated through the integration of various thematic maps viz., land use/land cover map (Figure 2), distance from settlement map (Figure 3), distance from road map (Figure 4), slope map (Figure 5), elevation map (Figure 6) using Remote Sensing and GIS techniques.

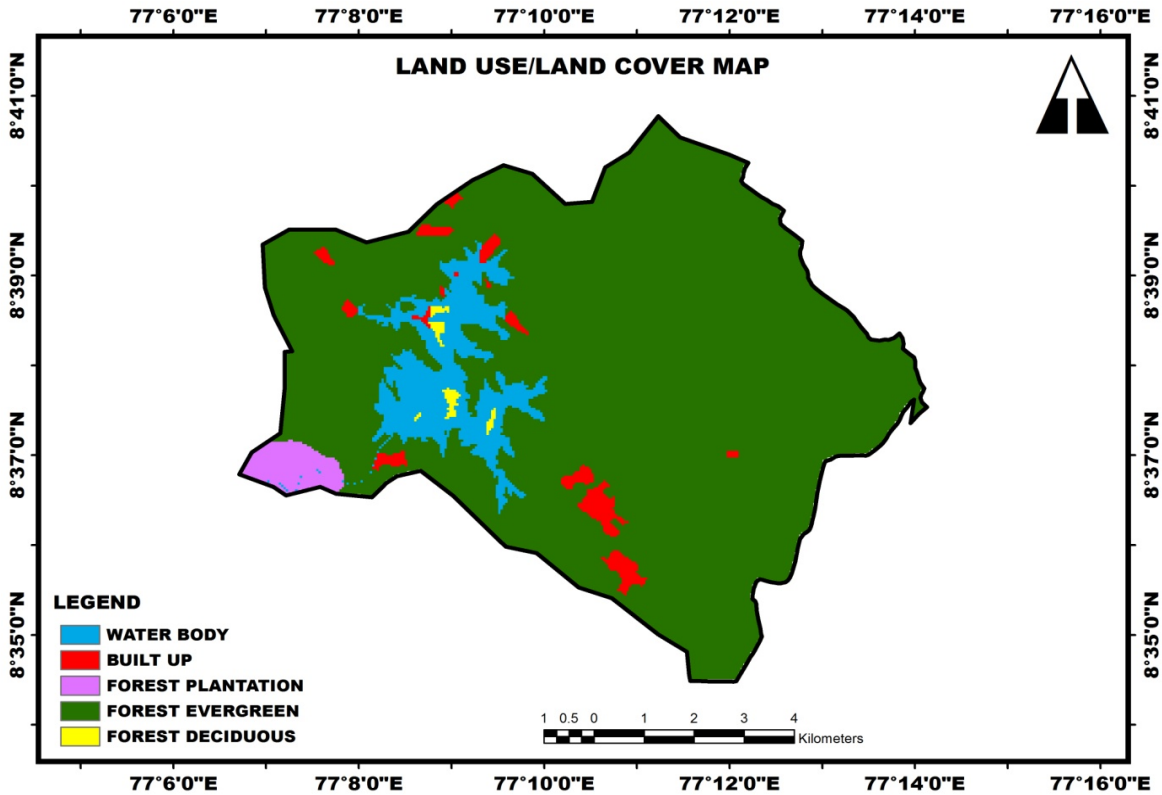

Figure 2: Land use/land cover map

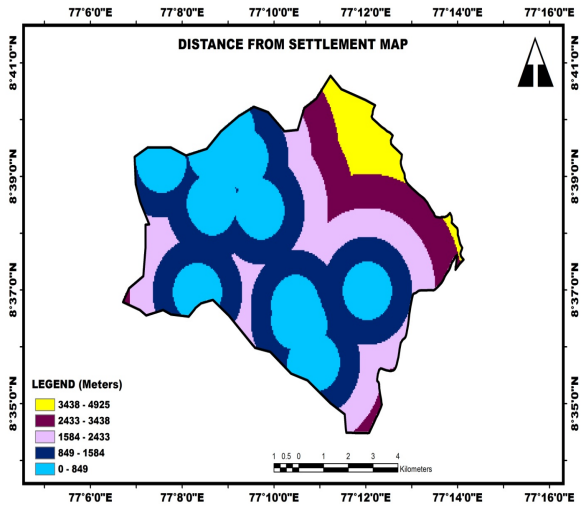

Figure 3: Distance from settlement map

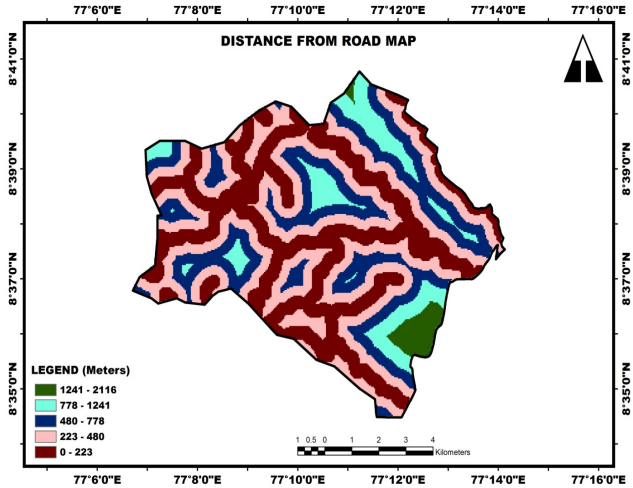

Figure 4: Distance from road map

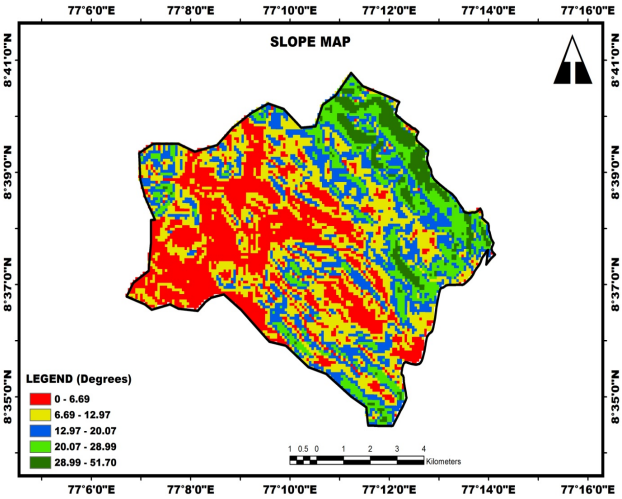

Figure 5: Slope map

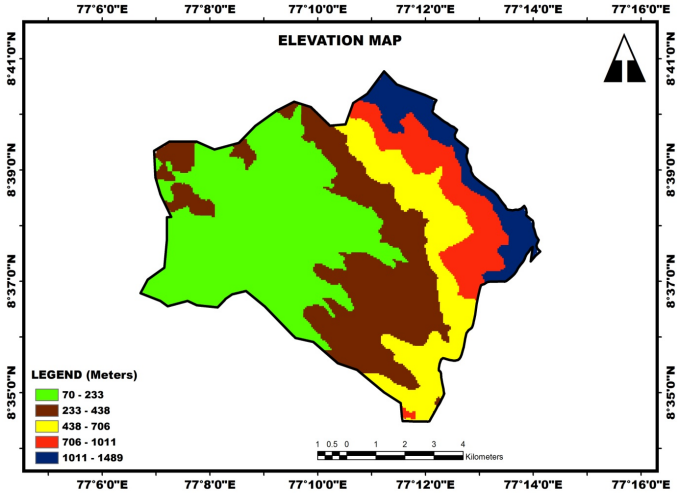

Figure 6: Elevation map

3.1. Forest Fire Risk Zone

The forest fire risk zone map (Figure 7) of Peppara Wildlife Sanctuary is prepared based on the parameters such as land use/land cover, slope, elevation, distance from road, and distance from human settlement. Ranks are assigned to different parameters according to their influence on fire and the opinion of the experts in the field. The highest rank of 10 is assigned to land use/land cover. Elevation is given a relatively lower rank of 1. The ranks, weights and index assigned to the different factors are given in the Table 1.

Finally the fire risk zone map is validated with the fire inventory points collected from the Forest Survey of India (FSI). It shows that out of 10 fire incidences, 8 had occurred in very high risk zones and 2 occurred in high risk zones.

4. Conclusion

Forest fire hazard assessments and risk evaluations are great challenge to planners, decision makers and forest officials. This study shows an efficient methodology to demarcate fire risk zones in Peppara Wildlife Sanctuary, Thiruvananthapuram district, Kerala, India. The methodology used, based upon a combination of Remote Sensing and GIS techniques is an excellent tool for the assessment of fire risk. Fire risk map was prepared by combining the index maps using GIS techniques. Ranks and weights were assigned to different themes and associated classes to prepare the fire risk zone map. Finally the fire risk map was classified into 4 categories; Very high, high, moderate, and low risk zones. The prepared map can be of great benefit for the better understanding of fire risks and will offer a more effective control on the forest fires.

Table 1: Weights, ranks and index assigned to different factor classes

Factor	Class	Weight	Rank	Index
	Water body	1		10
	Built up	2		20
Land use/land cover	Forest Plantation	3	10	30
	Forest Evergreen	4		40
	Forest Deciduous	5		50
	3438 - 4925	1		2
	2433 - 3438	2		4
Distance from settlements (m)	1584 - 2433	3	2	6
	849 - 1584	4		8
	0 - 849	5		10
	1241 - 2116	1		2
	778 – 1241	2		4
Distance from road (m)	480 – 778	3	2	6
	223 – 480	4		8
	0 – 223	5		10
	0 – 6.69	1		3
	6.69 – 12.97	2		6
Slope (degree)	12.97 – 20.07	3	3	9
	20.07 – 28.99	4		12
	28.99 – 51.70	5		15
	70 – 233	1		1
Elevation (m)	233 – 438	2	1	2
	438 – 706	3		3
	706 – 1011	4		4
	1011 – 1489	5		5

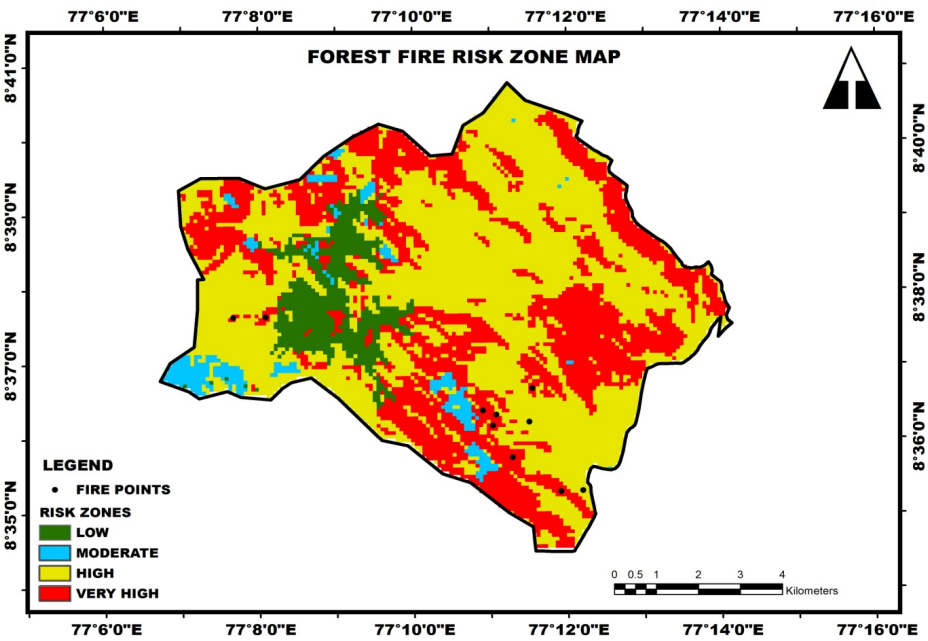

Figure 7: Forest fire risk zone map

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RISK MANAGEMENT USING MORPHOLOGICAL FIELD ANALYSIS: A CASE STUDY FROM NELLORE DISTRICT, INDIA

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Abstract

In this paper, attempt has been made by the authors to identify various "elements of risk" in the Nellore district of Andhra Pradesh, India from the District Disaster Management Plan (DDMP) and also through inputs received from district officials in Disaster Management cell. Through MA/CARMA, an advanced computer program, morphology analysis has been done through Cross Compatibility Matrix between different elements of risk and a relationship has been established between various parameters of Hazard, Vulnerability and the Coping capacity (resilience) as prevalent in the district based on the available data and correlation on the risk factors through "cross-consistency assessment" (CCA). The model developed would allow to quickly identify synergies or disparities in disaster reduction methods adopted by district administration by providing the option to select the right choice of the support functions during the time of crisis, as applicable to any particular disaster thereby saving time.

Keywords

District, Risk, Morphology, Cross-consistency assessment, Model

1. Introduction

The primary objective of all the disaster management studies is to identify and assess the risk associated with any geographical area and prepare mechanisms to mitigate risk factors and equip the social system to be resilient. District administrators across India are taking various measures to make necessary arrangements within different functionaries and allocating the responsibilities to the concerned officials to cooperate, interoperate and coordinate to work efficiently with each other without any misunderstanding of their roles during the time of crisis. Many district administrations also conduct mock drills to measure effectiveness of their plans in the real world scenarios.

Based on the magnitude (and frequency in many cases) of the event, the communities are affected through loss of lives, injury to the health and loss of private and public properties. This causes unrest and based on the economic condition the resilience period differs from one community to other. Undoubtedly the weaker sections of the societies are affected the most. Geography Matters! While historic disaster events are important to find the trend it is the geography that gets affected and it matters the most. Therefore it is important for disaster studies to understand the cause and type of disasters, its effect in various geographies, the hidden relationship that exist between various natural and manmade features in the real world. Actions are happening all around and government is conscious that proactive measures with sound planning is required that helps to take quick and right decisions.

2. Study area

Among all the geographies the coastal districts suffers the most due to various hazards. Amarajeevi Potti Sri Ramulu Nellore district of Andhra Pradesh State in India (Figure 1) has been chosen as a study area as it is affected and prone to multiple hazards. It lies between 13-30' and 15-6' of the Northern Latitude and 70-5' and 80-15' of the Eastern Longitude. It is extended over an area of 13076 Sq Kms, accounting for 4.75% of the total area of the state. It is located along the Bay of Bengal and has a coastline of 163 km covering 11 mandals.

In 2011, Sri Potti Sriramulu Nellore had population of 2,966,082 of which male and female were 1,493,254 and 1,472,828 respectively. Population density was 227 during census in 2011. The district broadly has 2 natural divisions from North to South. The eastern Half of the District adjoins coastal belt is fairly fertile and the western half of the district has low elevation towards west with large track of low shrub jungles diversified with rocky will stony plains. The Principal rivers are Pennar and Swarnamukhi. The other streams are Kandaleru and Boggeru which are occasionally torrential in Character during rainy season. The rivers and rivulets remain dry for major part of the year and carry floods during rainy season. Pennar river is the most important one and flows for about 112 Kms in the District.

The District lies in an area of precarious and uncertain rainfall. Most rainfall (about 70%) occurs from July to September, during the "Southwest Monsoon" period, when the ITCZ shifts northwards and the land is target of floods. A major portion of the district is underlain by Dharwar Super Group, Peninsular Gneissic Complex and Older Metamorphic of Archaean Age consisting of granite gneisses, schists intruded by basic dykes and pegmatite reefs. The windblown sand

deposits of 3 to 7 m, generally parallel to coast, occur as narrow dunes. The red soil is predominant with 40% of the area in the District whereas a belt of sand runs along the sea coast. The black cotton soil and sandy loams occupy 23% and 34% of the area respectively. The district is also having a major port Krishnapatnam which is a critical infrastructure located at 180 kilometer north of Chennai. The port is being upgraded into India's biggest privately owned world-class port by Navayuga Company.

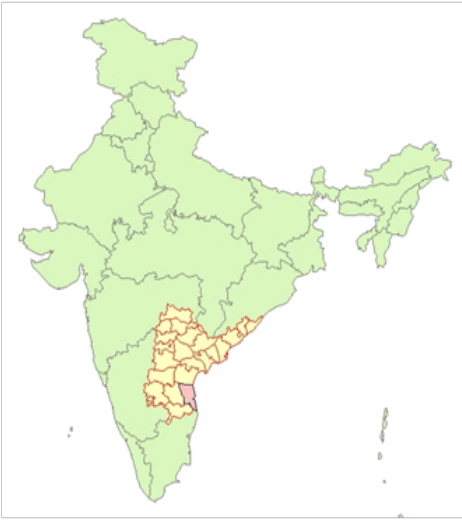


Figure 1. Study area – Sri Potti Sriramulu Nellore District in Andhra Pradesh, India.

3. Approach

Approaches for reducing the risk require knowledge of multi-disciplinary sciences. For multi-hazard or all-hazard approach in the pre disaster situation, a combination of "top-down" and "bottom-up" thinking, and linking mitigation with development is required (Mattingly, 2002). Historically, scientific knowledge develops through cycles of analysis and synthesis. Every synthesis is built upon the results of a proceeding analysis, and every analysis requires a subsequent synthesis in order to verify and correct its results (Ritchey, 1991). Morphological analysis (MA) was developed by Professor Fritz Zwicky – the Swiss astrophysicist and aerospace scientist based at the California Institute of Technology (CalTech) – as a method for structuring and investigating the total set of relationships contained in multi-dimensional, non-quantifiable, problem complexes (Zwicky 1969, Zwicky & Wilson, 1967). More recently, morphological analysis has been extended and applied by a number of researchers in the U.S.A and Europe in the field of futures studies, policy analysis and strategy modeling (Coyle et.al., 1994; Rhyne 1995). In 1995 advanced computer support for MA was developed at the Swedish Defense Research Agency (Ritchey, 2003a). This has made it possible to create non-quantified inference models, which significantly extends MA's functionality and areas of application. Since then, more than 100 projects have been carried out using computer aided morphological analysis, for structuring complex policy and planning issues, developing scenario and strategy laboratories, and analyzing organizational and stakeholder structures. More recently, General Morphology Analysis (G MA) has been applied by a number of researchers in the USA and Europe in the fields of policy analysis and futures studies (e.g. Godet, 1994; Rhyne 1995; Ritchey 1997). In 1995, advanced computer support for GMA was developed at the Swedish Defense Research Agency (Ritchey, 2003b).

Hazards are always prevalent, but the hazard becomes a disaster only when there is greater vulnerability and less of capacity to cope with it in the geography of the event. In other words the frequency or likelihood of a hazard and the vulnerability of the community increases the risk of being severely affected. Risk assessments are carried out to identify which hazards are more likely to occur and to have the biggest impact on a community's or individual's assets. It has two distinct components Hazard Analysis and Vulnerability Analysis. These two analyses allow us to assess the risk facing communities by identifying the hazards which are most likely to occur within a given time-frame and to determine which of them will have the greatest magnitude of impact on the assets and livelihood options of a community. Over time, changes can occur in terms of both the vulnerability of a community and the type, causes, nature, and intensity of the hazards that it faces.

Risk is expressed as, **Risk = (Hazard * Vulnerability) /Coping Capacity**

In the following sections the elements of risks are described in the context of the study area

3.1 Hazard

Hazard is a potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. The word 'hazard' owes its origin to the word 'hasard' in old French and 'az-zahr' in Arabic meaning 'chance' or 'luck'. Hazards can be grouped into two broad categories namely natural and manmade. Hazards can include latent conditions that may represent future threats and can have different origins: natural (geological, hydro-meteorological and biological) or induced by human processes (environmental degradation and technological hazards). Hazards can be single, sequential or combined in their origin and

effects. Each hazard is characterised by its location, intensity, frequency and probability. There are many geographical areas which are affected by multiple hazards. The hazards which are prevalent in the Nellore districts have been identified from historical records of Disaster Management Cell of the district. They are as follows:

Hailstorm, Floods, Cyclones, Tsunami, Earthquake, Drought, Epidemics, Road Accidents, Industrial & Chemical Accidents, Fires

However, the Nellore district official does not take into account drought as a hazard in the disaster management cell, as there are separate programs to deal drought management. The following are the parameters to measure and study hazards:

- Warning Signs and Signals: Scientific and indigenous indicators that hazard is likely to happen.
- Forewarning**:** Time between warning and impact.
- Speed of Onset: Rapidity of arrival and impact. One can distinguish between hazards that occur without almost any warning (earthquake) and hazards that can be predicted three to four days in advance (typhoon) to very slow-onset hazards like drought and famine.
- Frequency**:** Periodicity of the occurrence of the hazard - seasonally, yearly, once every 10 years, once in a lifetime, etc
- When (Time): To identify the temporal pattern. Occurrence at a particular time of the year (wet or dry season; in November to December etc.
- Duration: The period for which the hazard is felt (earthquake and aftershocks; days/weeks/months that area is flooded; length of period of operations).

The classification of the hazard magnitude has been done as shown in Table 1

Table 1. Classification of Hazard Magnitude

High	Several deaths + Severe Injuries + Loss of property)
Medium	Severe injuries + Loss of Property
Low	Loss of property

3.2 Vulnerability

Vulnerability- Blaikie et al (2004), define vulnerability as the characteristics of a person or group and their situation that influences their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard. For the Nellore district, vulnerabilities can be broadly categorized into physical, technical and economical vulnerability. These are primarily based on the studies made by Maskrey (1998).

- Physical Vulnerability**:** Identification of areas likely to be affected under certain atmospheric, topographic and physical conditions and having physical proximity to the identified hazard areas. It includes the likelihood of damage with respect to the people or property who and what may be damaged or destroyed by natural hazard such as earthquakes or floods. It is based on the physical condition of people and elements at risk, such as buildings, infrastructure etc; and their proximity, location and nature of the hazard.
- Technical Vulnerability**:** Structures and infrastructures (houses roads, bridges, irrigation channels, etc) unable to withstand and resist hazard events.
- Economic Vulnerability**:** The degree to which a population is affected by a hazard which is not in the close proximity but the socio economic conditions merely lie in the physical components of vulnerability but also on the socioeconomic conditions. The socio-economic condition of the people also determines the intensity of the impact. People who are poor and living in the sea coast have longer resilience period.

The attributes analysed for the Nellore district for the vulnerability has been tabulated in Table 2

Table 2. Vulnerability Types in Nellore District

Physical	Communities in hazard prone locations
Technical	Structures and infrastructures (houses roads, bridges, irrigation channels, etc) unable to withstand and resist hazard events.
Economical	Insufficient assets and reserves to withstand loss; lack of economic diversification.

3.3 Coping Capacity

Capacity is a combination of all the strengths and resources available within a community, society or organization that can reduce the level of risk, or the effects of a disaster. In most of the disasters, people suffer their greatest losses in the physical and material realm. Rich people have the capacity to recover soon because of their wealth. In fact, they are hardly hit by disasters because they live in safe areas and their houses are built with stronger materials. The more is the coping capacity better will be the resilience. The individual line department of the district which plays a significant role for providing the support has been taken into consideration. Table 3 shows the list of the support departments take for this study and participated into the analysis.

Table 3. Disaster Coping Capacity in Nellore District

Early Warning dissemination response	Evacuation, search and rescue response	Medical & First Aid Response	Shelter management response	Relief Response	Infrastructure restoration response
RCS	RD	RD	RD	RD	RD
Police	Police	AH&F	Police	PR & PRI	R&B, PRE
PR & PRI	AH&F	M&HD	M&HD	AH&F	I&CAD
AH&F	MH&D		R&B & PR	AD	
M&HD	RTA/APSRTC		APCSC		
			YS		
			WS&CDR		
			PR & PRI		
			AH&F		
			APPTC		

Source: Disaster Management Cell, Nellore district

AD	Agriculture Department
AH&F	Animal Husbandry and Fisheries
APCSC	AP Civil Supplies Corporation
APPTC	AP Power Transmission Corporation (AP Transco)
APSRTC	Andhra Pradesh State Road Transport Corporation
I&CAD	Irrigation & Command Area Development
M&HD	Medical & Health Department
Police	Home Department
PR	Panchayat Raj
PRE	Panchayat Raj Engineering
PRI	Panchayat Raj Institutions
R&B	Roads and Buildings
RCS	Revenue and Civil Supplies
RD	Revenue Department
RTA	Road Transport Authority
WS&CDR	Water and Sanitation and carcass disposal response
YS	Youth Services

3.4 Risk Identification

Risk is a "measure of the expected losses due to a hazard event occurring in a given area over a specific time period. Risk is a function of the probability of particular hazardous event and the losses each would cause." A community/locality is said to be at 'risk' when it is exposed to hazards and is likely to be adversely affected by its impact. Beyond expressing a possibility of physical harm, it is crucial to recognize that risks are inherent or can be created or exist within social systems. It is important to consider the social contexts in which risks occur and that people therefore do not necessarily share the same perceptions of risk and their underlying causes. For the purpose of the district level disasters the capacity has been mapped based on the capacity available through the district authority as Emergency Support Functionaries (ESF).

4. Methodology

The overall methodology as adopted for the study describing the basics of morphology analysis and governing parameters are described in the following sections.

4.1 Morphology Analysis

The idea behind the multi-hazard risk reduction model is to make it possible to identify and compare risk reduction strategies, and preparedness and mitigation measures, for different types of disasters. This would allow to identify synergies or disparities in disaster reduction methods as concerns different types of hazards, which may be concurrent. It would also give us a common conceptual framework and terminology over a wide range of disaster reduction issues.

Multi-hazard Risk reduction method is a complex problem area requiring expert knowledge and much practical experience in a wide range of disciplines. It also requires a methodology which can collate and organize this knowledge through a participatory dialogue process. The method begins by identifying and defining the most important parameters (dimensions) of the Risk assessment, and assigning each parameter a range of relevant "values" or conditions. This is done in natural language. A morphological field is constructed by setting the parameters against each other in an n-dimensional configuration space. The next step in the analysis-synthesis process is to examine the internal relationships between the field parameters and "reduce" the field by weeding out all mutually contradictory conditions.

4.2 Governing Parameters

The term morphology comes from classical Greek (morphe) and means shape or form. Thus morphology is the study of the shape and arrangement of parts of an object, and how these parts "conform" to create a whole or Gestalt. The "objects" in question can be physical objects (e.g. an organism or ecology), social objects (a social system of organisation) or mental objects (e.g. word forms, concepts or systems of ideas). General Morphology Analysis (GMA) is a general method for structuring and analysing complex problem fields which

- are inherently non-quantifiable
- contain non-resolvable uncertainties (both antagonistic and non-specified uncertainty); and
- cannot be causally modelled or simulated in a meaningful way.

The approach was taken through highly structured method of morphological analysis. Morphological analysis is a process of collective creativity. MA/CARMA, an advanced computer support for morphological analysis – has been used for finding correlation on the risk factors for Nellore district. The inputs provided for this program has come through vast literature survey, communication with Nellore district DM cell staffs and subject matter experts. MA is a general method for non-quantified modelling. It sets no specific preconditions and fairly transparent. A morphological analysis was carried out in a number of iterative steps, in which risk assessment subject with all parameters were taken through analysis-synthesis cycles. Hazard Type, Hazard Magnitude, Vulnerability and district capacity as provided by various departments in the DM plan of the district has been taken into account. For each parameter, conditions were defined – which represent alternative solutions to the particular issue that the parameter expresses. The totality of the parameters and their respective values is a morphological field. The governing parameters for the Risk elements that have been considered for the morphology analysis has been mentioned in Table 4. It is based upon the insight that there may be numerous pairs of conditions in the morphological field which are mutually incompatible. Through the pair-wise comparison of the variables, the fitment process is completed based on the established procedure, then CCA Model of risk for Nellore was established.

Table 4. Elements of Risk in Nellore District

Type of Hazards	Hazard Magnitude	Vulnerability	Capacity - District Authority
Cyclones	High	Physical	Animal Husbandry and Fisheries
Drought	Medium	Technical	Carcass Disposal Team
Earthquake	Low	Economical	Fire Services
Epidemics			Home (Police)
Fires			Irrigation and Command Area Development
Floods			Medical and Health(Hospitals/ Dispensaries)
Hailstorm			Panchayat Raj(PR) and PRIs
Industrial & Chemical Accidents			Power Transmission Corporation
Road Accidents			Revenue and Civil Supplies
Tsunami			Road Transport
			Water Tanks and Sanitation
			Youth Services

4.3 Development of Cross Compatibility Assessment

Having identified the elements of risk, namely the hazard, vulnerability and coping capacity which are a set of variables, the next step in the analysis-synthesis process is to reduce the total set of (formally) possible configurations in the total problem space to a smaller set of internally consistent configurations representing a "solution space". This is principle of contradiction and reduction, also known as the process of "cross-consistency assessment" (CCA). CCA is based upon the insight that there may be numerous pairs of conditions in the morphological field which are mutually incompatible. To make a cross-consistency assessment, all of the parameter values (conditions) in the morphological field are compared with one another, pair-wise, in the manner of a cross impact matrix . As each pair of conditions is examined, a judgment is made as to whether – or to what extent – the pair can coexist, i.e. represent a consistent relationship. There is no causality or direction, but only mutual consistency is judged. The pair wise comparisons of the variables were judged on their fitment. For this model, three "keys" were utilized for the cross-consistency assessment:

"—"= these two conditions can/should co-exist.
"X" = these two conditions cannot/should not, co-exist.
"K" = these two conditions can co-exist, but are highly unlikely or uninteresting.

In order to support the district administrators, a methodology of the morphology analysis was carried out in the study area. The magnitude of hazard (High, Medium and Low) has been developed based on the logic of expected loss in terms of death, injury and loss of properties (civil structures and agricultural crops). The coping capacity actually depends on the magnitude of the hazard. For the low hazards wherein there are minimum losses of property, the local community can cope up with the same. The economic status of the Mandal wise population could not be considered for this study as the Census data 2011 was not publicly available during the study duration. If the magnitude of the disaster is intense or High then even the National level support is required to brought in. A matrix has been created with the variables in Hazard, Vulnerability and coping capacity. For acquiring the capacity both district level departments capacity (as per the District DM Plan) and National framework (as per the NDMA institutional framework) was compiled.

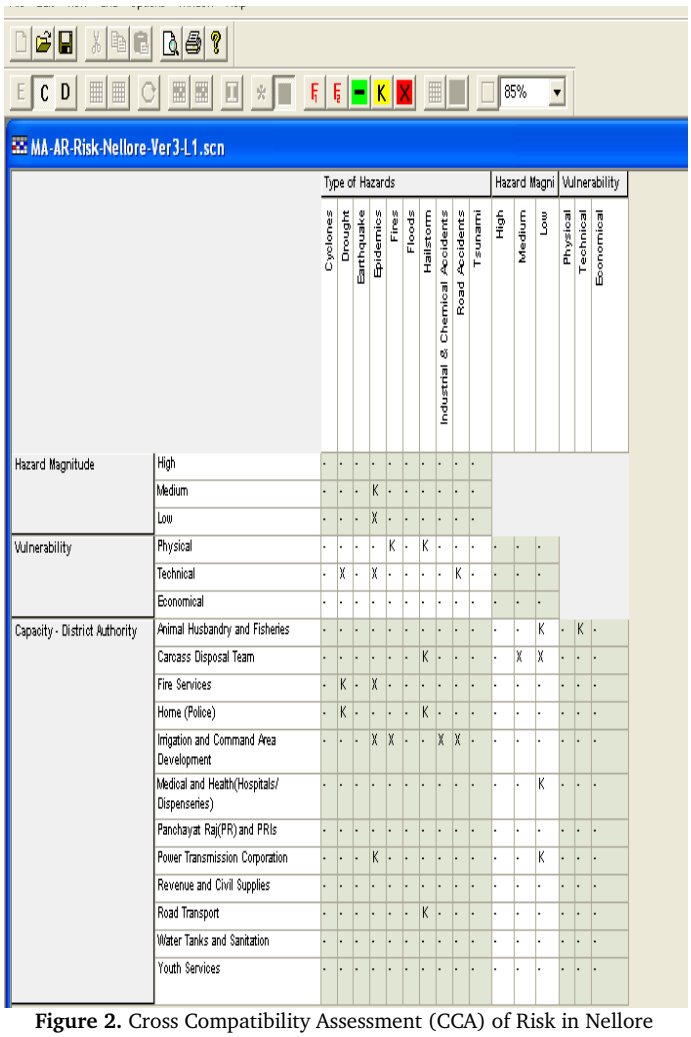


Figure 2. Cross Compatibility Assessment (CCA) of Risk in Nellore

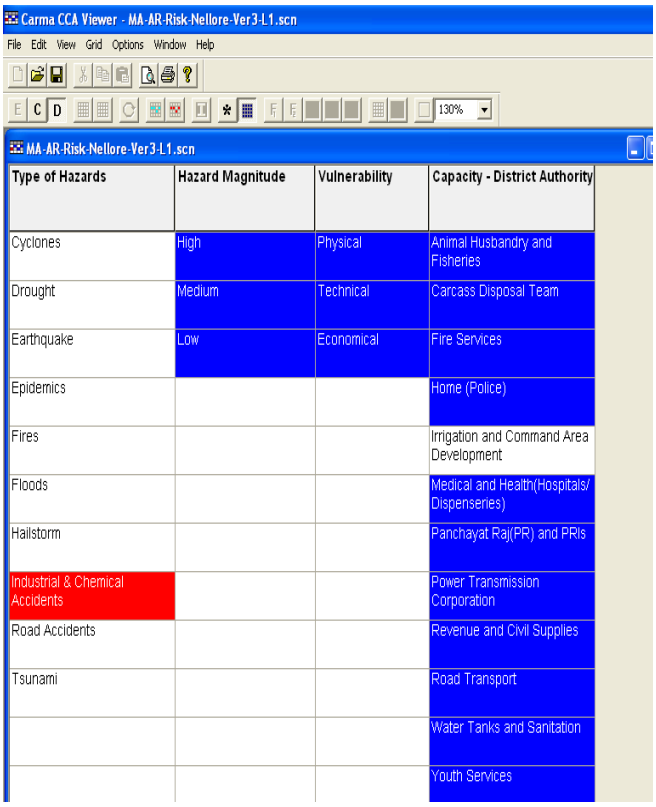
Figure 3. CCA for Cyclone, Nellore

The Cross Compatibility Assessment Risk of the Nellore district has been computed in the CARMA software. When the fitment process is completed in the assessment, the morphological field is ready to be reduced. The file was sent to Swedish Morphological Institute for their processing. They executed a function in the software developed to support morphological analysis. The Carma CCA viewer is shown in Figure 2.

5. Results

The CCA Viewer software provides the possibilities to view different relationship that exist with each contribution parameter like each type of Hazard.If the type of Hazard is chosen as Cyclone, the system shows that in the event of Cyclone hazard for all types magnitude and vulnerable at all levels, all capacities of the district are required as shown in Figure 3. The Cross Compatibility Assessment (CCA) of the Industry and Chemical accidents is shown in Figure 4. It is clearly shown that the decision making process intelligently understands that for this activity the capacity of the Irrigation and command area is not required as that department is not related to the chemical accidents, as per the declaration in the DM plan. Like that different combinations can be chosen to see the output as derived through the morphology analysis.

In the context of Disaster management the basis of the hazards were derived from Nellore District Disaster Management Plan (2010). The discussions with the officers from the district authorities helped to compile the list of 10 hazards which are natural and manmade. However the historic databank of the disaster events shows that the losses are primarily due to Cyclones and Floods.



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Floods			Medical and Health(Hospitals/ Dispenseries)
Hailstorm			Panchayat Raj(PR) and PRIs
Industrial & Chemical Accidents			Power Transmission Corporation
Road Accidents			Revenue and Civil Supplies
Tsunami			Road Transport
			Water Tanks and Sanitation
			Youth Services

Figure 4. CCA for Industries and Chemical Accident, Nellore

6. Conclusion

The matrix elements of risk available with Nellore district administration were populated into the CARMA software developed by Swedish Morphological Institute and results were visualized. On a similar manner appropriate risk related datasets from any district of India can be fed into the system and corresponding results can be derived. This tool can be very effective for the District Disaster Management Authority and will provide instant decision support. The results of risk assessments should serve as the basis for the prioritized administration of mitigation programs and funding.

Acknowledgements

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THE NEED FOR ENGENDERING INSTITUTIONAL PROCESSES IN POST DISASTER RECONSTRUCTION TO ADDRESS LONG TERM VULNERABILITIES OF WOMEN: A CASE STUDY OF GUJARAT EARTHQUAKE 2001

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"A daughter born / To husband or death / She's already gone"
Old Indian proverb (taken from Women and Human Development: The Capabilities Approach, 2000)

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Introduction

The effects of disaster, institutional as well as individual differ for men and women. Gender issues need not necessarily be manifestations of disaster related crisis situation, but are inherent and intrinsic factors of the society, operational and visible in daily life. Disasters do not represent a clean slate. Gender of a person shapes his disaster experience and ability to recover from it. Certain groups of people have a slower pace of recovery for the same reason. Incorporation of sensitivity of the gender aspect in the recovery process is important, primarily, because it affects the delegation of roles and responsibilities and in defining the access to resources. With the help of a case study of a Social Rehabilitation Scheme for Widow Pension, the challenges faced by women have been explored and the reasons for the same in institutional processes have been analysed. It is important to understand the instrumentality within the program and how beneficiaries were not able to access the benefit because of their social, cultural and political disadvantages and constraints. Women's lower status and lack of economic power, lack of documentation, gendered division of labour and gender defined social roles in so – called "normal times" have serious ramifications in a disaster scenarios. Recovery is usually cited as the least understood phase of the disaster cycle. Databases like EM-DAT or Emergency Disaster Databases exist only for quantifying immediate losses from disasters; no such consolidated information system actually exists for recovery exclusively. In most of the literature recovery is portrayed as an uncertain, conflict laden process where outcomes are characterized by social disparities, strongly influenced by decision making authority and conditioned on institutional capacities of the intervening organizations or efforts. Long-term losses may not be apparent at first glance, but require consideration against pre-disaster trends and non-disaster influences. They also may not be apparent from aggregate statistics, but require inquiry into recovery differentials across sectors, neighbourhoods and population groups. It is important to understand how resources, responsibility and power forms the institution and the reaching out of the policy forms a part of the instrumentalities which are flawed and indeed negligent of the gender specificities in the governance processes. The earthquake occurred on January 26, 2001 at 0846 hrs and lasted for around 100 seconds and shook the entire state of Gujarat. The epicentre was in the Bhachau Taluka of Kachchh District. The tremors were felt even in the state of Uttar Pradesh, which is 1500 kilometres from the area and in East Pakistan where 18 people were reported dead officially. The earthquake caused massive loss of life and injury. It left nearly a million families homeless, and destroyed much of the area's social infrastructure from schools and village health clinics, to water supply systems, communications and power. The Kutch district of Gujarat was the worst affected, in many villages and several towns the destruction was nearly total. Kachchh bore the brunt of the tremors and accounted for more than 90 percent of the fatalities in Gujarat.

Women's Differential Vulnerabilities

"The process of recovery favours only those who have had access to resources and power prior to disaster." Usually, in the post disaster scenarios, it is considered that women have to informally involve themselves into taking on new roles in the name of ensuring their family's survival and well-being. Yet, most of their roles are often ignored or not given the due recognition. An understanding of women and their role in emergency, management and planning is very often overlooked, because of which even their needs go unheard. It has been observed in case studies from South East Asian countries that the gendered division of labor exists in all the phases of disaster management and affects the preparedness as well as the recovery of women. It is observed that in many emergencies and disasters women outnumber men in helping and arranging in the post disaster phases, yet in the proper official documentation, their work is often almost entirely neglected and women are mostly portrayed narrowly as mere victims and helpless, if I may say. These gaps in turn reinforce the existing (Bolin 1993, Chang 2010, Kumar 1997) socially and economically imbalanced relationships and tend to increase the dependency ratio. And the worst part is that these things are exacerbated by the intensification of women's responsibilities and duties post disaster, a scenario which becomes gravely clear in the case of post Indian Ocean Tsunami disaster and post Katrina New Orleans. And the repercussions of it are not to be faced only by women, as Enarson (2011) suggests, but also to the strategic working of the camps in the post disaster scenarios where their

knowledge and experience about their family can actually help in better and smooth functioning of the institutional recovery help. The most severe gaps in the women's access to aid and compensation are due to the 'head of the household' procedures of governance, observed in various cases from Sri Lanka to Africa to Pakistan. The situation is not much better for women in the developed countries, the recovery process was found to be slow in South Florida, post Hurricane Andrew. Women, as noted by Blakie et. al. (2005), on such new schemes may lose conventional rights to land on which they used to grow food for their families, or their knowledge and skills may be rendered 'obsolete'. In the case of 2010 flash floods in Pakistan huge debates and discrepancies were surfaced in the post disaster delivery of aid, especially due to the huge numbers of unregistered women-headed households as well as women who were not registered with any main patriarchal family head. But the problem does not restrict itself to these countries. Minority women were the most at risk to Florida's hurricane Andrew because they lacked status power and resources. Also, in Africa during the draught, women were more at risk due to their role of providing care to the family and thus were more exposed to the ill effects of draughts than men, who were out and migrated for work. In 1985 Mexico City earthquake, poor single women with children were the most affected by the disaster and were completely robbed out of their livelihoods to an extent that they had to sell food they prepared on streets. For many women, home is the place where they exercise some authority, but in cases where public domain is not open to women, loss of home becomes particularly very important, for example in cases of Kasain women in Zaire, women in Maharashtra, India during Latur and tribal women in Kachchh earthquake in Gujarat. For urban populations, researchers have documented the losses to women, in particular, caught in the shift to part-time and contingent work, cutbacks in the public sector etc. Women's vulnerability to disaster is deep rooted in a gender global economy. Urban women residing in informal settlements or public housing have unique needs in disaster contexts and are a significant enough group to engage in community-based mitigation.14 Metros also have significant populations of women migrants and refugees who usually live in minimal conditions and engage in labour which renders them even more vulnerable in case of any disaster. Breakdown in social cohesion can lead to serious threats to women's safety and security.15 Also, in a case study conducted in 2009 by Climate and Knowledge Network in Dhaka, a city prone to numerous natural hazards due to degrading environment, has a growing need for mainstreaming women in the recovery and broader developmental debate because they are often the neglected ones and the most at risk from not recovering post a disaster, largely due to lack in proper and defined policies ((Elaine Enarson and PG Chakraborty 2011, Blakie et al 2004, Mustafa 2012, Gray 1993, Elaine Enarson, Lori Peek and Alice Fothergill 2006, Walker 1996).

The aftermath of the 2001 earthquake has caused enormous socio-economic changes which have posed a threat to survivors' recovery from the ill effects and trauma of the disaster. As Simpson and Corbridge (2006) have described about the recovery in their paper, it seems evident that the sociological aspects were clearly involved in the uneven pattern of recovery in Gujarat. Various nationalistic organizations competed to impose their own visions of the nation on rural people as they reconstructed the remote villages of Kachchh. Post-earthquake reconstruction has changed Kachchh drastically. Lucrative construction contracts, new roads and infrastructure, and tax breaks for heavy industry have rapidly introduced a semi-industrial form of modernity. Some people have been encompassed in the ambit of ensuing benefits; many more, and arguably most of Kachchh itself in relation to Gujarat, have been marginalized from the new cash-rich economy. Some cling tenaciously to the old ways and locales; others have been forced into new suburban housing societies. It is usually the urban areas which had to bear the brunt the most. According to them, in Kachchh, the individual and social memories of the 'lower orders', including Muslims and Dalits, and large numbers of women have generally been erased or in more politically relevant terms, privatized in favour of ideas coming from social elites. The silencing of other (if I may say, subaltern) memories was supposed to be argued as an important part of the contested politics. Same ideas were also echoed in the paper by Ravi Priya (2004), who also mentioned that the socio-economic changes in the post disaster period in Gujarat posed a threat to survivor's recovery and trauma. It was however mentioned in that paper, that in the initial phase of relief and early recovery, people actually dissolved the boundaries of socio-economic barriers, but in the long term recovery the trend seem to change. Also, these conditions of staying as a collective were seen to be for longer time in rural, than in the urban areas (Enarson 1998, Walker 1996, Sharmind Neelorami and Ahsanuddin Ahmed 2012, Edward Simpson and Stuart Corbridge 2006).

Also, specifically in case of women, as it is the widows faced social pressure, which was felt with even more intensity among the older widowed women rather than the younger, who got remarried and created social isolation for older widowed females. The male members were categorically found to be more dissatisfied and frustrated with the process of recovery due to non-receipt of the relief package and economic deprivation. Due to this reason apathy in them was observed towards the other members of the household, basically women, which led to inadequate recovery space for them. The concern for other victims tends to dissipate as the role of relief and aid delivery starts. The main reason is attributed to the poor management and distribution of the aid on the lines of class and community. Maheshwari, specifically calls it as "community divide". Also in the distribution of relief packages the presence of intra-community and intra-caste divide escalated rendering the social support network feeble in fabric. In the leading daily of the district, Kutchmitra (published on January 24, 2002), there were articles which mentioned that women who were left with no earning male members had to succumb to flesh trade, leading them to sexual victimhood. Also, livelihood issues relating to people getting used to the relief aid and lack to earn their own livelihood were found in many males, the ultimate pressure of which were felt by the women as the main care taker for everyone. Of all the articles and case studies I have come across up till, almost all of them agree that women are disadvantaged in the long term recovery process, but there is not much clarity on as to how are they most disadvantaged group. Marginalization of women in the long term recovery has been mentioned without the specifications in most cases about how it happens on field. Literature although, does cover the aspects of initial recovery and rehabilitation but beyond those just mentions are given about their being sidelined and their interests being marginalized, though not much clarity is obtained on the same. Also, the other factors

which affect the extent of recovery process are cast, class, religion and region to some extent, as mentioned in the review above. In the light of the mentioned arguments, the present study tries (Priya 2004, Provention Consortium 2005, Maheshwari 2002). To find the issues and challenges faced by women on ground in long term recovery and what has been done to address those issues categorically keeping in view the instruments as well as the instrumentalities.

Engendering Institutional Processes

Societies construct and deconstruct ideas and ideal behaviourisms or norms according to their convenience and benefits, even if it is at the cost of marginalization of any sub-group. For this society, the difference between male and female is beyond the recognition of their different biological sexes, but rather rests deep seated in their descriptive and normative social constructs of men and women. This failure of separating biology from cultural influences is also evident in the governance processes of a nation. The very acknowledgement of this fact with an approach to understand how these lives operate within a system of gendered thought processes and gendered power must be understood in-toto comprehensively if the lives of women, and their access to governance, are to be assessed and improved. Governance is not merely a system but a process wherein the state works according to certain stakeholder pressures which is now encompassing a paradigm shift and includes new politics along with additional politics. Governance has become a complex interplay of state, market and society where concerns are addressed regarding the changing position of the state vis-a-vis the market and the transitional forces of the society. Post 1990, with the change from the minimalist to the neo-liberal policies, it was observed that state comes out with affirmative and equal policies, but that did not necessarily mean equal outcomes. Before laying out sanctions and its positive and negative incentives, it is important for the state to be responsive and understanding in order to impose them. This gave importance to the renewed recognition of state centred development where state acts as a facilitator. It gave way to shifts in thinking about governance and not just mechanisms, but also interactions and collective actions which were multilateral were being re-thought. Thus, governance is a result of human endeavour, which is not a neutral phenomena and neither is at an automated response to a developmental concern because of the wide range of receivers and response and the dynamics of the factors underplaying. The state is not an apolitical provider and hence interests do not get equally represented every time for everyone. The three broad approaches that have evolved out of collective understandings in the last three decades that have attempted to institutionalize women's concerns in the structures and institutionalities of governance as a result of women's movements are: The WID (Women in Development) model which rests its foundations in the economic growth paradigm, explains the reasons for women being treated as beneficiaries of the petty helps thrown at them, in the margins of the economy, as consumers and as adjunctive labour force to be utilised in the crisis period and released out the moment men are ready for takeover. The WAD (Women and Development) model includes women in the development activities as active proponents of change. It argues for the affirmative action against the patriarchal forces of society by the state and a pro-active approach by the civil society for empowerment of women (Nussbaum, Gender and Governance: An Introduction 2003). Finally, the GAD (Gender and Development) model is based on the understanding of the gendered relations in the society and the political dynamics associated with it.

"There is a tendency to conflate 'sexual difference' with 'gender difference', and this often results in 'gender-blindness' in governance process and policies." It is with the paradigm shift towards the GAD that we address the concern raised whether the system is gender blind or why do the concerns of women not focussed on. Social interpretation of roles is linked to biological differences which exist in more ways than one. These biological views sanction opinions or attitudes about appropriate distribution of resources and responsibilities, which are inequitable and lead to gender inequalities in well being and opportunities, as Sen's capability approach suggests. Nussbaum argues that women are not recognised as "ends" in themselves, rather are understood as mere the instrumentalities of reaching the "ends". Women are not treated as individuals in themselves with dignity to be given equal rights in the society, which governs the instrumentalities of the governance processes. It is due to this basic premise and unequal social and political circumstances that give women unequal human capabilities. She argues that poverty is strongly related to gender inequality and when both combine, it results in acute failure of central human capabilities. She calls women the "second class citizens", in a country like India wherein they are theoretically equals according to the constitutional democracy. There are deliberate interventions to bring about changes which may be constitutional or civil society movements through voices of dissent. This lays out the importance of an institutional construct which is marred by gender relations which are an aspect of broader social relations constituted through rules, norms and practice. It enables a framework for institutional understanding of governance which includes resource mobilization and allocation, assignment of tasks and responsibilities, the way values are given and power mobilized (Panda 2008, Nussbaum, Women and Human Development:The Capabilities Approach 2000). Gendered relations do not operate in vacuum rather are product of ways in which instruments are organized and constituted, which is also contextual in terms of various factors. Drawing from Naila Kabeer's Social Relations Framework, developed at IDA, these instrumentalities are reproduced over a range of institutions including policy making agencies which should reinforce the need for institutional analysis of governance processes in terms of Rules i.e. how things are done, Activities i.e. what things are done, Resources i.e. what is used and what is produced, People i.e. who are to be included and excluded and Power i.e. who determines priorities and makes rules. It is important therefore, to understand both the instruments and the instrumentalities of the process of the institutional processes, which has different actors including the State to reclaim legitimacy, Civil Society Actors to justify their claims by demanding voice and accountability and Market which demands a conducive investment climate. Thus, governance is marked by a collaborative management of a participatory process with multiple stakeholders which are affected directly and indirectly. As Goetz argues, getting the institutions right for the market has been the priority but getting them right for women, has been neglected. The need for engendering governance for institutional change is to routinize gender equitable forms of social interactions and to challenge the legitimacy of other discriminatory norms. She argues on recognizing the human dimension in the

construction of institutions which are not controlled by "immutable or natural" social processes. It is important to understand the instrumentality within the program and how beneficiaries were not able to access the benefit because of their social, cultural and political disadvantages and constraints. This is how resources, responsibility and power forms the institution and the reaching out of the policy forms a part of the instrumentalities which are flawed and indeed negligent of the gender specificities in the governance processes (Naila Kabeer and Ramya Subrahmanian 1996, Goetz 1998).

Findings and Discussion

The majority women respondents, who were Gujarat Earthquake widows were found to be independently managing their households without much support from their families. The women who were literate and better educated were found to have secured better jobs than those who came from socially and economically backward backgrounds, who were found to be engaged in more physically laborious tasks like masonry, handicrafts, daily wage earners in agricultural fields and domestic helpers in houses. The most axiomatic problem that these women faced after the death of their husbands was to restart their lives from the very beginning and provide for their children since prior to this incident they had never been a part of the public domain life in an explicit manner since it were their husbands who had mostly played the role of bread winners. The private domain of these women never really socially allowed them access to resources and exposure of the public sphere which was manifested in forms of institution such as marriage or socially determined acceptable behaviour of girls. In most of the cases, the women were not supported by their families to work and step beyond the glass ceiling so firmly adhered to by the societal norms. These pre-determined norms were found to be controlling women's roles and rights even after the earthquake and did not consider the added responsibility on them. The girl child or the married woman was not traditionally found to be a successor to the father or the husband and thus, she was not given any rights to property or land ownership post any such incident which took a huge toll on women's independence and reduced their coping capacity in general and also in comparison to men at the similar stratum. These relationships were reproduced in the claims that women could make and their rights which they could demand for. These micro level changes influence the policies and the course of action that these policy providers and implementers take, which in turn affect the macro level changes and vice versa. In availing the Widow Pension Scheme, problems ranged right from the very registration of the scheme to the selection and rejection of beneficiaries even after the presence of strict rules and criteria for selection. Just merely the presence of a son above 21 years of age automatically discards the women from availing the scheme but the scheme does not mention what should be the consideration when the child is himself physically challenged. The agony of the mother to see her child in such situation is increased manifold when she realizes that even after pleading the authorities for number of times, the help is not made available and the problem is not even heard with respect. In families where the woman manages to get the meagre amount of Rs. 700 per month, she is not the one responsible for deciding in how to spend the money since all the major financial decisions rest in the hands of the patriarchal family head. To this, when the woman for the advantage of her child would propose to work for herself, she is looked down upon by the community which apparently has decided her social role of mourning throughout her life for her husband. The four key institutional realms as suggested by Kabeer and as mentioned above include the state, the market, the community and the family. The family is the primary sphere that the women has to resist to vocally demand her rights and claims and the relations which are heavily dominated by social patriarchy resisted the very actions taken by these women in terms of asking about the decisions on how to spend the money earned by their own selves. The profiles of the deceased also affected the quality of life that the widow had to survive with. The skilled workers had better economic security in the first place than the semi-skilled or unskilled workers and thus, this was also visible post the earthquake since the initial setting up was easy for women with better economic security. And also, the widow pension in certain areas depend on this very categorisation of population among the below poverty line and above poverty line stands. Although, there is an inherent irony in this basis of categorization since after the earthquake every household in the area had lost almost all their savings and property so the above poverty line households were in disadvantaged positions. The nature of family, in terms of whether, joint or nuclear family were responsible for their independence in decision making. Women in joint family were usually more prone to face the issues regarding the control over money and in nuclear families the very access to the scheme was very difficult. The women who were living alone reported the procedures of applying for the scheme and the quarterly resubmission of the documents for the same to be very hectic and cumbersome since the government procedures were very elaborate and difficult which requires them to visit the office numerous times. The single mothers who are also working found it very difficult to abide by the document submission deadlines since the weekends were the only off which they got from their regular schedule and government offices were not flexible in their timings. Also, the women complained of not getting the pension at regular intervals of time i.e. once in three months, which is the stipulated time period usually.

The reason for gender inequality are not merely the institutions of household or family but the same gender differences are reproduced throughout the whole arena of institutions including the state and the market which controls most of these patriarchal processes. The social relations are reinforced and made evidently visible in the activities and decisions of the institutions. The main reason is attributed to the poor institutional management and distribution of the aid on the lines of gender, class and community. Also in the distribution of relief packages the presence of intra-community and intra-caste divide escalated rendering the social support network feeble in fabric. The rules of getting things done are decided and constructed in the society in a manner which has been convenient for the business endorsing capitalist patriarchy. The official policy proponents and implementers are majorly males, since it is a male dominated society. Though, this does not check the impact of the policy which is majorly on women. This gap between proponents and beneficiaries is further extended by the virtue of the fact that the processes which are supposedly to be gender – neutral are not so, because the medium of these institutions are not neutral. In other words, the implementers or the people involved in practicing the policy are mostly males, which do not relate to the issues of women and are obviously not

sensitized enough to understand the agony of a wife who had just lost her husband and is under tremendous pressure to suffice for herself and her child while constantly bearing the social burden of being a "widow". The myth that the institutions are independent or separate or operate unbiased is challenged in the manner the institutional realms of the state, the market, the community and the family interact among each other and modulate each other's decisions. The methods of availing the services or access to resources is over the time made so entrenched in the system of working and normative procedures in the society that they seem unchangeable now. The productive, distributive and regulative activities are so tagged that the social determination of work has surmounted the very purpose of the activity. The relations of authority and control have established a power dynamics which has reinforced the privileged position in the society. There are however exceptions, which are constantly striving to make a difference among these odds. One such example is the Sarpanch of the village Khakru, in Kachchh district where she had lost her husband in the earthquake but after the initial pressure from her family she has managed to stand up for the rights of the women in the village. She was elected the Sarpanch of the village in 2010 after the death of her father-in-law and is also now a member of the advisory committee of the Community Development Centre of the Tolani Polytechnic, Adipur. It is in the light of the findings and lessons from the Gujarat experience that the Uttarakhand government can improve their policies for the long term recovery and make it more inclusive and not merely in words but also in practice.

Conclusion

The ways basic services are defined are based on the agencies defining them. The conception of service delivery procedures, even in post disaster relief is to increase the social accountability of state institutions and agencies or companies with which they are linked towards the users of services for which they have ultimate responsibility. It is in this respect that Broody (2009) suggests that this principle of accountability is important in order to ensure that if the state fails to meet its obligations, the elected representatives, media and the civil society agents expose its limitations. These "democratic spaces" are thus found to be unaccountable in post disaster response and relief scenarios and unanswered in the policies formed for the same, especially for the women. The gendered policy agendas leading to constructed inclusiveness and representation have rendered these systems of relief distribution and aid provisioning to be usually gender neutral at the most, if not blind (that too in cases of certain specific policies targeting women) and unequivocally ignorant to specific gender needs of women in a post disaster scenario. There is a serious need for these reconstruction policies to follow a pattern from gender neutral to gender specific. The guidance and direction to achieve this paradigm shift will need to flow from National Disaster Management Authority (NDMA), and in the true spirit of the Disaster Management Act, 2005 to all stakeholders including State Governments and Union Territories, right up to the Panchyati Raj (local administration by five locally elected citizens) Institutions. This dichotomy is the crux of the problems and differential discrimination along the gender differential against women in disaster scenarios, including recovery, which is a major part in shaping the future developmental process. Therefore, gender inclusiveness in policies, strategies, plans and programs is vital in order to empower nations and communities to successfully build the resilience to face the challenges posed by disasters.

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DISASTER MANAGEMENT AND PUBLIC ADMINISTRATION: ROLE OF GOVERNMENT IN PHASES OF DISASTER MANAGEMENT

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Introduction

Modern man, for all his intellectual development, his technological sophistication and even his technical abilities, is still at the mercy of natural forces (Singh 1998). Disaster Management involves actions and demands resources beyond the means of individuals and family groups. Indeed, threats to life and property from nature and from human kind encouraged the development of communities to pool resources and find common solutions. There was increasing need for full-time, technically trained, professional emergency response and recovery agencies (Waugh 2005). Previously post disaster management was the only approach towards coping with the effects of natural disasters. After the initial trauma of the occurrence of the natural disaster is over within few days or weeks, the phase of reconstruction and rehabilitation, economic, social and psychological is taken up by the people and by the Government authorities (Acharya, et al 2009). Disaster management activities shift in focus from emergency response, rehabilitation and reconstruction to preparedness, mitigation and prevention (Dr. Singh 2009).

Significance of the study The study aims at critically examining and evaluating the role of the Government during different phases of disaster management. The study also aims at drawing up a comprehensive plant to mitigate the hazard.To facilitate the disseminations and exchange of information and the sharing and transfer of experience on risk reduction.

Limitation of the study
Availability of resources is very scarce. First hand information about the requirement to the disaster victim has not been concentrated upon. The research is focused on Natural disaster and not on manmade disaster. No empirical research is conducted. No on field impact is done and victim centric perspective is not undertaken.

Method of analysis
The research carried is Doctrinal, analytical and descriptive method. The researchers' attempt is only to cover the natural disaster and suggest some solutions to the problem of disaster management like resettlement, rehabilitation, relief management and disaster mitigation. Sources of data for the most part of this research paper are secondary. The secondary sources such as books, journals and the online data base materials are extensively used to bring out this research.

Disaster response
Once a disaster has occurred following activities may need urgent attention: Restoration of utility services, Rescue and debris clearance work, Demolition of dangerous structures, Care of the injured and the sick, Information on the missing, Provision for food, clothing, fuel, medical supplies, transportation, manpower and equipment, Personal damage surveys, Establishment of emergency operations centre for the proper coordination of the activities of the different services, Identification and disposal of the dead, Proper sanitation of the surroundings to avoid epidemics, Giving solution to the housing problems of the homeless victims, Informing the local authority (Modh 2006).

Phases of disaster management
According to the traditional view, a cycle in disaster response consists of a succession of clearly distinct phases, from prevention to preparedness, early warning, impact and relief, recovery and reconstruction. Over the years, this neat picture has been replaced by a continuum of activities and phases managed by the humanitarian community and development organizations (Amin & Goldstein).

❖ Prediction (Martin E. Silverstein), Warning, Evacuation (Syed 2008), Assessment (Dasgupta 2007), Coordination (Talwar & Juneja 2008), Preparedness : Pre-Disaster Stage and Post-Disaster Review, Prevention (Narayan 2000) , Risk Reduction (Anand et al 2009), Rescue, Relief (Sinha), Mitigation, Response, Recovery, Rehabilitation and Reconstruction (Dasgupta 2007).

Prediction

Prediction is a system or claim that a particular event will occur in the future in more certain terms than forecast. Disaster prediction is an intuitive learning related both to instinct and imagination, experience and interpretation, perception and projection. In different countries across the world there are rich inventories of traditional knowledge and wisdom in predicting the possibility and probability of the happenings of disaster.

The traditional indigenous weather and climate prediction practices are based on indicators established over generations through keen observations of plants, animals, birds, insects, the solar system, winds, clouds and lightning patterns. The communities recognize unique situations associated with the behaviour of these living organisms, the location and patterns of cloud, winds, lighting, the sun, moon and stars. The predictions based on these indicators and human feelings support the early warnings issued to enable the community cope with the anticipated natural hazard (Acharya et al 2009).

Warning

A warning system is any system of biological or technical nature deployed by an individual or group to inform of a future danger (Syed 2008). A warning is a risk communication about an imminent event and is intended to produce an appropriate disaster response (Gaur 2008). Early warning provides communities with timely information, enabling them to prepare for an anticipated hazardous event to minimize its impacts. Warning and emergency declarations activate the emergency plan both at the onset and conclusion of an emergency (Singh 2009). If disasters arise from the concatenation of multiple factors, natural and social, then in principle at least, an early warning system should address all of the factors relevant to the particular risk (Singh 2008).

To be effective and complete, an early warning system needs to comprise four interacting elements, namely: Risk knowledge, Monitoring and warning service, Dissemination and communication and Response capability.

To be effective, warnings should have the following characteristics: Authority, Consistency, Accuracy, Clarity, Level of Certainty, Level of Detail, Clear Guidance, Repetition of Warnings, Impact Areas, Methods of Information dissemination, Information Dissemination for Special Needs Groups (http://www.em.gov.au/Documents/Manual11-EvacuationPlanning.pdf).

Clear verbal warnings that instruct potential victims to proceed with previously inculcated plans of action. Warning systems need not be very technical. Where pre-positioned loudspeakers, TVs, and battery-operated transistors radios are unavailable, messengers to town criers can provide warning and instruction. Warning should be ranked and explained. When the warning reaches the stage of "Take shelter" or "begin evacuation", the location of the shelter and the route to that shelter should be clearly described. Poor evacuation instructions add to the severity of the calamity. Good instructions, calmly given, are a boon. One guiding precepts in disaster preparation is faith that the majority of the public will respond to clear, intelligently communicated information before the event (Silverstein 1992).

Evacuation

Evacuation is a pre-emptive move to protect life and property, where as rescue in a post-disaster phenomenon of helping people to move from areas that have been hit by disaster to a safer place. Very often, due to lack of information or in haste, living during evacuation and rescue becomes difficult and painful (http://www.agritech.tnau.ac.in/agriculture/agri_majorareas_disastermgt_flood.html).

In areas threatened by disasters evacuation plans are established to prepare for an efficient evacuation and to avoid panic. The duration of an evacuation is called the 'evacuation time'. Evacuation may be carried out before, during or after natural disasters (Syed 2008). One facet of evacuation is the removal of persons from a stricken or threatened area. Another is the resettlement of the victims, or potential victims, and the provision of shelter and resources in the areas to which those residents are moved, known as the host areas (http://www.au.af.mil/au/awc/awcgate/crs/rs22235.pdf). It is important to know who might need additional services. Planners must also know where they are located within the community. Important steps of preparedness include: Identifying the location and condition of those with special transportation concerns, identify the type of transport necessary, determining who will transport each person, identifying the equipment needed to enable transport. Door-to-door pick up may be an option

Include community resources. Planners may benefit from using resources already in the community. Potential partners include: Transportation providers, emergency response organizations, local community-based services, advocacy groups, agencies that serve transportation-dependent populations, employment and training providers, health and social services, including home health care and long term care facilities, faith based organisations, state departments of transportations, paratransit services.

Sequence of an Evacuation. Detection, decision, alarm, reaction, movement to an area of refuge or an assembly station and transportation (Syed 2008).

Assessment

A system of comprehensive risk assessment and analysis, based upon detailed and accurate information on hazards and people's vulnerability to them, is a pre-requisite to an adequate and successful disaster reduction strategy. It has to be regularly updated and widely disseminated. Risk is rooted in environment. Such conditions require assessment and management on a continuing basis with the main aim of minimizing exposure to hazards. This can be done by strengthening relationships and by developing reliance on individual capabilities and institutional capacities that can withstand loss or damage, or those that will hasten recovery if loss or damage occurs (Kumar 2006). A natural hazard assessment promotes an awareness of the issue in a developing region, evaluates the threat of natural hazards, identifies the additional information needed for a definitive evolution, and recommends appropriate means of obtaining it (Talwar

& Juneja 2008). Immediately after disaster, assessment is a crucial management task which contributes directly to effective decision-making, planning and control of the organised response. Assessment will be needed during all the identifiable phases of a disaster, from the start of emergency life-saving, through the period of stabilisation and rehabilitation and into the long-term recovery, reconstruction and return to normalcy.

Assessments must be carefully planned and managed. A sequence of activities is involved and each must be planned in detail. The following activities typically constitute the assessment process: Identify information needs and sources of reliable date, collect data analyse and interpret data and report conclusions, forecast and alternative to appropriate planners and decision-makers. Assessment is the process by which decision-makers begin to bring order to the chaos to those results from a disaster (Dasgupta 2007).

Coordination

There should be adequate coordination among all of the actors to avoid misuse of resources or duplicated efforts. It requires the involvement of a diverse team of people, including rescue personnel, forensic medicine experts, prosecutors, police, administrative personnel, psychologists, support teams, representatives from nongovernmental and international organisation, as well as community volunteers. If the function is not assigned by law to an institution that is a member of the Emergency Committee, the responsible institution should be specified (Talwar & Juneja 2008). Disasters pose unusual demands for inter-organizational coordination. For this reason, a substantial portion of disaster communications problems are related to the exchange of information among organizations (http://www.coe-dmha.org/Media/Disaster_Response_Principals.pdf).

Preparedness

Preparedness is usually regarded as comprising measures which enable governments, organisations, communities and individuals to respond rapidly and effectively to disaster situation. Examples of preparedness measures are: The formulation and maintenance of valid, up-to-date counter-disaster plans which can be brought into effect whenever required, Special provisions for emergency actions, such as the evacuation of populations or their temporary movement to safe havens, The provision of warning systems, Emergency Communications, Public education and awareness, Training programs, including exercises and tests (Narayan 2000) .

Two levels of preparedness can be identified: public safety information and hazard awareness planning (Talwar & Juneja 2008). Disaster Preparedness consists of a wide range of measures, both long and short-term, designed to save lives and limit the amount of damage that might otherwise be caused by the event. Preparedness is concerned with long-term policies and programmes to minimize the impact of disasters. The corresponding measures are taken in such fields of legislation, physical and urban planning, public works and building".

Pre-disaster stage. This stage includes preparedness and mitigation for the disaster. The preparedness for disaster in general comprises of: Preparing hazard zonation maps, predictability/forecasting and warning, Preparing disaster preparedness plan, Land use zoning, Preparedness through IEC.

Post-disaster review. Post-disaster review should be carried as early as practicable in the recovery period. Such review will often reveal deficiencies in plans and will also indicate, for example, if certain activities such as preparedness measures and response arrangements need strengthening. Provided exercises and simulations are accurately evaluated and the lessons from them are correctly drawn, they can exert influences similar to those of post-disaster review. In some cases, in fact, exercises and simulations can be more effective because: They can be directed towards testing a particular part within the disaster management cycle and their lessons can be more accurately defined than is sometimes the case with post-disaster review (Narayan 2000). The post-disaster activities are as follows: Rescue, Release, Repair, Rehabilitation, Reconstruction and Renewals (Syed 2008).

Prevention

Action within this segment is designed to impede the occurrence of a disaster event and / or prevent such an occurrence having harmful efforts on communities or key installations. The following are usually classified as preventive measures:

- The construction of a dam or levee to control flood waters.
- Controlled burning –off in a bush fire-prone area a prior to the high fire risk season.
- Some forms of legislation can also be regarded as prevention; for instance, land-use regulations (Singh et al 1998).
- Legislation preventing building in the flood prone areas
- Hurricane/Tornado/Cyclone/Tsunami warning systems
- Requirement of protective cellars/shelters in disaster prone areas
- A seismic housing code for earthquake – prone area (Siva 2009).

Apart from the above mentioned a list of action plans are also to be chalked out to provide timely, appropriate and adequate health facilities post disaster periods. They are:

1. Identification of disease pattern of the high risk areas
2. Identification of factors responsible for aggravating disease during disasters
3. Identification of number and location of the health facilities in high risk areas

4. Location of manpower available in the area (both general and specialised)
5. Arrangement for the training of personal-medical and para-medical at operational and the managerial levels to explain the details of contingency plan.
6. Preparation of a contingency action plan with specific responsibilities assigned to specific persons (Roy 2004)

Risk reduction

Risk reduction is a systematic approach to identifying, assessing and reducing risk of all kinds associated with disasters and human activities. Risk reduction should be an integral part of the way organisations do their work. The modern risk reduction approach recognises that a wide range of geological, meteorological, environmental, technological and socio-political hazards threaten society, individual and their interactions. Risks are located on the point where hazards, communities and environments interact and so effective risk reduction and management must address all of these aspects (Anand et al 2009).

Rescue. Rescue operations consist of searching for and removing trapped occupants of hazardous conditions. Animals may also be recovered, if resources and conditions permit. Generally triage and first aid are performed outside, as removal from the hazardous atmosphere is the primary goal in preserving life. Search patterns include movement against room walls (to prevent rescuers from becoming lost or disoriented) and methodical searches of specific areas by designated teams (Syed 2008).

Relief: Relief happens to be the immediate response by the government, whatever is their nature. Relief is generally conceived as a short term measure to which others, particularly, voluntary agencies, local, regional, national and international organisations participate without any reservation. The relief work has the duration determined by the extent and severity of disasters concerned. No work of a permanent character is envisaged in this stage. There should be policies and procedures at the national and state level for relief. A corpus of funds called "Calamity Relief Fund" is earmarked for the purpose. There are two tiers of relief functions: Primary and Secondary. In both the relief functions, some areas are distinctly identified so that there are overlaps in respect of relief operations (Sinha 2006).

Challenges during relief operation

Information systems that were unrealistic or rudimentary in the first weeks following the disaster may be set up or strengthened during early recovery. Nonetheless, various factors affect the establishment of consolidated system wide databases on health, water, food and shelter as follows:

- Lack of a centralised, detailed registry of all households in need of assistance
- Little true consultation with beneficiaries.
- Lack of realistic standards acceptable to humanitarian workers and development planners
- Limited specific information sharing on who is doing what and with what resources
- Ongoing marginalization of the national coordinating mechanism because many actors are directly accountable to the sources of funding
- Projects to create durable shelters require a broader range of information
- Data are needed on the availability of water, schools and health facilities
- Levels of vulnerability to natural disasters
- The prior and projected economic activities of the relocated beneficiaries and
- The status of land ownership (Amin & Goldstein)

Mitigation

Mitigation efforts attempt to prevent hazards form developing into disaster altogether, or to reduce the effects of disasters when they occur. The mitigation phase differs from the other phases because it focuses on long-term measures for reducing and elimination risk. Mitigation is the most cost-efficient method for reducing the impact of hazards. Mitigative measures can be structural or non-structural. Structural measures use technological solutions, like flood levees. Non-structural measures include legislation, land use planning, and insurance e.g., the designation of non-essential land like parks to be used as flood zones. Non-structural personal mitigation is mainly about knowing and avoiding unnecessary risks. E.g.,. Would be to avoid buying property that is exposed to hazards, e.g. in a flood plain, in the areas of subsidence of landslides (Dasgupta 2007).

Mitigation measures aim to reduce the vulnerability of the system (e.g. by improving and enforcing building codes). Mitigation compliments the Disaster Preparedness and Disaster Response activities. The mitigation program will direct the following activities:

1. Identify areas exposed to Natural hazards and determine the vulnerability of key health facilities and water systems.
2. Coordinate the work of Multi Disciplinary teams in designing and developing building codes and protect the water distribution from damages.
3. Hospitals must remain operational to attend to disaster victims.
4. Include disaster mitigation measures in the planning and development of new facilities.
5. Identify priority hospitals and critical health facilities that comply with current building codes and standards (Siva 2009).
6. Ensure that mitigation measures are taken into account in a facility's maintenance plans.

7. Inform, sensitize and train those personnel's who are involved in planning, administration, operation, maintenance and use of facilities about disaster mitigation.
8. Promote the inclusion of Disaster Mitigation in the curricula of Professional training institutes (Prasad 2009).
9. Use of vulnerability atlas for planning of appropriate disaster reduction measures.
10. Implementation strategy for creating awareness, education and training at various levels.
11. In view of the huge amounts involved in the retrofitting exercise, it will be necessary to priorities the buildings which may be based on the following parameters.
a. Severity of the hazard – the most severe zones are taken first then the other zones in decreasing priority.
b. Social buildings, such as schools and health centres are taken up as high priority in view of their post disaster use as shelters.
c. Housing and other buildings, the private buildings may be encouraged to be retrofitted through awareness programme and a system of incentives, reduced insurance premium, etc (Jain 2008).

Response

Response can be defined as a wide array of endogenous and exogenous reactions, measures and policies that mitigate counteract and prevent disaster impacts and effects (Kreimer et al 2003). Response measures are usually those which are taken immediately prior to and following disaster impact. Such measures are mainly directed towards saving life and protecting property and to dealing with the immediate disruption, damage and other effects caused by the disaster. Typical measures include: Implementation of plans, Activation of the counter-disaster system, Search of emergency food, shelter, medical assistance etc, Survey and assessment, Evacuation measures (Narayan 2000). This phase generates three main areas of attention in a disaster situation: Response mechanisms, Compensatory response and Anticipatory response. The response phase of an emergency may commence with a search and rescue phase. However in all cases the focus will be on fulfilling the basic needs of the affected population on a humanitarian basis. This assistance may be provided by national and / or international agencies and organisation.

Recovery

The aim of the recovery phase is to restore the affected area to its previous state. Recovery efforts are concerned with issues and decisions that must be made after immediate needs are addressed. Recovery efforts are primarily concerned with actions that involve rebuilding destroyed property, reemployment and the repair of other essential infrastructure. The recovery phase starts when the immediate threat to human life has subsided (Dasgupta 2007). The recovery process can be very protracted, taking 5-10 years or even more. Three main categories of activity are normally regarded as coming within the recovery segment are: Restoration, Rehabilitation, and Reconstruction

Typical activities include: Restoration of essential services, repairable homes and other buildings/installations, temporary housing, Measures to assist the physical and psychological rehabilitation of persons who have suffered from the effects of disaster, Long-term measures of reconstruction, including the replacement of buildings and infrastructure which have been destroyed by the disaster (Narayan 2000), Removal of debris, Making community aware on the health and safety measures, Restoration of sanitation, Providing relief interim – financial and in lieu as per Relief Manual, Restoring employment opportunities, Counselling trauma cases (Brig (Dr) Khanna & Khanna 2011).

Disaster Recovery Plans will include components to develop and document arrangements for the effective management of the recovery planning process (Prasad 2009).

Rehabilitation

Rehabilitation refers to the actions taken in the aftermath of a disaster to enable basic services to resume functioning, assist victims' self-help efforts to repair physical damage and community facilities, revive economic activities and provide support for the psychological and social well being of the survivors. It focuses on enabling the affected population to resume more-or-less normal (pre-disaster) patterns of life. It may be considered as a transitional phase between immediate relief and more major, long-term development (Dasgupta 2007). The success of these projects depends upon, how effectively the displacement is governed and the various rehabilitation programmes are regarded as appropriate and adequate sources of gratification of needs by the affected population. The felt needs of the affected population should be given due consideration before designing any such programme. In addition Rehabilitation programmes should make use of available skills and talents and also focus upon providing new skills and competencies to the affected population, to enable them to face the outer world (Murthy 2004). Rehabilitation is more often understood as economic rather than psycho-sociological phenomenon resulting from displacement. Rehabilitation programmes necessarily need to be designed according to the felt needs of the affected population (Gupta 2006).

Reconstruction

Reconstruction refers to the full restoration of all services and local infrastructure, replacement of damaged physical structures, the revitalisation of economy and the restoration of social and cultural life. Reconstruction must be fully integrated into long-term development plans, taking into account future disaster risks and possibilities to reduce such risks by incorporating appropriate measures (Dasgupta 2007). Avoiding rebuilding vulnerability. Operations that finance rehabilitation and reconstruction after a disaster require special precautions to avoid rebuilding and increasing vulnerability. Particular attention must be given to lessons learned from recent hazard events (Singh 2008).

Conclusion

Though large efforts have been made to manage the environmental hazards, such efforts prove to be in futility when disaster strikes at a huge magnitude. Disaster recovery and mitigation offer clear picture that there is a need for holistic approach. Society's attention should change towards such severe event. Greater understanding has come with increasing governmental responsibility. Little blame can be placed on governments' inadequacy. The administrative system has to know how to relate information and how to coordinate and manage effectively.

Further it is also needed to analyse the requirement of the people at this time of crisis. The analysis would definitely help in understanding the human rights perspective of the victims. Ensuring that the human rights of the people have been respected by the Government while providing rehabilitation and an effort by various organisation engaged in the relief work forms the critical component for the framing of the policy in the future.

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HEAVY METAL REMEDIATION IN WATER TREATMENT SYSTEMS: REVISITING SOME USEFUL APPLICATIONS AND PROCESSES

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Abstract

The term "heavy metals" refer to a group of naturally occurring metals and metalloids that have atomic density over 6 gm/cm^3. Although many of these elements serve as useful links and essential micronutrients for life forms, the same may reflect toxic manifestations if their concentrations deviate from the optimum range. Discharge of wastewater laden with heavy metals without proper treatment is, therefore, a threat to public health. These heavy metals show biosorption, bioaccumulation, biomethylation and biomagnification phenomena under varying natural environments. Further, these heavy metals are known to be persistent pollutants, much stronger than their organic counterparts, such as pesticides, PAHs, or petroleum byproducts. Fate, transport, capture, remobilization and reworking of these metals in natural environment is still an enigma, and depends heavily on the interplay of physico-chemical conditions such as Eh-pH, chemical speciation, thermodynamic controls, reaction kinetics and biotic influences. Various technologies and processes are in vogue for heavy metal remediation. The present study gives a re-look to the understanding of these interactions between mineral surfaces and species in solution, and aqueous partitioning of toxins on oxide and silicate surfaces. The paper elucidates some of the salient processes that could be effective for heavy metal remediation in water treatment systems. If such attempts to decode the environmental flows of heavy metal assemblages achieve moderate success, it will hopefully be a foundation work of further research on heavy metal remediation in India.

Keywords

Heavy metal remediation, wastewater treatment, environmental bio-monitoring

1. Introduction

"Heavy metal" is a general collective term, mainly applied to recognize the group of metals and metalloids with atomic density greater than 6 g/cm^{3}and they are natural components of the earth's crust. Few of them are important for many metabolic pathways of living being in minute concentration, but at higher concentration they pose severe toxicity (Lenntech, 2004). At present situation, heavy metals are matter of concern because of their unique properties such as less degradable, easy accumulation and long persistence within the environment. At least 20 metals are classified as toxic among them the common that have been identified in polluted water include arsenic, copper, cadmium, lead, chromium, nickel, mercury and zinc. These metals are more toxic when they are present in the most stable oxidation states e.g. As^{3+}, Cu^{2+}, Cd^{2+}, Pb^{2+}, Hg^{2+}, Ag^{+} and Zn^{2+}. Metals in these states can bind with various bio-molecules of living body to form highly stable bio-toxic compounds that are difficult to isolate (Duruibe *et al.,* 2007). Occurrence of heavy metals on the earth crust is a natural phenomenon but elevated concentration and accumulation of these metals within different sectors of environment is the outcome of rapid industrialization, urbanization, and anthropogenic sources (EPA, 2000; Gardea-Torresdey *et al.,* 2005; Hussein *et al.,* 2005; Martin-Gonzalez *et al.,* 2006).Heavy are one of the most persistent pollutants in water. Discharges of wastewater containing high concentrations of heavy metal from residential areas, groundwater infiltration, industrial and consumer wastes to receiving water bodies has serious adverse environmental effects. Mobility of these metals within the soil is depending on soil pH and their chemical speciation so small fraction of total mass can leach to aquifer or can become bio-available to living beings (Alloway, 1990; Santona *et al.,* 2006). The release waste containing heavy metals in the environment without proper treatment poses a significant threat to living biota because of their long persistence, biomagnifying nature.

Use of domestic and industrial effluents as the source of irrigation in the agricultural fields is a common practice in various parts of world. Heavy metals from these effluents have the ability to persist in natural ecosystems for an extended period. These toxic metals may be concentrated on plant tissues thus disturbed various metabolic and enzymatic activities of the plants. They may also pose health hazards to man and animals because of their accumulation in successive levels of the biological chain, thereby causing acute and chronic diseases (Athar and Ahmad, 2002). For example, cadmium and zinc are responsible for acute gastrointestinal and respiratory damages, cadmium is also well known for its phytotoxicity (Nomanbhay and Palanisamy, 2005; Lone *et al*., 2008). Thus the quality of drinking water supply and wastewater discharge adversely affected due to heavy metal pollution. To overcome the problem efforts have been made in the last two decades to reduce pollution sources and also remediate the water resources. For this purpose many remediation technologies have been developed all over the world to deal with the contaminated groundwater and

as well as wastewater. So, in this document, summarization of most applied and emerging technologies for heavy metal groundwater and wastewater remediation, along with their scopes, merits and demerits have been discussed.

2. Remediation Technologies for treatment of groundwater and wastewater contaminated with heavy metals:

Heavy metals the naturally occurring elements in earth's crust generally capable of being dispersed in ground water through natural processes or may be due to the change in soil pH. Landfill leachate, sewage, industrial waste, deep-well disposal of liquid wastes, seepage from sewage treatment plants or from industrial spills and leaks (Evanko *et al*., 1997) are considered as the main reasons of groundwater contamination with heavy metals. Chemical speciation of heavy metals plays a vital role to determining the mobility, toxicity and reactivity of heavy metals. These metals can either be detected in their elemental state or bound in various salt complexes. So it should be prime concern that those metals known as environmentally hazardous, or which are of technological importance, be removed/recovered at their source with the help of appropriate treatment systems.

2.1. **Chemical and physical treatment processes**

Chemical treatment processes like precipitation/neutralization or physical processes such as ion exchange, activated carbon sorption, and reverse osmosis are considered as the most conventional technologies that have been used widely as the primary method of treating metal-laden groundwater and industrial wastewater. In chemical precipitation, a separable solid substance is dissociated from the solution, either by converting the substance into an insoluble form or by changing the composition of the solvent to diminish the solubility of the substance in it. Then the contaminants can easily removed from the liquid phase by physical methods, such as clarification and filtration (Nomanbhay and Palanisamy, 2005). In most of precipitation processes, adjustment of pH to the basic conditions (pH 11) is the important parameter that significantly improves heavy metal removal by chemical precipitation. Lime or calcium hydroxide is the most commonly used precipitant agent. pH and alkalinity of the water also play the key role to determine the exact amount chemical that is required during treatment process and usually, sodium hydroxide or lime are used to treat inorganic effluent with a metal concentration of higher than 1000mg/L (Chan G. Y.S *.et al.,*,2006). During neutralization and presence of complex forming agents may lower the process effeciency in many cases. (NEESA, 1993; Xu and Xu, 2008). Combined precipitation and ion exchange has been reported to be effective in heavy metal removal from wastewater. In a study in South Africa, acid mine water from gold mine on has been treated by this combined precipitation-ion exchange technology. During this treatment process acid mine water firstly treated with lime and sulphides then followed by ion exchange process and the outcome of this combined method was the yield of very pure water from acid mine water with moderate cost (Akpor O. B.2010). Lime or calcium hydroxide is the frequently used precipitating agent that can be able to treat inorganic effluent effectively with a metal concentration of higher than 1000mg/L. The simplicity and safe operation procedure, low cost and easy availability of equipments, low maintenance cost make this process more convenient and well established technology for heavy metal removal from water (Akpor O. B.2010). There are few limitations of this process, such as large amount of chemicals needed for the treatment process to achieve the desirable metal concentration for discharge (Jüttner. K., et *al., 2000*). Generation of excessive sludge is another drawback of this process. Treatment and disposal of the sludge increase the maintenance cost.

2.2. Coagulation and Flocculation

Coagulation and flocculation processes are mainly used to separate the suspended solids portion from the water. In the coagulation process a coagulant added to the wastewater to destabilize colloidal particles results in sedimentation. Following the first step of coagulation, a second process called flocculation occurs. Flocculation, a gentle mixing stage, increases the particle size from submicroscopic micro-floc to visible suspended particles. The micro-flocs are brought into contact with each other through the process of slow mixing. Collisions of the microfloc particles cause them to bond to produce larger, visible flocs called pinflocs. The floc size continues to build through additional collisions and interaction with inorganic polymers formed by the coagulant. The commonly used metal coagulants fall into two general categories: those based on aluminum and those based on iron. The aluminum coagulants include aluminum sulfate, aluminum chloride and sodium aluminate. The iron coagulants include ferric sulfate, ferrous sulfate, ferric chloride and ferric chloride sulfate. Other chemicals used as coagulants include hydrated lime and magnesium carbonate. The effectiveness of aluminum and iron coagulants arises principally from their ability to form multi-charged polynuclear complexes with enhanced adsorption characteristics. The nature of the complexes formed may be controlled by the pH of the system. When metal coagulants are added to water the metal ions (Al and Fe) hydrolyze rapidly but in a somewhat uncontrolled manner, forming a series of metal hydrolysis species. The efficiency of rapid mixing, the pH, and the coagulant dosage determine which hydrolysis species is effective for treatment. It was observed that, coagulation–flocculation process can be very effective to treat inorganic effluent with a metal concentration within the vast range of 100mg/L to 1000mg/L .Range of pH from 11.0 to 12 has been found to be effective to improve the heavy metal removal by this process. The sludge generated during the process is very much stable in nature because of its dewatering characteristics, bacterial inactivation capability and this main favorable feature of this treatment process. But the operational cost is very high due to large scale chemical consumption.

2.3. Ion Exchange

Ion-exchange processes another widely used technique to remove heavy metals from waste water. Typical ion exchangers are ion exchange resins (functionalized porous or gel polymer), Zeolites, montmorillonite, clay, and soil humus. Ion exchangers are either cation exchangers that exchange positively charged ions (cations) or anion exchangers that

exchange negatively charged ions (anions). There are also amphoteric exchangers that are able to exchange both cations and anions simultaneously. However, the simultaneous exchange of cations and anions can be more efficiently performed in mixed beds that contain a mixture of anion and cation exchange resins, or passing the treated solution through several different ion exchange materials. It was observed that synthetic resins have the specific ability to exchange its cations with the metals in the wastewater and effectively remove them from the solution (Alyüz and Veli, 2009). Temperature, pH, initial metal concentration and contact time are considered as the key factors that control the uptake mechanism of heavy metal ions by ion-exchange resins (Gode and Pehlivan, 2006). At present, natural zeolites, silicate minerals, have also been applicable to remove heavy metals from aqueous solutions. Clinoptilolite, a natural zeolites that have received extensive attention due to its selectivity for heavy metals. It was reported that that Clinoptilolite a useful ion exchange resin has the potential to remove of Cadmium, Chromium, copper, nickel and zinc with an initial concentration of 100mg/L, respectively (Rengaraj. S.*et al,* 2001; Abrowski, A. D.*et al.,*2004). It was also reported that zeolites exhibit good cation-exchange capacities for heavy metal ions under different experimental conditions (Motsi et al., 2009; Ostroski et al., 2009; Taffarel and Rubio, 2002). Use of zeolite as ion-exchange resin is restricted to the laboratory level study and more elaborate study on application of zeolite is needed. Ion-exchange process is a reversible process and the ion exchanger can be regenerated or loaded with desirable ions by washing with an excess of these ions. This character made this process a well accepted method of wastewater treatment.

2.4 Reverse Osmosis

Osmosis is a natural process. When two liquids with different concentrations of a solute are separated by a semi-permeable membrane, the fluid has a tendency to move from low to high solute concentrations for chemical potential equilibrium. Formally, reverse osmosis is the process of forcing a solvent from a region of high solute concentration through a semi- permeable membrane to a region of low solute concentration by applying a pressure in excess of the osmotic pressure. Reverse osmosis process can efficiently remove a wide range of dissolved species from water. It is well known for its desalination capability. According to the Shahalam Harthy and Al-Zawhry (2002), reverse osmosis accounts for more than 20% of the world's desalination capacity. In a Experimental study the established fact is if a pilot-scale membrane bioreactor system and reverse osmosis process applied together metal removal efficiencies of the combined process were very high (Dialynas, *et al.,*2009). In reverse osmosis process huge energy supply is needed due to the pumping pressures, membranes restoration of the membranes. This is the major limitation of this technique.

3. Green remediation of heavy metals

Green remediation or popularly known as Phyto-remediation is a remediation process in which plant species are used to partially or substantially remediate selected substances in contaminated soil, sludge, sediment, groundwater, surface water and wastewater. Depending on the applicability, and type of contaminant, phyto-remediation can be broadly categorized as: Rhizofiltration: In this type of phytoremediation, hydroponically cultivated plant roots are used to remediate contaminated water through absorption, concentration, and precipitation of cotaminants. It also filters through water and dirt.

Phytostabilization: Plants are used to immobilize the contaminants in soil matrix either by simply preventing erosion, leaching or runoff, or by reducing their bioavailability.

Rhizodegradation/Phytostimulation: Rhizospheric associations between plants and symbiotic soil microbes influence the Degradation of pollutants.

Phytoextraction: Plants extract the contaminants and accumulate them matrix into their root and shoot tissues, followed by harvesting of the plant materials.

Phytovolatilization: certain plants have the ability to uptake contaminants from the growth matrix and subsequently transform and volatilize contaminants into the atmosphere.

Phytomining: Phytomining refers to the production of 'crop' of a metal through growing very high biomass plants which accumulate high metal concentrations. In some plants, the property can be induced but most of them are natural hyper accumulators.

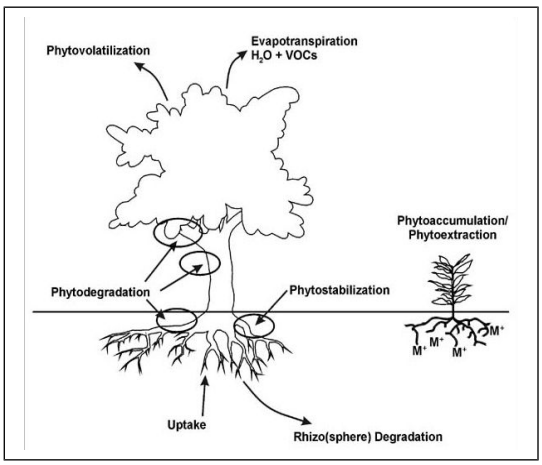

Figure 1: Schematic representation of various category of Phytoremediation

At sites contaminated with metals, plants can be used to either stabilize or remove the metals from the soil and groundwater through three mechanisms: phytoextraction, rhizofiltration, and phytostabilisation. So in this paper only these three techniques will be discussed.

3.1. Phytoextraction

Phytoextraction, also termed as phyto-accumulation, accounts for the uptake of metals from soil by plant roots then transfer them into above-ground portions of plants (Figure 1). Certain plants have been known as hyperaccumulators, because of their ability to absorb unusually large amounts of metals in comparison to other plants but due low shoot biomass, long time period is required to achieve an acceptable metal level in the soils for the remediation. Therefore, the use of trees for phytoextraction process has been found to be more advantageous (Pulford & Dickinson 2005). The plants are harvested for some period of time and then the fully developed plants are either incinerated or composted to recycle the metals. Repetition of this procedure will depend on the necessity to keep up soil contaminant levels down to allowable limits. Ash generated after the plant incineration likely to be disposed of in a hazardous waste landfill ,and another important aspect of this process is the volume maintenance of originated ash. Volume of the ash must be less than 10% of the volume that would be generated if the contaminated soil dug up for treatment. It was an established fact that metals such as nickel, zinc, and copper are more readily by this mechanishm (UNEP, 2010). At present lead and chromium removal by phyto-extraction process are being studied at laboratory conditions. The addition of chelates increase the bioavailability of metals thus accelerate the efficiency this phytoextraction process (Utmazian and Wenzel, 2006).

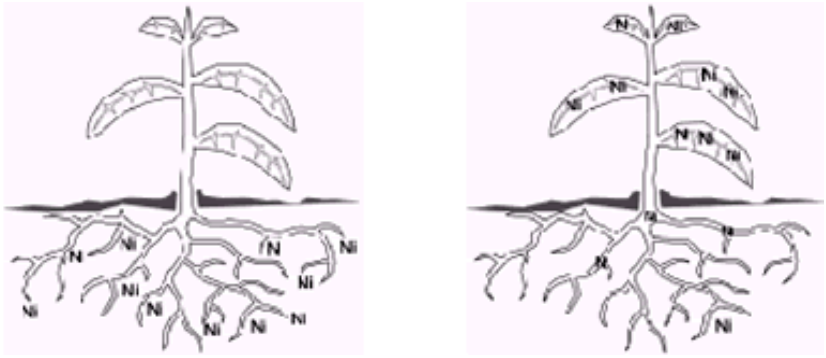

Figure 2: Schematic representation of Uptake of Metals (Nickel) by Phytoextraction process
Nickel is removed from soil by moving up into plant roots, stems, and leaves. The plant is then harvested and disposed of and the site replanted until the nickel in the soil is lowered to acceptable levels (UNEP, 2010).

3.2 Rhizofiltration

Rhizofiltration is a type of phytoremediation, which refers to the approach of using hydroponically cultivated plant roots to remediate contaminated water through absorption, concentration, and precipitation of pollutants. It also filters through water and dirt. The contaminated water is collected from a waste site and brought to the plants, or the plants are planted in the contaminated area, where the roots then take up the water and the contaminants dissolved in it. This process is very similar to phytoextraction in that it removes contaminants by trapping them into harvestable plant biomass. Both phytoextraction and rhizofiltration follow the same basic path to remediation. First, plants are put in contact with the contamination. They absorb contaminants through their root systems and store them in root biomass and/or transport them up into the stems and/or leaves. The plants continue to absorb contaminants until they are harvested. The plants are then replaced to continue the growth/harvest cycle until satisfactory levels of contaminant are achieved. Both processes are also aimed more toward concentrating and precipitating heavy metals than organic contaminants. Various plant species have been found to effectively remove toxic metals such as Copper, Cadmium, Chromium, Nickel , lead, and Zinc from aqueous solutions (Dushenkov. *et al.,*1995**)**. The major difference between rhizofiltration and phytoextraction is that rhizofiltration is used for treatment in aquatic environments, while phytoextraction deals with soil remediation.

3.3. Phytostabilization

Plant species used in the process of Phytostabilisation are able to immobilize the contaminants present in the soil and groundwater. They can absorb and then accumulate the contaminants in plant tissues. Adsorption may occur onto roots, or precipitation of pollutants within the root zone may prevent their migration in soil. Leaching of contaminants by erosion and deflation may also checked by this process (Erakhrumen. and Agbontalor 2007; Erdei. L. *et al.,* 2005). The affectivity of phytostabilization may depend to some extent on the tolerance level of a plant in respect to the contaminants. It was reported that suppose a plant has the potentiality to remove little or no contaminants but in case of phytostabilization this plant is considered as useful because of its tolerance ability and growing capability in harsh condition (Scheper and Tsao, 2003).

In comparison to other conventional remediation methods, phytoremediation has many advantages that include:

1. Environment friendly, more green technology and very much cost-effective .

2. Applicable to large sites, and to the areas with higher contamination level.
3. Established as an alternative treatment method for hazardous waste sites because no need for disposal sites, thus reducing the risk factors.
4. Has the potential to remediate a vast range of environmental contaminants including toxic metals,other inorganic and organic pollutants and redionuclides also.

Some limitations of this method are:

1. Very much time-consuming process, several growing seasons may required to clean up a site.May show cytotoxic effects to plaants species due to the intermediates generated during treatment process.
2. Dependent on growth rate of the plants so more time may be required to remediate a site rather than other traditional cleanup technologies.
3. Disposal of plant residue, incineration of plant parts are time consuming may take weeks to months to accomplish. Disposal sites may be vulnerable to human health, and local ecosystem may be affected.

Phyto-remediation technology applied to uptake the heavy metals from contaminated sites, by plants seems to be a prosperous recovery process of heavy metals contaminated environment. It has some advantages compared with other commonly used conventional technologies. Several factors must be considered in order to accomplish a high performance of remediation result. The most important factor is a suitable plant species which can be used to uptake the contaminant. Even the phytoremediation technique seems to be one of the best alternatives, it also has some limitations. Prolong research needs to be conducted to minimize this limitation in order to apply this technique effectively.

4. Concluding remarks

Heavy metal contamination of drinking water and wastewater is a matter of concern over the past two decades. Various Legislations and guidelines have been established with proper upper and lower limits of contaminant discharge with a hope that the quality of treated effluent will be improved. A number of treatment technologies are functioning at present to minimize heavy metal contamination problem. Among these technologies, chemical precipitation, coagulation–flocculation, ion exchange, reverse osmosis are most widely used applications. It is an established fact that ion exchange process has the potential to remove of cadmium, chromium, copper, nickel and zinc with an initial concentration of 100mg/L, respectively (Rengaraj. S.*et al,* 2001; Abrowski, A. D.*et al.,*2004; Rengaraj. S.*et al,* 2003).Lime precipitation is known as an another effective means to treat inorganic effluent even when metal concentration higher than 1000 mg/L. Although many techniques at present are in use for the treatment of heavy metals enriched wastewater but initial metal concentration is the key factor for the selection of suitable treatment technology. Acceptability of a technology is not only depend on the metal removal efficiency of the process but economical utility such as the capital investment, operational costs, energy requirement, maintenance cost also play a significant role for treatment technique selection. Consideration of all these factors along with the merits and demerits of each technology will help us in selecting the most effective and inexpensive treatment in order to protect the environment. So implementation of integrated treatment mechanisms to achieve a safe and economically viable remediation option for heavy metals in water and wastewater system may ensure better public health and cleaner environment.

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HUMANITARIAN AID AND LOGISTICS

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Introduction

The Indian sub-continent is one of the most disaster prone areas of the world. The geo-climatic conditions coupled with a rapidly growing population and rising urbanization scenario have manifested in increasing impact and devastation from disasters. Recent mega-disasters which took a toll of thousands of lives and displaced large populations have reinforced the urgent need for a comprehensive system, focusing on safe national development and local level risk reduction measures to inculcate a culture of prevention. A disaster event transcends all divisions created by society and polity to affect the entire population in range. Therefore, prevention and mitigation of disasters also requires active participation of the entire population. It is increasingly becoming apparent that risk reduction initiatives taken at the local level, owned and implemented by the community are the most effective prevention options. Disaster management therefore presupposes active and coordinated participation from all actors.

Logistics and supply chain management

The council of Logistics Management defines Logistics as the process planning, implementing and controlling the efficient flow and storage of raw materials, in-process inventory, finished goods, services and related information from the point of origin to the point of consumption for the purpose of conforming to customer requirements. Supply Chain Management is a concept that originated and flourished in the manufacturing industry and has been subsequently adapted to many different areas. Disaster Management is one of those areas to which it has been adapted. Disaster Management is a set of rules for coordination of activities at the disaster area and the rational usage of resources. During a disaster several logistics decisions should be made. The unpredictability of global emergencies and the stakes of the adequate and timely delivery of the goods/ services and challenge of managing material flow in the relief operations, which hold as their ultimate objective the delivery of the appropriate level of resources to locations worldwide in order to minimise human suffering and loss of life. With an increasing number of disrupting business and community life around the world, it is timely to position humanitarian and disaster relief supply chains within the broad field of supply chain management

Disaster management and humanitarian relief chain

Disaster Management

Disaster is a term that can be defined in different ways depending on whether the spectrum is broad or narrow, and also can be classified as either a rapid onset disaster, such as an earthquake or flood, which requires immediate intervention of rescue and aid, or a slow onset disaster such as drought or famine that may allow more time to respond. There are three main types of disaster.

1. **Natural Disasters**: These disasters include floods, landslides, hurricanes, cyclones, tsunami, earthquakes and volcano eruptions that can have immediate impacts on human health, as well as secondary impacts causing further death and suffering from floods causing landslides, earthquakes resulting in fires, tsunamis causing widespread flooding and typhoons sinking ferries.
2. **Man-made Disasters:** Man-made disasters are the result of nuclear, biological, chemical or technological such as fires, transport accidents, industrial accidents, oil spills and nuclear explosions/radiation. War and deliberate attacks may also be put in this category.
3. **Pandemic Emergencies:** These emergencies involve a sudden onset of a contagious disease that affects health but also disrupts services and businesses, bringing economic and social costs.

Disaster Management means a continuous and integrated process of planning, organising, coordinating and implementing measures which are necessary or expedient for prevention of threat of any disaster; mitigation of risk of any disaster or its severity or consequences; capacity-building; preparedness to deal with any disaster; prompt response to any threatening disaster situation or disaster; assessing the severity or magnitude of effects of any disaster; evacuation, rescue and relief; rehabilitation and reconstruction.

The Humanitarian Disaster Relief Supply Chain management experiences a heightened urgency for making decisions and taking action. Although the effectiveness and efficiency of private sector supply chains can be the difference between profit and loss, for firms in that sector Humanitarian Disaster Relief Supply Chain effectiveness can mean the difference between life and death of disaster victims

Phases of disaster management

Disaster Management can be divided into two phases, which are proactive and reactive

a. Risk management process phase, which includes pre disaster risk reduction and preparedness, rehabilitation and reconstruction and

b. Crisis Management phase, which include rescue and first aid during the disaster.

Figure.1 **Phases of Disaster Management**

Since disaster relief efforts are characterized by considerable uncertainty and complexity, they need to be properly managed in order to address and implement better responses. Thus, disaster management is a key factor that drives successful execution of relief efforts, and it begins with strategic process design. Disaster management is often described as a process composed of several stages. The four phases constitute the disaster management cycle are,

- Mitigation
- Preparation
- Response
- Reconstruction

With the focus on logistics and supply chain management, the process that involves logisticians mainly concerns the preparation, response and reconstruction; together these constitute humanitarian logistics stream.

Mitigation: The mitigation phase refers to laws and mechanisms that reduce social vulnerability. These are issues that relate to the responsibilities of governments and do not involve the direct participation of logisticians.
Preparation: The preparation phase refers to various operations that occur during the period before a disaster strikes. This phase incorporates the strategies put into place that allow the implementation of a successful operational response. This phase is crucial because it is the one in which the physical network design, information and communications technology systems, and the bases for collaboration are developed. The aim of this stage is to avoid the gravest possible consequences of a disaster. This phase also incorporates the efforts that are made between disasters in learning and adapting from past experiences so as to meet new challenges.
Response: The response phase refers to the various operations that are instantly implemented after a disaster occurs. In the response stage, coordination and collaboration among all the actors involved in the humanitarian emergency deserve particular attention. Connections to feasible donors, suppliers, NGOs, and other partners are made in the first phase, but they are not activated until the catastrophic event takes place. Then, all the actors involved operate as quickly as possible.
Reconstruction: The reconstruction phase refers to different operations in the aftermath of a disaster. It involves rehabilitation, and this phase aims to address the problem from a long-term perspective. The effects of a disaster can continue for a long period of time, and they have severe consequences on the affected population

Relief operations and the humanitarian relief chain
Relief operations aim to preserve life and reduce the sufferings of members of communities in crisis. Relief Operations comprise the provision of material and technical aid as well as the delivery of essential services in response to crisis situation when the community's ability to cope has been severely impeded. Relief Operations are launched in response to both natural and man –made crisis and executed normally over a short to medium- term time horizon. As soon as the political and security situation permits, these operations are replaced by rehabilitation and reconstruction programs, which in turn are followed by development aid. During a disaster several logistics decisions should be made. These must be structured according to the needs of the community. When a disaster hits, the distribution of supplies to victims at a certain time is vital. Any delay in procurement may complicate logistics operations and accelerate casualties. Effective operation of the procurement process requires financial resources to maintain procurement activities before and during the disaster. Priorities should be given to the most affected regions and coordination between the different agencies there. It is important to note that each crisis is unique and may require a tailor-made response.

Relief operations are a time-limited process. Relief Operations start immediately after the occurrence of the disaster and continue 1-3 months depending on the size of the disaster. The simplest Relief Operations start with the procurement and dispatch of aid for transportation to the beneficiary region. These grants can be in the form of materials, services and cash. The aid may be stored in either a national or regional warehouse before transport to central warehouses and distribution points in the disaster area and then to local ware houses where the aid is handed to the beneficiaries. The activities executed during this period are mainly vital activities and should be managed by appropriate methods with in a very short time. For this reason, Humanitarian Relief Operations create Supply Chain. The Humanitarian Relief Chain (HRC) is a Supply Chain that can create cost-effective material flows, financial value flows and information flows for the planning, implementing and controlling of Relief Operations. In Relief Operations, the Humanitarian Relief Chain (HRC) is required to organise and implement the efforts of organisations responding to a crisis. This is not a simple matter. Often large amounts of people, food, shelter, clothing, heavy machinery and medical supplies must be moved into and around disaster area using m any different modes of transportation. Lives are at stake, so the procurement of disaster relief goods at a certain time should be made to meet the needs of the victims in a disaster. This must be done quickly, while holding cost low. The main problem areas of any Relief Operation can be characterized by the following elements:

- Generally the demand pattern is unpredictable in terms of timing, location, type and size.
- The lead time is approximately zero and affects inventory availability, procurement and distribution.
- Inventory control is challenging due to the high variations in lead times, demands, and demand locations. Supply information is unreliable, incomplete or non-existent.
- Transportation and distribution network configuration are challenging due to the nature of the unknowns and occurrences away from major traffic lanes in less developed regions with inadequate infrastructure. Locations are frequently unknown until the demand occurs.
- The strategic goals are to minimise the loss of life and alleviate suffering.
- Information systems are often unreliable, incomplete or non-existent.
- Lack of or poor structure of coordination among NGOs.

However, the operational characteristics of the HRC also differ depending on the type of disaster and the types of relief actors involved. The HRC links all of the stake holders such as donors, humanitarian organisations, military, governments, beneficiaries, etc in the processes. Material flows of humanitarian aid activities and deliveries of goods and equipment to disasters follow routes from the suppliers to the warehouses. Delays or disruptions in the flow of material during a disaster may cause additional pain. Information flows connect the actors and the following HRC process: preparedness, assessment and appeal, track and trace, monitoring, evaluation and reporting and communications. Financial flows take place during the subsequent processes: preparedness, assessment and appeal, procurement, monitoring, evaluation and reporting.

Relief operations crucially rely on logistics support and effective HRC, which enable the prompt delivery of required goods and services. Applied to Relief Operations, the fundamental aspects of supply chain remain the same. Lack of coordination among chain members has been shown to increase inventory costs, lengthen delivery times, and compromise customer service. Since logistics accounts for 80 per cent of relief operations, relief chain coordination is the key to improving HRC performance. The objectives of commercial supply chains is the maximisation of profits where as the HRC is driven by alleviating the suffering of the people in crisis

Agile and lean principle

There a certain aspects of humanitarian logistics response that could usefully be incorporated within commercial supply networks. Humanitarian organisations are frequently to be found working in environment with high degree of uncertainty and such organisations have become specialists in the implementation of agile system. With regard to humanitarian logistics stream, it is interesting that the transition between the stages involves the shift in focus from speed to cost reduction in terms of operational performance. Each stage of the process has a specific objective that can be achieved through the application of two supply chain principles: agility and leanness. Agility is usually defined as the ability to respond to unexpected changes when an unpredictable demand is combined with short lead. Leanness usually refers to doing more and better with less when demand is relatively stable and predictable. Briefly, while agility focuses on effectiveness and speed, leanness focuses on efficiency and cost saving. In humanitarian supply chains, effectiveness ensures that we save time, and time saved means more lives saved; efficiency ensures that we save costs, and costs saved means more lives helped. The objective of the reconstruction phase is saving as many costs as possible, and it can be achieved through leanness

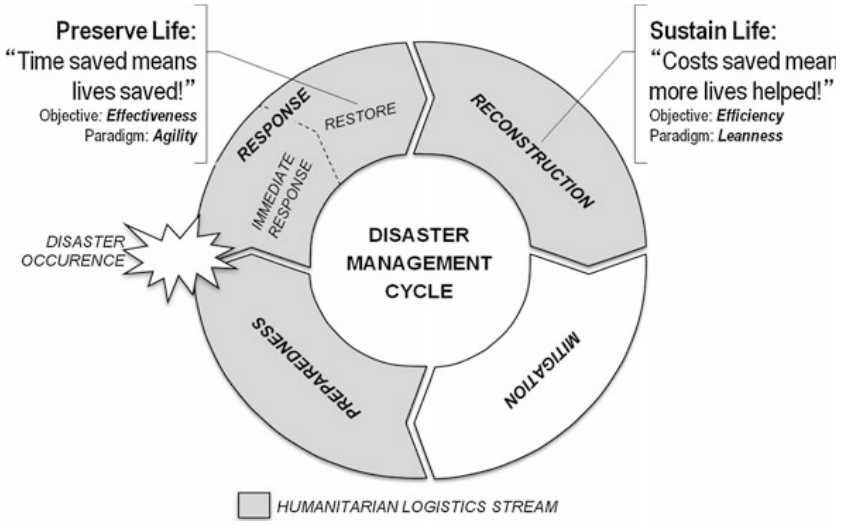

Figure.2 Agility and Leanness in the Humanitarian Logistics Stream

Key actors in humaniatarian system and their role

In a disaster it is important to ensure efficient and effective delivery, such that the appropriate commodities and people reach the victims of the emergency. However, optimizing the logistic performance requires that all the relationships among the actors involved are managed through an integrated approach to efficiently and effectively coordinate inter-organizational performance, eliminate redundancy, and maximize efficiency along the entire emergency supply chain. In fact, though logistics is more focused on moving something or someone from a point of origin to a destination, supply chain management mainly focuses on relationships among the factors that make such movement possible. Logistics and supply chain management are both crucial to properly set the response to a disaster. Logistics is the most important element in any disaster relief effort, and it is the one that makes the difference between a successful and a failed operation But it is also the most expensive part of any disaster relief: it has been estimated that logistics accounts for about 80 % of the total costs in disaster relief. Thus, proper investment in logistics in disaster relief provides the main opportunity to develop and implement effective and efficient use of resources in humanitarian operations. Humanitarian organizations are therefore under greater scrutiny to monitor the impact of aid and the arrangement of their entire operations; they have to prove to donors, who are pledging millions in aid and goods, that they are really reaching the ones in need.

Humanitarian relief-operation management engages very different players, who may have a high degree of heterogeneity in terms of culture, purposes, interests, mandates, capacity, and logistics expertise. Key players can be categorized as follow: governments, the military, aid agencies, donors, non-governmental organizations (NGOs), and private sector companies, among which logistics service providers are prominent. Host governments, neighbouring country governments, and other country governments within the international community are the activators of humanitarian logistics stream after a disaster strikes since they have the power to authorize operations and mobilize resources. In fact, without the host government authorization, no other player with the exception of national aid agencies and the military can operate in the disaster. Host government authorization is fundamental for the involvement of other countries (neighbours or not). The engagement of other countries is a delicate matter since it can be facilitated or blocked as a consequence of the relationship quality between the host government and the international community. In many cases host countries do not enjoy good relations with their neighbours. Another important role in the aid process can be played by international agreements to which the host government subscribes with other countries. Moreover, host governments have the responsibility to put into place protocols and take action to reduce the probability of disasters. On many occasions, the military has been a very important actor since soldiers are called upon to provide primary assistance (i.e., hospital and camp installation, telecommunications, and route repair). Aid agencies are actors through which governments are able to alleviate the suffering caused by disasters. The largest agencies are global actors, but there are also many small regional and country-specific aid agencies. Donors provide the bulk of funding for major relief activities. Generally, donations consist of giving financial means (in-cash donations) to support humanitarian operations or providing goods and/or services for free (in-kind donations) while performing logistics operations. Since each player within its own specific role can provide in-kind donations, in the humanitarian relationship model the term donor refers to those who exclusively give financial means to fund aid operations. Thus, in addition to country-specific funding provided by governments in recent years, foundations, individual donors, and companies have become important sources of funds for aid agencies. NGOs include several and disparate actors, ranging from influential and international players to small and micro-organizations that develop within local communities but are also able to operate at the international level. Some of these players are temporary, being created just to address one particular crisis. The presence of private-sector companies is increasingly growing in the humanitarian relief environment. In the humanitarian logistics, companies can play one or more of the following roles:

Donors; Collectors; Providers.

As a donor, a company can support humanitarian logistics by giving financial contributions (in cash) to fund aid operations. As a collector, a company can gather financial means from its customers, its employees, and its suppliers in order to fund aid operations. As a provider, a company can offer its goods and services for free (in-kind donation) or as a consequence of a selling action. In the humanitarian relationship, when a company exclusively plays the role of donor and/or collector, it simply belongs to the donors' category.

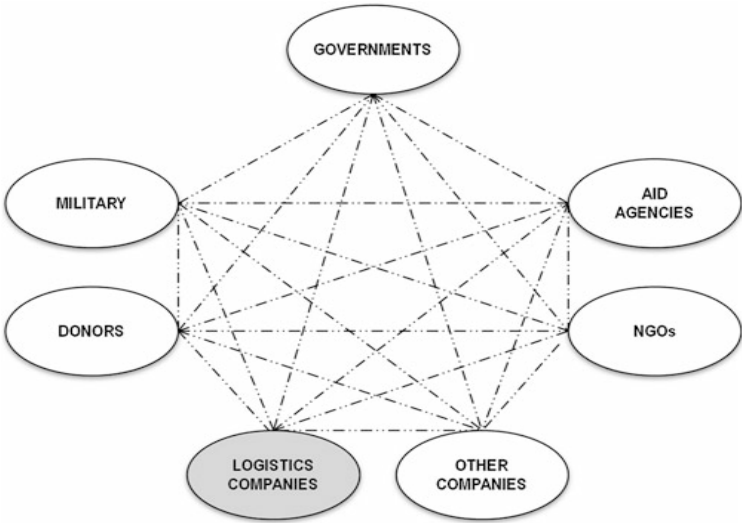

Figure.3 The Humanitarian players and their Relationships

Complexities of relief operations

Humanitarian Disaster Relief Supply Chains are also different because they involve all the stages of the supply chain life-cycle from pre-planning to termination. At each stage, demands and desired outcomes change. Humanitarian Disaster Relief Supply Chains function in the presence of high levels of uncertainty about disaster timing and location, victims' needs, donors' contributions, infrastructure and even relief group composition. In a post disaster environment, some information is simply not available, while other information may available but may not make it to the organisations that need it.

Not only the priorities change over time, but the local conditions are highly dynamic as well. This situation requires different response, resources and capabilities. It is uncommon to encounter number of uninvited or unexpected individuals, groups or even newly formed organisations attempting to help in disaster relief mission. Although they are usually motivated by best of intentions, these efforts can create numerous problems. They compete for coordination, communication, logistics and sustenance capacity like everyone else. They often need more coordination effort since they did not participate in any prior planning efforts and they often disrupt or complicate the efforts of the others. Their presence or actions, such as donations of materials or other items, creates what can be best described as turbulence that complicates the Supply Chain Management.

Although the United Nations has a leadership role in prescribed procedures in the event of a major international disaster, the role of government must be recognised. No international action can take place if the local government does not request it. Even when permission is granted, there are still occasional conflicts of authority and delays in decision making, due to distance, communication impediments or misunderstanding. In the private sector world, there may be delays in decision making, but conflicts of authority are very unusual even across great distance. There must also be recognition of the possibility for inter stage conflict. That is, actions that we might take at one stage can affect our ability to achieve the objective of another stage.

The specific group of organisations assembled for any particular disaster is a function of location, the nature and severity of the disaster, availability of potential responder units, anticipated needs and prescribed procedures. When delivering aid in some regions of the world, cargo and personnel security is significant issue. In other regions logistics alternatives may be limited due to strained relationship between nations. And in others, some well-qualified organisations may not be permitted to enter country or traverse a specific country or area. Thus the relief group's membership could change from one disaster to another, adding an extra dimension of complication to the coordination.

One of the major challenges of Humanitarian Disaster Relief Supply Chain is that there are relatively few resources devoted in advance of disasters, rather, these resources flow in once a disaster has taken place. Consequently, disaster relief effort often depends upon donor organisations to provide goods and services needed for responding to the disaster. During the initial phases, when speed in getting these supplies to the disaster area is important food, water, shelter and medical supplies are usually the highest priority. As more specific needs are identified, supply chain managers can make more precise requests, however what they receive may be determined by what donors decide to provide.

All Humanitarian Disaster Relief Supply Chain are ultimately transient. That is, they exist for a given period of time and are intend to end when certain conditions are met. In nearly every cases of major disaster, response activities give rise to long-term recovery activities. That is after urgency of initial disaster response and the creation of conditions in

which the affected population is safe and critical infrastructure are restored, the focus turns to help the affected population regain a normal pattern of life.

Conclusion

When disasters occurs in today's interconnected world their social, economical and emotional effects are not limited to the areas directly affected, rather effects ripple through supply chain around the world. Disaster has always affected mankind and will probably continue as long as life exists on this planet. This exists all over the world and India is one of the most vulnerable regions. As a welfare state, it is the responsibility of the government to look after disaster management. Many a times it is observed that civil society organisations have actively involved themselves in disaster management process. The paper aims at highlighting the roles played by various agencies and the strengths and weaknesses experienced during the different stages of post-disaster phase. The flow of both financial and technical resources needs to be smoother to avoid overwhelming influxes during the relief phase of high-profile disasters, and to increase long-term, planned and coordinated risk reduction, capacity-building and preparedness. The paper contributes clear understanding of the supply chain agility. To increase quick response capability and the effectiveness of relief operations, any HRO needs careful planning and strong relations with its suppliers and donors.

The Humanitarian Relief Chain has the opportunity to increase its contribution to disaster relief, as well as to be recognised for this contribution by implementing initiatives in the areas of logistics, knowledge management, performance measurements, community and positioning. If this can be achieved, humanitarian logistics will have successfully made the transition to HRC management, where every partner in the chain is committed to the goal of creating and fostering value creation for the poorest, most marginalised and disaster-stricken population on earth. It is clear that many activities should be done to bring HROs closer to the private sector in terms of accountability, transparency of operations, coordination and collaboration, improved logistics and streamlined operations, HRC has been recognised as being of crucial importance for the effectiveness and efficiency of humanitarian operations. However, many humanitarian actors have not yet acknowledged this importance and continue to mainly concentrate their efforts on fund raising, communications or public relations.

The paper brought light into the important role of operations management in the improvement of disaster response. The paper also described the humanitarian supply chain and commercial supply chain, opportunities for the private and humanitarian sector work together towards social improvement. In disaster preparedness, the paper focussed on what organisation can do between disasters in order to improve their response when disaster strikes where as in disaster response, it focussed on co-ordination issues that emerge when multiple actors need to interact to respond to an emergency. The study also described the different ways in which actors can contribute to emergencies response operations. Agencies investing in information management can help facilitate the response by creating greater visibility of the needs and more accountability among the different actors involved.

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SAFETY PRACTICES IN EDUCATIONAL INSTITUTIONS IN INDIA: POLICY, PRACTICE AND NEED

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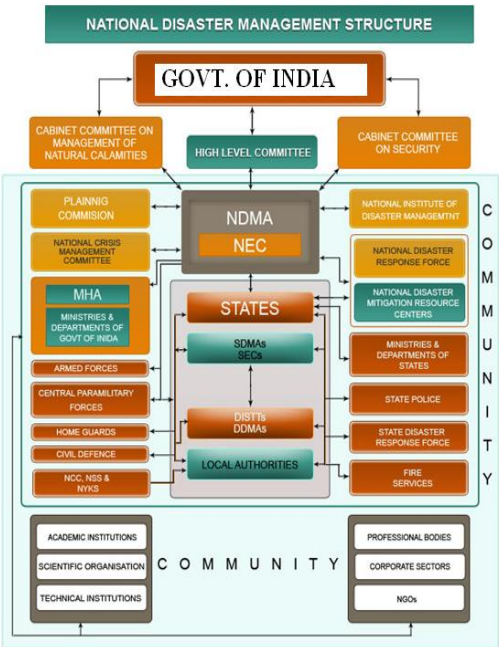
Introduction

Disaster Management is not new to India. The world's oldest famine relief code 1880 has been constituted in India after the major Famine of 1876-1878.Since then disaster response approach was reactive and the response for relief was being initiated only after the disaster. Eventually after every disaster, India has learnt the lessons and developed its programmes and plans to mitigate with the situation. In 1999, the ***High Powered Committee*** *was established to recommend and suggest for effective mitigation mechanisms. The committee's suggestions and recommendations proved to be a milestone, which has played an important role in shifting the entire approach of disaster management from reactive to proactive. Earlier our approach was to provide relief only after the calamity or emergency. This committee brings a paradigm shift in entire approach from relief based to prevention, preparation and mitigation based approach. Disaster management has emerged as a priority area for the country. For the first time* ***Tenth V year plan*** *(2002-2007) had a detailed chapter on Disaster Management.* ***Eleventh five year plan*** *(2007 -2012) gave emphasis on disaster prevention and advocated the need to put disaster management on the high priority agenda of the development planning. The* ***Gujarat Disaster Management Act 2003*** *was the first act, which was enacted in India, after the devastating Earthquake in Gujarat.* ***National Disaster Management Act 2005****, constitution of* ***National Disaster Management Authority*** *and shifting of Disaster Management from Ministry of Agriculture to Ministry of Home Affairs are the major outcomes of the reports of planning commissions.*

Disaster Management Act 2005

Disaster Management Act 2005 was the major step in the entire approach to deal with the disasters. NIDM has been assigned nodal responsibilities for human resource development, capacity building, training, research, documentation and policy advocacy in the field of disaster management[1]. Academic courses, of engineers and architects, included specialized subjects of disaster management. It was also introduced in school curricula in the 8th and 9th grades, to spread awareness and to inculcate the culture of safety among the students and through them to the family and community.

Following flowchart shows administrative arrangements for disaster management in India **(Source Nidm.gov.in**)



The National Institute for Disaster Management (NIDM) has been established as the apex-training institute for disaster management in India. NIDM coordinates the capacity building efforts of disaster management faculty in State Training Institutes and is also offering a few distance education programmes and online courses in disaster management in collaboration with the World Bank. The NIDM also hosts the **SAARC Centre for Disaster Management**.

Disaster Management Policy 2009

National policy on Disaster Management 2009 defines its vision statement in the policy document. "To build a safe and disaster resilient India by developing holistic, proactive, multi-disaster oriented and technology driven strategy through a culture of prevention, mitigation, preparedness and response" [2] The vulnerable condition of India and possible hazards are explained in its background note.

National Policy on Disaster Management came with constructive solutions and comprehensive plan of action in 2009. Policy advocates a holistic and integrated approach towards disaster management and suggests building partnerships with the local community and institutions. With the participatory approach, national policy aims to fulfil its objectives. Some of the major objectives are-

1. Promoting a culture of prevention, preparedness and resilience at all levels through knowledge, innovation and education
2. Encouraging mitigation measures based on technology, traditional wisdom and environmental sustainability.
3. Mainstreaming disaster management into the developmental planning process
4. Establishing institutional and techno-legal frameworks to create an enabling regulatory environment and a compliance regime
5. Ensuring efficient mechanism for identification, assessment and monitoring of disaster risks.
6. Understanding reconstruction as an opportunity to build disaster resilient structures and habitat for ensuring safer living

Policy document, under the sub-heading of Training, Simulation and Mock drills, emphasized the need of community based disaster preparedness. As mentioned in the policy, during any disaster, communities are always not only the first to be affected but the first responders also. The needs of the elderly, women, children, and differently able persons require special attention.

Safe schools and hospitals (with large capacity) and national monuments besides other critical lifeline buildings are regarded as a national priority. According to the policy, School buildings and hostels should be made with earthquake resilient features and equip them with appropriate fire safety measures.

Disaster management training in educational institutions is considered under the national priorities in the policy. National policy on disaster management under the subtitle of 10.6.1 mentioned the disaster management education in schools. It advocates the CBSE's move towards incorporating disaster management in curricula. The content suggested in the policy are- skill based training, psychological resilience and qualities of leadership. The role of NCC and Boy Scout expected to be included in schools and colleges for disaster management related work. Disaster education aims to develop a culture of safety, besides implementing school disaster management plans. Policy further made a provision for research, development and training in the area of disaster management.

National Policy on education, under the subtitle, essence and role of education, mentioned that education is essential for everyone. This is fundamental to overall development - spiritual and material.

Initiative of Government of Maharashtra. After the National policy on disaster management, India stepped ahead with the state policy on disaster management. Many states prepared their policy on disaster management. Maharashtra is also ready with the Maharashtra State Disaster Management Plan. After the Latur Earthquake in 1993, Maharashtra Earthquake Rehabilitation Project was launched with the support of World Bank, United Nations Development Programme as well as several other donor agencies. The multi dimensional disaster response was resulted due to this initiative. Strategies were developed in the state on mainly three aspects.

1. Communication network
2. State disaster management plan,
3. District disaster management plan

Maharashtra is the first State in India to prepare a comprehensive **State Disaster Management Plan** and to undertake risks assessment and vulnerability of various districts, Taluks and cluster of villages to earthquakes, floods and cyclones, epidemics, road accidents, and fire, and chemical and industrial disasters etc.

The Maharashtra Disaster Risk Management Program (MDRMP) has been accomplished its target on March 2013.After the feedback from all District Collectors, Divisional Disaster Management Officers and District Disaster Management Officers, Government has decided to extend the program for a period of two years. As on March 2013, the target accomplished specifically about School Disaster Management programme is as follows,

This programme is implemented in some selected schools run by the government. According to the District Disaster Management Officer, Nagpur, only government run schools were the target for this programme. The District Disaster Management Officer, Nagpur, provided the list of the School Disaster Management Team. (120 teams were prepared by the MDRP) The members of the team were not aware about any of such imitative and their membership on the team also. They do not have any training or orientation about the school safety initiative. It indicates that this programme is not yet reached to the stakeholders.

School safety is considered as a priority area for safety at national level, basically for two reasons, one: - children are vulnerable to cope with the disaster; they are the future of our nation. Providing safe environment to the children is our prime duty. Second: - school buildings are our lifeline buildings. These buildings are to be used for relief operations and treated as a relief camps for the victims and survivors after the disasters. The National Disaster Management Authority is preparing Comprehensive School safety programme. The programme is considered as guidelines for the schools. The National Institute of Disaster Management has issued guidelines and standard checklist to assess the existing structural and non-structural safety measures to provide safe school environment to the school community. (Annexure no. 05) Model of school disaster management plan is also presented in this document and school retrofitting is suggested for old buildings. School safety programme initiated by the NIDM and Ministry of Home Affairs, in the high risk zones incorporated a detailed plan of action in school safety document.

Central Board of Secondary Education was the first organisation in India who took very bold step to introduce disaster management in their frontline curriculum. The board issued a circular on 14 July 2003, and 26th July 2003 regarding the inclusion of disaster management course in the frontline curriculum. (Annexure 06) India has also participated in the global efforts by starting disaster management education from middle and high school. CBSE expressed while issuing the decision on inclusion of this subject the middle and high school students of this generation will make a revolution in community based disaster management. This is the only proven method of disaster management; and it is hoped that India would be world leader in disaster management.[3]Questionnaire related with safety arrangements has to be fulfilled at the time of affiliation and at the time of renewal.
The board has also brought out Comprehensive School Health Manuals in four volumes which deal with six themes and one of them is 'Being Responsible and Safe. The principal's conference was organised by the board on the theme on Safe School- Safe India. Out of this meet has emerged a checklist for different dimensions of safety which all schools can use as a ready reckoner to map their schools and plan ahead.

National Building Code provides standard codes for lifeline buildings, national guidelines on earthquake management are also discusses about the safe construction practices. There are discussions and documents on laboratory safety, health safety etc. India takes a lead in spreading awareness on disaster management to ensure disaster risk reduction. After nearly a decade, it is high time to take a realistic review of all this efforts and initiatives.
As far as school safety is concerned transportation is again a major issue related with safety of students. Incidences of accidents related with transportation and rate of casualties are high in India. School bus, Auto Rickshaw accidents are also in frequent news. Students attending to the school by various modes of transportation also meet with the accidents. To minimize the accidents among the school children school bus facility was introduced by the schools. The school bus safety policy was framed in due course to ensure the safety of students. **Maharashtra** was the first state to frame and to implement this policy.

Relief Centric Focus. In spite of all these acts it was experienced that the core focused area and approach of disaster mitigation was relief centric, considering to the increasing frequency of the disasters and loss to the human ,livestock, capital and material, it was felt necessary to change the approach of disaster mitigation. To minimize the loss, not only relief work but prevention and preparedness of the stakeholders are very important. In view of the above background the comprehensive disaster management programme is the need of the hour and has its own significance.

Situational analysis in Nagpur City. In Nagpur the situation is not very satisfactory in terms of all the above concerns and issues of DM. The local Self Government i.e. Nagpur Municipal Corporation, and other organizations have hardly any co-ordination and effective linkages. Urban – rural linkages are also non visible. Nagpur City has four major National level organisations working in the area related with disaster management. National Environmental Engineering and Research Institute, National Civil Defence College, National Fire Engineering College, Remote Sensing Centre, But all are working in isolation. They hardly come together and plan together for preparedness or education activities.
National Disaster Relief fund is created for relief and rehabilitation purpose. For preparedness and educational activities no special fund is created, hence departments are least interested to organize disaster management education programme. There is a need to create separate financial arrangements. Rashtrasant Tukdoji Maharaj Nagpur University along with other Universities in Maharashtra created the Disaster Management Fund. But its utilization is a major issue. Organisations of awareness programmes and training of volunteers are the important components which are completely neglected by the educational institutions.

Situational analysis and response from Schools. Writer's observations during the visits to the schools for the research study, discussions with respondents and visits to District Disaster Management Control Room can be summarized as follows –
i) **Building code and infrastructure:** Structure of the school building is discussed in the building code but majority of the schools were not aware about this code. The size and number of the stair cases, windows, doors, height of the class rooms, were not taken into consideration while constructing the school buildings. To develop the resilience of the building provisions for retrofitting is mentioned in the building code and earthquake safety guidelines. It was found that Most of the schools under this study have not taken cognizance of these provisions and retrofitting work was not undertaken. Only 6 percent of the schools made an effort to meet with the suggestions of retrofitting. While talking with the school management representatives it was found, that very few of the school management representatives were aware

about the National Building Code. Out of 25 Schools except 4 central schools, only two management representatives were aware about the National Building Code.

ii) **School safety norms:** In most of the schools safety norms are not given priority, violated due to ignorance and lack of knowledge. Writer observed that in most of the schools, exit roots were blocked by putting all the extra storage and broken furniture etc. Fire extinguishers are outdated and schools are not even aware about it. Science laboratories should be a major concern and all the precautions for safety must be taken care of, but only two schools are taking care about the safety in the science laboratory.

Furniture in the laboratory is very congested and not ample space is provided to escape in case of emergency. Aprons and mask are not used by the majority of the students. Science laboratories need to be situated near exit route, but in reality, they are situated in the last corner of the school and an exit is not easy. Explosive materials are kept within the reach of the students; safety manual is not displayed on the walls of the laboratory. Only four schools have displayed safety manuals on the walls of the laboratory while in other schools, it is kept in the cupboard.

iii) **School curriculum on DM:** Central Board of Secondary Education has issued circulars regarding introduction of disaster management in school in school curriculum. Respondents from management representatives were not aware about these circulars. However, they were aware about inclusion of disaster management subject in curriculum. Principals should take care of these circulars must reach to the management as far as safety arrangements are concerned. When asked about the questionnaire (quoted in chapter 4) provided by the board for introspection regarding school safety and safety provisions that are mentioned in the rule book for the schools, three management representatives were aware about these rules and the questionnaire. School management is the authority for policy making and without their consent; the school authority has limitations in implementing any of the policies and have restrictions in making infrastructural changes.

iv) **Training and awareness**: Training to the stakeholders is considered as a priority area in the National Policy, but schools have not taken it very seriously. The teachers, who have been deputed to attend training programmes on disaster management, are not teaching the subject and those who are teaching disaster management have not been deputed to attend training on disaster management. This gap influenced the sensitivity of teachers about disaster management programme and it is reflected in teaching the disaster management subject. The goal of introducing disaster management in school curriculum is not accomplished if the schools are responding just to fulfil the responsibility and follow the orders. Though the National Building Code and Town Planning bye laws exist these provisions are not strictly enforced. Monitoring and enforcement regarding earthquake resilience of the school buildings is not satisfactory.

v) **Networking and co-ordination:** The agencies, in the field of disaster management, are working in isolation and coordinating efforts are not visible. Disaster management is not at all an activity which can be carried out in isolation. (Even the school managements are not ready to work in collaboration with neighbourhood community.) Schools did not even know about the District Disaster Management Control Room. DDMO is not very much keen to visit to schools or other lifeline buildings as he has no powers to inspect them or to make these provisions mandatory. During the discussion, the respondents from school management were keen to know about the disaster management and express their wish to implement the school safety programme in their school. Majority were unaware about DDMO, as well as NGO's. But they were not found very keen to work in collaboration with neighbourhood community.

vi) **Transportation facility, School Bus Safety Policy and Norms**: School bus safety is the major area of concern and safety provisions. School bus safety policy is framed and should be implemented, but complete ignorance was found about the school bus safety policy amongst the Management, Principals and Teachers. The appearance of the school bus is very well drafted in this policy but right from the colour of school bus which needs to be yellow to the instructions, mirror position, signs on the school bus is mentioned in this policy, but in most of the school buses it was not observed. First aid box was there in the bus but not refilled since installation of the box. Lady conductor or assistant is the major issue in all the school buses. The schools have not found very keen regarding the school bus safety policy as most of the schools gave a contract to the private bus operators. So they were not ready to shoulder the responsibility to take safety precautions it should be taken by the bus operators as per most of the school management's opinion. Policy says in every school there should be a transportation committee. Principal as a chairperson, representative of Parent- Teacher Association, Traffic Inspector or Police inspector of that region or ward, etc should be a part of school transportation committee. Not in a single school this committee is formed and management representatives and principals were not very keen to form this committee.

As the Principals are the implementing authority, it is important to know the level of awareness of the principals about disaster management policy. It was assumed that higher the educational level higher the level of awareness about the National Disaster Management Policy. Writer tried to know the association between the level of awareness of the Principal's and their education. The responses given by the respondents are shown in the following table.

Principal of the schools are responsible to implement and execute the plans and programmes in the view of development and safety of the stakeholders. It is important to know in the analysis that how far the principals of the schools are aware about the National Policy on Disaster Management.

It was observed that around 50 percent of the principals were aware about the National policy on disaster management and rests were unaware. Their education and the level of awareness about the National Policy on Disaster Management is not up to the satisfactory level and the awareness needs to be created.

Teacher's awareness:

Teachers, teaching this subject are the source of inculcating values among children. If they were aware about the vision and objective behind the programme then only they can act appropriately to fulfil the nation's dream. It is important to

know that how far the subject teachers are aware about the National Policy on Disaster Management. The teacher who are teaching this subject have neither studied dm subject nor they were deputed to attend training in disaster management, this can be the reason about their low level of awareness about the national policy. Low level of awareness can affect their teaching, imparting training or organizing mock drills in the school.

Summary

The purpose of this paper is to take a brief review of the initiatives taken by the government in disaster management. Government took initiative in forming various committees, framing National Policy on Disaster Management, providing legal framework and making institutional arrangements for disaster management programme. The purpose of these initiatives is to cope with the disaster situations effectively.Writer tried to study the efforts taken by the Government of India, and States. The response from educational institutions in Nagpur district is analyzed in the context of integrating the national vision and mission of making disaster resilient India. Total 25 schools have been visited by the writer which is part of the study. The conclusions drawn are based upon the observations and discussions with the School Management. The pre-structured interview guide was prepared and the writer briefed the respondents (management representatives) about the purpose of the interview and interview guide. Writer also tried to study the awareness about national policy amongst the principals and teachers.

Government of India has put in remarkable efforts in the field of disaster management. It is reflected from its policy document, which declares that, the country will not make any appeal to foreign countries for monitory assistance after the disasters. The government will acknowledge the voluntary contribution in rendering their services in response, reliefs, and rehabilitation. It is also evident from the tsunami response Indian relief teams not only rendered their services in the country but they also have been deputed and contribute remarkably in response, rescue and rehabilitation work especially in Srilanka, Nepal, and Indonesia

The question remains that can India claim to be a disaster resilient country. When –

1 Communities are not prepared yet to respond to the disasters?
2 Disaster Management plans in some of the Sates are yet to be prepared,
3 Information and communication about disaster management is not yet reached to the people,
4 Lack of required trained personnel to deal with disaster management,
5 Our lifeline buildings are very much unsafe, Unsafe schools and hospitals are the reality

India's vision of disaster resilient country can be accomplished only when citizens of our country are aware, sensitized and trained in basic life saving skills. The CBSE has made an attempt to introduced disaster management education in their curriculum. The board has also brought out Comprehensive School Health Manuals in four volumes which deal with six themes and one of them is 'Being Responsible and Safe'[4]. These manuals have graded activities for various levels and must definitely be a Part of school curriculum. Now it's the responsibility of the schools to impart it to fulfil the mission. It was observed that the schools are not well equipped with the vision and mission. Safety concerns are not on the priority for many of the schools. Disaster management subject is treated as one more subject per se, which can be taught like other academic subjects to pass the examination. Writer observed that the school bus safety policy is completely overlooked by the school managements. Maharashtra is the first state to prepare, introduce and implement the school bus safety policy. A uniform pattern of school bus safety policy should be applicable to all the other states to ensure safe transportation of the students and reduce the rate of accident incidences. Inclusion of school bus safety policy in the National policy on Disaster Management will help the states to comply with the provisions of the policy.

Conclusions

Provision of punishment to overlook national priority areas must be incorporated in the Disaster Management Act. The scope of the Act needs to make broad and it is high time to redefine the definition of Disaster and Disaster Management. Preparedness activities are still overlooked and government officials and school authorities are not very serious about it. Many school management representatives and Principals asked the writer if there is no possibility of major disasters is predicted in the region then, why all these activities needs to conduct and occupy the schools busy hours. Finally it can be concluded that the periodical review of the Disaster Management Act 2005, Policies i.e. National policy on disaster management and school bus safety policy, building code and school dm plan is necessary to ensure the safety of the future generation.

UTTRAKHAND DISASTER: SUSTAINABILITY RELEGATED?

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Abstract

Uttarakhand (Uttaranchal) is a state in the northern part of India.Uttarakhand is mainly known for its serene beauty of the Himalayas and Char dham pilgrims. It is also seismically and ecologically very sensitive and delicate, even a minute changes can create a dangerous disaster.The multiday cloudburst from 14 June to 17 June 2013 centered on the state of Uttarakhand is a sorry tale about the anthropogenic stress on the environment. The eco fragile Uttarakhand has become a victim to human greed. The paper focuses on these anthropogenic effects on the natural environment which lead to this natural catastrophe. This tragedy is a classic example of the callowness towards sustainability prevailing in the Indian society.

Introduction

Uttarakhand is a state in the northern part of India, which is often referred as "Land of God". Uttarakhand is mainly known for its natural beauty of the Himalayas, the Bhabhar and the Terai (Figure1).Uttarakhand has a total area of 53,484 km² of which 93% is mountainous and 64% is covered by forest. It is located between 28° 43' – 31°27' N latitudes and 77°34' – 81° 02' E longitudes. Most part of the state is covered by high Himalayan peaks and glaciers. Two of India's largest rivers, the Ganges and the Yamuna, originate in the glaciers of Uttarakhand.Uttarakhand was formed on 9th November 2000 as the 27th State of India, when it was carved out of northern Uttar Pradesh, located at the foothills of the Himalayan mountain ranges [1]. The multiday cloudburst from 14th June to 17th June 2013 centered on the state of Uttarakhand.

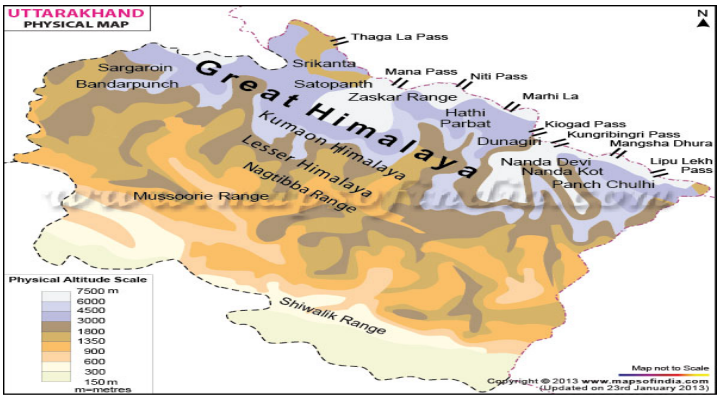


Figure1. Uttarakhand-Geographical Map

Dave Petley, Professor, Department of Geography at Durham University, United Kingdom, has reported in his blog about the Uttarakhand tragedy after analyzing the high resolution images (Figure 2) from ISRO's Geographic Information System (GIS) platform, Bhuvan. According to Petley, "a massive landslide (in the north-east region of the Kedar valley) and heavy rainfall (in the north-west of the Kedar valley) occurred at the same time and formed a small lake. Under normal circumstances, water would have flowed away. But a block formed by debris led to the accumulation of water. When extreme pressure caused a breach in the boundary of the lake, a large amount of water gushed out, forcing another rock to flow away. This created a new stream, in addition to the two streams that existed already. The amount of water, moraines and debris was high enough to increase the level of the biggest stream in the west, creating a new stream in between, and increased water level substantially in the eastern stream [2]. The debris from the landslide and water from the lake travelled down the slope, channeled into the glacier,and came down to Kedarnath town. High resolution images show that the large flow of the landslide eroded a amount of material. The amount and flow of debris was so high, that the boulders did not stop at Kedarnath and were carried to Rambara village and beyond. This estimation was made on the basis of rough parameters using images of the landslide retrieved from the Google Earth. Indian Space Research Organization (ISRO) is yet to come up with a detailed analysis but agrees with this possibility. Uttarakhand state faced an

unpredicted amount of rainfall from 16thJune to 17thJune 2013 which caused floods but anthropogenic effects on the natural environment compounded the scale of disaster. A sudden gush of water engulfed the centuries-old Kedarnath temple, and washed away everything in its vicinity and nearby area in a matter of minutes. The Chief Minister of Uttarakhand, Vijay Bahuguna, mentioned in a press conference that "I would call this natural disaster the 'Himalayan tsunami'. In one of the largest rescue operations in the world, the Army deployed 10,000 soldiers and 11 helicopters, the Navy sent 45 naval divers, and the Air force deployed 43 aircraft including 36 helicopters in Uttarakhand's flood-hit districts of Rudraprayag, Chamoli and Uttarakashi, to save and airlift the stranded pilgrims and local residents. Rescue operation ended on 2nd of July, 2013 after 17 days of enormous work with the evacuation of over 1, 10,000 people [5].

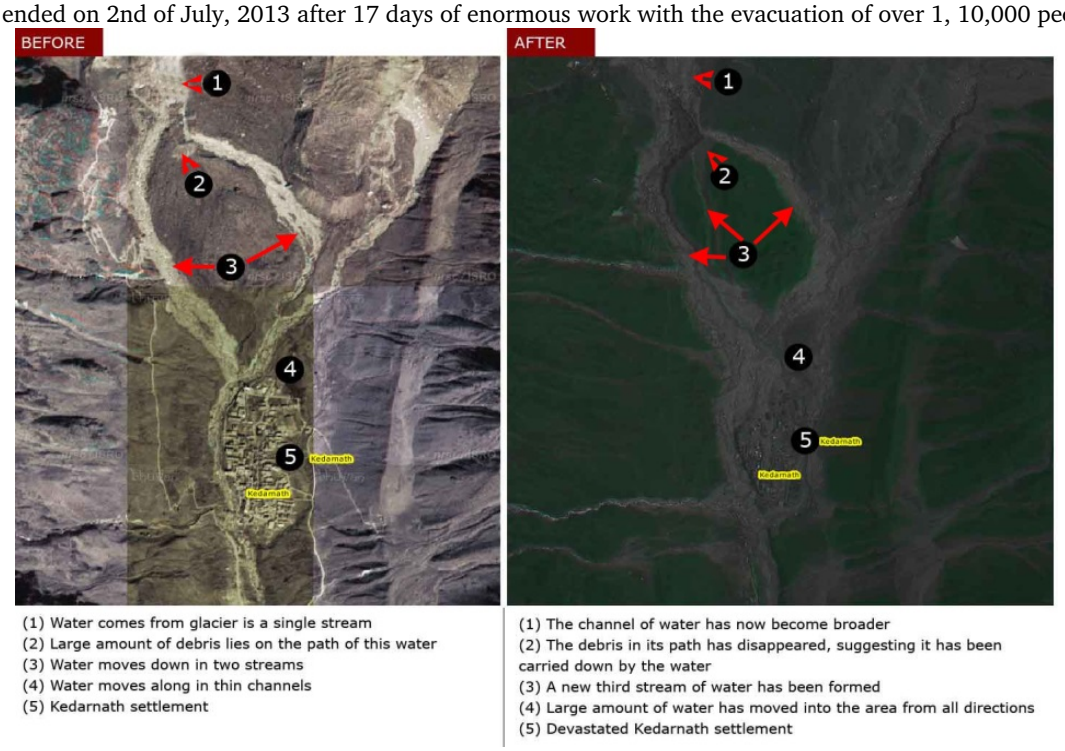


Figure2. High resolution images from ISRO's Geographic Information System (GIS) platform, Bhuvan [3.4]

Uttarakhand Disaster: Nature's Wrath

The unusual monsoon behavior of the monsoon

Uttarakhand received early rain in 2013, which was about 375 percent more than the benchmark rainfall. Heavy rains (64.5mm - 124.4mm) to very heavy rains (124.5mm – 244.4mm) lashed Uttrakhandon 16th and 17th June (Figure 3). According to IMD sources, the state had received > 400% rainfall during this period. This abnormally high amount of rain has been attributed to the fusion of westerlies with the monsoonal cloud system. This heavy precipitation resulted into the swelling of rivers, both in the upstream as well as downstream areas.

. The glaciers melt faster when water falls on ice, and the massive run-off began to engorge the river that causes heavier flow in the rivers. The Himalayas are the world's youngest mountain range; they are prone to erosion, landslides and seismic activity and brutal rainstorms lash the region. Therefore, this region is vulnerable and fragile. There is a clear link between climate change and changing rainfall patterns in the Himalayas. Scientists predict that rainfall in India will become more extreme. The Indian Institute of Tropical Meteorology in Pune, which has extensively studied the trends in monsoons in the country, finds that moderate rain events are on decline and intense rain events are increasing.

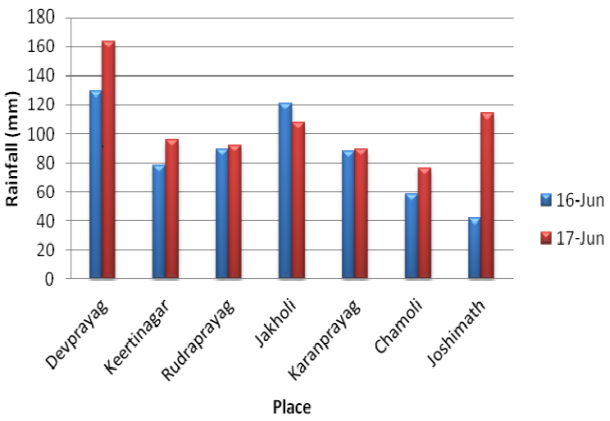
Uttarakhand Disaster: Man Made Calamity

Heavy rainfall has wreaked havoc on the region because of the fragile nature of the Himalayan range and poor soil stability in its steep slopes. But it is man-made factors that have compounded the scale of the disaster [7]. The three main reasons that can be identified in the context of Uttarakhand disaster are

Deforestation

The recorded forest area of the state is 34,461 km² which constitutes 64.79% of its geographical area.Deforestation aggravated floods in Uttarakhand. As per reports from the Union Ministry of Environment and Forests (MoEF), 44,868 ha of forest land have been diverted to non-forest use in Uttarakhand since 1980.The maximum forest area diverted for hydel projects , roads expansion and transmission lines has been in districts like Chamoli, Rudraprayag, Uttarkashi and Pithoragarh – the most badly affected by the floods Local environmentalists share their earthly wisdom and narrates wherever there has been intact forest, the damage from floods was much less than where it has been diverted to non-forest use. For instance, in Kedar Valley there have been very few landslidesin comparison to the Valley of Flowers, Nanda Devi Biosphere Reserve and regions around Joshimath where the villages have been devastated by landslides along with the cloudburst, as the native oak forests of the region have great soil-binding capacity and water retention power..The

forest eco -systems have been severely damaged due to large number of development projects. The total forest cover is shown in figure-4



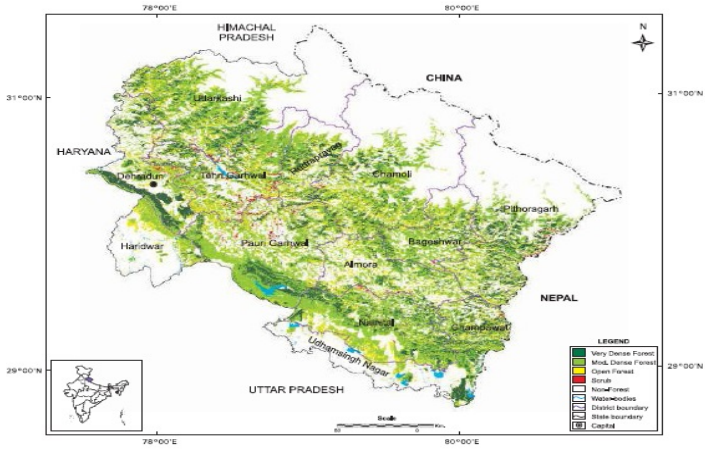


Fig 3. Rainfall Distribution in the visited affected areas (Source of data: IMD) **Fig-4.**Forest cover map of Uttarakhand

Disorganized construction work

The valleys of the Yamuna, the Ganga and the Alaknanda witness heavy traffic of tourists especially the Pilgrims who visit the holy places in the state annually. According to the Uttarakhand Tourism Department reports, in the past decade, the number of tourists has risen by 155 %. The state's population is 14 million. However last year alone, 28.4 million tourists visited the state between May and November. A survey done by the Indian Council for Research on International Economic Relations in 2006 states that there is an average of 102.5 hotels per million tourists in the state. Shortage of dwelling units has led to mushrooming of illegal structures, some right on the riverbanks.

Data with the Uttarakhand State Transport Department confirms this. In 2005-06, 83,000-odd vehicles were registered in the state. The figure rose to nearly 180,000 in 2012-13. Out of this, proportion of cars, jeeps and taxis, which are the most preferred means of transport for tourists landing in the state, increased the most. In 2005-06, 4,000 such vehicles were registered, which jumped to 40,000 in 2012-13. It is an established fact that there is a straight co-relation between tourism increase and higher incidence of landslides.

The dams of Uttrakhand

Most of the dams in Uttarakhand are constructed without proper planning and paying heed to their environmental impacts. Since long, these are considered as one of the reasons why floods turned so devastating in the state of Uttarakhand in 2009, 2010, 2012 and now in 2013. Srinagar Hydro Electric Project (SHEP) located in Tehri /PauriGarhwal district of Uttar Pradesh was a project envisaged by the then Uttar Pradesh State Electricity Board (UPSEB) on river Alaknanda, which was basically run-of-the-river scheme. The Ministry of Environment and Forest (MoEF) granted Environmental Clearance for the project to UPSEB vide its letter dated 03.05.1985 subject to certain safeguards. The project involved diversion of forest land to the extent of 338.38 hectares which was cleared by the Forest Department video proceeding No. 8-227/86-PC dated 15th April, 1987, in accordance with Section 2 of the Forest (Conservation) Act,1980. According to "Uttarakhand JalVidyut Nigam Limited" (UJVNL) website [8], atotal of 244 hydro-projects of different capacity developed by various state/private agencies are going on in the State. The poorly planned construction of hydro power projects causes reduced ecological flow of rivers.

The Uttarakhand Water Management and Regulatory Act, 2013

The Uttarakhand Water Management and Regulatory Act, 2013, came into being after Governor Aziz Qureshi gave his consent on April 4, much before the disaster struck the state on June.The act provides for establishment of a Water Management Regulatory Authority which will ensure judicious and equitable management of water resources in the state as well as its proper allocation and optimal utilisation. The proposed authority will also fix rates for water use for industrial, drinking, power, agriculture and other purposes and take cess on land benefited by flood protection and drainage works. The authority will have the power to take action against anyone found polluting the surface and ground water.

Eco Tourism

To meet the twin objectives of ecological sustainability by conserving biological diversity and ensuring needs of the forest dependent communities through sustainable harvesting of natural resources it is important to strengthen the existing egalitarian and traditional resource use practices among the local communities. The state has 12 National Parks and Wildlife Sanctuaries which covers 13.8 percent of the total area of the state. The various Parks and Sanctuaries are

locating at different altitudes varying from 800 mts to the high altitude Protected Areas at 5400 mts. Apart from these there are two Conservation Reserves– The Asan Barrage and Jhilmil Tal conservation Reserves, two World Heritage sites of the Nanda Devi Biosphere reserve and Valley of Flowers National Park. The state can boast of the first national park of the Indian Sub-continent-the Corbett National Park, with its major attractions being tiger, elephant and leopard. It also supports a wide variety of birds sharing its boundary with the Rajaji National Park. The high altitude National Park includes the Nandadevi National Park and the Valley of Flowers National Park which are regarded as unique creation of nature. They have become popular with trekkers and mountaineers. Almost 300 species of wild flowers bloom here and attracts nature lovers, botanists, ecologists, zoologists, ornithologists and trekkers. Other National Parks and Sanctuaries include BinogWildlifie Sanctuary near Mussoorie, GovindPashuVihar and National Park, Askot wildlife Sanctuary, Kedarnath Wildlife Sanctuary,Sonanadi Wildlife Sanctuary, Binsar WLS near almora, Gangotri National Park.Ecotourism and particularly Community-based tourism have the potential to be more suitable livelihood option and to make substantial positive contribution to management and conservation of forest and wildlife [9].

Major Challenge

At present the area is only accessible by air and establishing the narrow roads and the foot bridges will be crucial.Also barring the temple everything around remains in shambles which needs restoration work and as hinted by the Uttarakhand Chief Minister that it will take at least 2 years. Many of the men who come from the villages in these valleys (and elsewhere) to earn a major part of their families' annual income on the yatra routes during the tourist season are missing and are feared dead. The tragedy of the families dependent on religious tourism for much of their annual income is compounded by the fact that the yatra season is over for the year, and is unlikely to resume even next year given the destruction of the roads and bridges in the upper reaches. Several thousand Char Dham valley families will now fall below the poverty line. Homeless families desperately need durable mid-term shelters to protect them from both wild animals and the monsoon rains. It will take them at least two years to rebuild permanent homes. Since the 1999 earthquake in Chamoli, voluntary organizations in Uttarakhand have built almost 1,000 shelters that beneficiaries have used for years. Similar structures are also required to get schools reopened – a vital part of restoring confidence in children. Sturdy tents, however, may be the only option for the present in villages where access is cut off. There is no electricity in the affected areas. The vast majority of planned hydroelectric power projects (HEPs) are still to get off the ground. Many still hope for their missing relatives to turn up. Incidents of trafficking are high in this region. So it is imperative that the missing children are found. The warnings given by the meteorology department went unheeded. Green development must include specific actions to reduce the impact of disasters in the Himalayan states[10].

Preventive Measures and Recommendations

In past few decades, natural resources especially forest, soil and air have observed sharp decline in quality due to poor management and over exploitation.ICIMOD, an independent, inter-governmental non-profit knowledge organization which acquires, develops and exchanges knowledge related to different aspects of integrated mountain development, has expertise in handling calamities in the Himalayan region. It has worked successfully in establishing early warning systems in rural Nepal prone to flash-floods which could also help India.

Science and technology will play its inseparable part in the prevention of catastrophes like this. In the first place, mismanagement of science paved the way for the beginning of these unnatural events. In between the economics and science, the voice of the common man must be heard- loud and clear, after all it is for him that earth was created. Social issues arising out of these events have to be addressed positively. Environmental sustainability and through it economic and Social sustainability have to be practiced in India. A mass awakening followed by a responsible scientific and political community can play the ultimate role in prevention of these calamities.

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ASSESSMENT OF SURFACE WATER AND GROUNDWATER QUALITY NEAR HINDUSTAN NEWSPRINT LIMITED, VELLUR, KERALA, INDIA – RISK OF INDUSTRIAL POLLUTION

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Abstract

The effects of industrial-pollutant sources on the surface water and groundwater system were evaluated in an area around Hindustan Newsprint Limited (HNL), Vellur, Kerala, India. The quality of river water and groundwater in the region has been affected negatively due to the discharge of effluents on open land and river. Water samples from surface-water bodies, dug wells, and bore wells were analyzed for their major ion concentrations and heavy metal content. The results indicate that the effluents from HNL contributes high concentration of major ions such as Na^+, Ca^{2+}, HCO_3^-, Cl^- and SO_4^{2-} and heavy metals like Fe, Cr and Mn to the river water. The concentrations are comparatively higher in the samples collected near townships, which could be due to the anthropogenic activities in the river basin. Poor quality of water is observed close to the Vembanad Lake due to the intrusion of lake water. Groundwater samples from the area around the solid waste dumping site of HNL contain higher concentration of Na^+, Ca^{2+}, HCO_3^-, Cl^- & SO_4^{2-} and also high Fe, Cr and Mn content. This reveals the effect of pollutant waste in the water. It is therefore, advisable that authorities should take appropriate steps to check the contamination of both surface and groundwater.

Keywords
Muvattupuzha river, groundwater, waste, heavy metals

1. Introduction

Pollution of underground water and surface water system through anthropogenic activities is the major environmental problem faced all around the globe. Water quality is an index of health and is one of the areas of major concern to environmentalists, since industrialization, urbanization and modern agriculture practices have direct impact on the water resources. In the developing countries industrial waste water, sewage sludge and solid waste materials are currently being discharged into the environment indiscriminately. These materials enter surface water and subsurface aquifers, resulting in the pollution of irrigation and drinking water. The toxic metals in these effluents are concentrated in the biota, depending on the accumulation factors of the individual metals, thus constituting a potential source of direct intake to man (Tanji and Valoppl, 1989). Therefore, comprehensive water quality monitoring program is becoming a necessity in order to safeguard public health and to protect the valuable and vulnerable freshwater resources.

Demand of paper is steeply increasing and now it exceeds 330 million tons per annum all over the world (PPI 2005). Paper is a cellulose fiber obtained after digestion of wood using alkali/sulphide, which requires bleaching to impart whiteness to preparation of better quality paper. Bleaching process is one of the major water polluting sources in pulp and paper manufacturing industries. The bleaching agent conventionally used is elemental chlorine, which is reasonably cost-effective but it causes group of toxic compounds in effluents. The average wastewater generation is in the range of 150–250 m^3 t^{-1} of paper/pulp products. Chloroligno sulphonic acids, low chlorinated Poly Aromatic Hydrocarbons (PAH) and dioxin in the level of 3–120 pg l^{-1} tetrachloro dibenzo dioxin (TCDD) and 7–2,200 pg l^{-1} tetrachloro dibenzo furan (TCDF) have been identified by various researchers (Ranganathan et al. 2007) in paper industries effluents. Soluble organics of raw materials and chemicals used in the processes contribute higher Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand and Adsorable Organic Halides (AOX) and Total Dissolved Solids (TDS). The present study aims to assess the quality of both surface and groundwater from the area around Hindustan Newsprint Limited (HNL) to downstream side of Muvattupuzha river. The paper also discusses the effect of industrial effluents on the stream water and groundwater near HNL.

Study Area. The investigation was carried out in the western part of Kottayam district of Kerala state and lies in the area around Muvattupuzha river near HNL, Vellur (Fig.1). Study area includes part of the river stretch near HNL at Vellur to downstream for about 18 km to Vembanad estuary, where the river debouches. Muvattupuzha river, a major perennial river of Central Kerala, is formed by the confluence of three rivers (Kothamangalam Ar, Kaliyarpuzha and Thodupuzha Ar) near Muvattupuzha town, hence the name Muvattupuzha (meaning three rivers). The river and its tributaries discharge to Vembanad estuary, near Vaikom (Fig.1). It has a dendritic drainage pattern at the headstream portion.

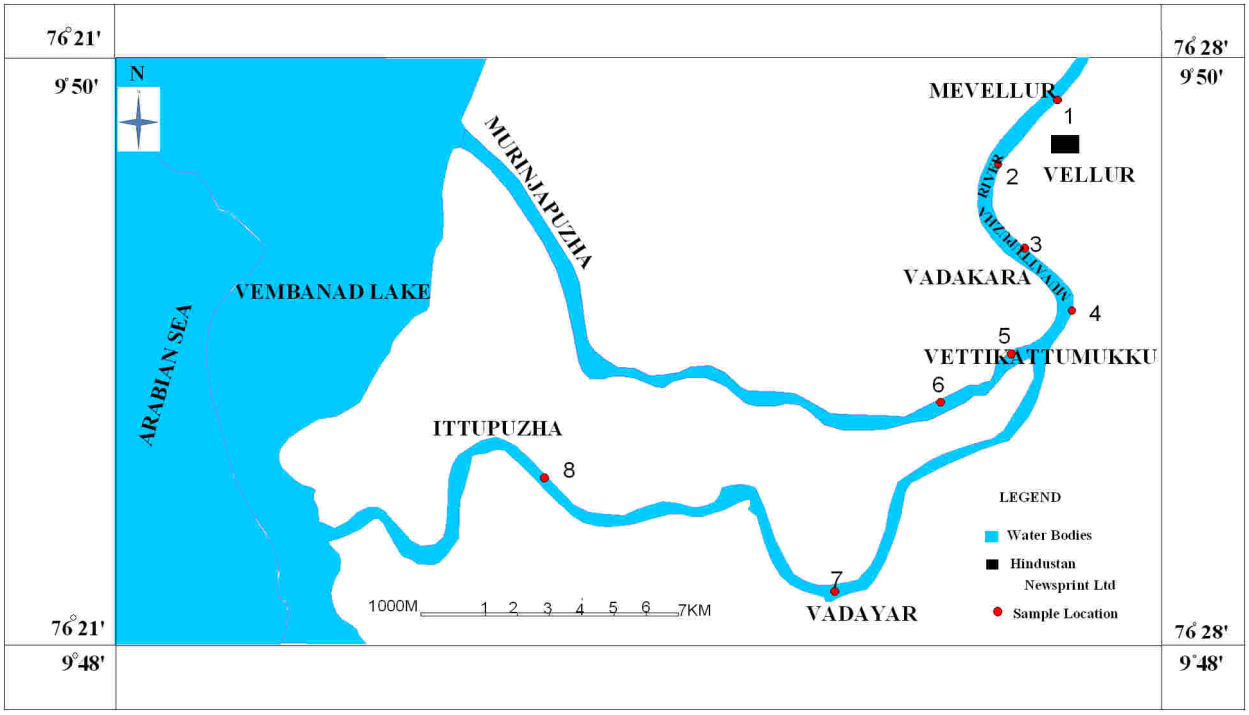

Figure 1. Location map of the study area.

Geologically, the present study area is covered by charnockite, laterite and alluvium and forms a part of the midland and coastal plain topography of Kerala. The midland region is covered by thick laterite. The upper part of charnockite is weathered into laterite. Riverine alluvium occurs along the banks of the river and its tributaries and near the estuary.

One of the major newsprint factories of India, Hindustan Newsprint Limited (HNL) is situated at the downstream of the Muvattupuzha river at Vellur. It produces standard newsprint conforming to international quality standard. Raw materials used in HNL are fibre rich woods, reeds, bamboos, eucalyptus and accasia. The major processing plants in this industry are chipper house, chemical pulp plant (CP), chemimechanical pulp plant (CMP), recovery plant and utility plant. The wood chips are digested with caustic soda, sodium hydroxide and sodium carbonate and undergoes bleaching by calcium hypochloride. Lignin in chips is removed as sodium lignate. The entire wastewater treatment could be conceived of as three faced viz. primary, secondary and tertiary treatments. Nutrient for aerobic bacteria in the form of urea and diammonium phosphate (DAP) are added at the entry of aeration lagoon. The treated effluent from HNL is being discharged into the river through pipes anchored at the riverbed extending to the middle of the Muvattupuzha river with dispersion arrangements. The solid waste from the factory is disposed of at the paddy field near Vellur.

2 Material and methods

In this study, both surface and groundwater samples have been collected for analysis. Sampling was conducted at part of the river stretch near HNL at Vellur to downstream for about 18 km to Vembanad estuary, where the river debouches. A total of 18 river water and 23 groundwater samples were collected. Two solid waste and wastewater samples were also collected from the aeration lagoon and solid waste dumping site of HNL. Physical and chemical analyses were done in the laboratory. Two main cations (Ca^{2+} and Mg^{2+}) and four major anions (CO_3^- , HCO_3^- , Cl^- and SO_4^{2-}) were analysed using standard methods(APHA, 1995) and cations such as Na^+ and K^+ and heavy metals (Fe, Mn, Cr, Zn, Cu and Pb) were determined using Atomic Absorption Spectroscopy (GBC 932 AA).

3 Results and discussion

The quality of water in the region has been affected negatively due to the discharge of effluents on open land and into the river. River water, generally contain some amount of dissolved solids which are derived from the weathered source rock in the drainage basin, but higher concentrations are noticed at certain locations reveal the anthropogenic activities. The chemical composition of groundwater is significantly affected either by soil chemistry or by dumping solid wastes.

Almost all the river water and groundwater samples are clear except the samples collected from the effluent discharge point in the Muvattupuzha river (Sample No.2, Fig.1) and groundwater samples from the waste dumping site of HNL. River water from the effluent discharge point is blackish in colour, turbid and possess unfavorable smell. The analytical results for major ions and heavy metals in waste and wastewater are shown in Tables 1 and 2. It can be seen that the concentration, especially those of major ions and heavy metal Fe is very high in the waste while wastewaters contain only smaller amounts of these elements. The concentration of Na^+, HCO_3^- and Cl^- is relatively more in waste waters compared to natural waters. Trace metals, except Fe occur in small amounts. The value of Fe is high in the waste (2%) and waste water (mean: 73.5 ppm) from the aeration lagoon. This shows that iron present is in soluble form in the

wastewater. The concentration of other trace metals is very low indicating that they are not released in the ionic form either due to incomplete decay of the waste or due to their fixation by the organic matter present in the waste.

Table 1: Chemical analysis data of waste from the solid waste dumping site of HNL (ppm)

Sample No:	Na	K	Ca	Mg	Fe	Mn	Zn	Pb	Cr	Cu
1	3908	1187	42100	19925	18253	467	143	8	55	40
2	3854	1190	29913	20102	23563	461	130	6	43	30

Table 2: Chemical analysis data of waste water from the aeration lagoon of HNL (ppm)

Sample No:	pH	EC (Micro siemen/cm)	Na	K	Ca	Mg	HCO_3	Cl	Fe	Mn	Zn	Pb	Cr	Cu
1	7.4	950	850	18	29	4	256	352	86	0.02	0.009	0.141	0.897	0.004
2	7.2	975	304	3	26	3	130	21	61	0.07	0.008	0.149	0.870	0.005

The analytical results of river water samples collected from Muvattupuzha river near HNL to downstream are presented in Table 3. The pH of the river water in the study area ranges from 7.2 to 7.8 with an average value of 7.4 indicating alkaline nature of water. Conductivity (EC) of river water was significantly different among sampling sites, varying from 60 to 8700 μS/cm. High conductivity at few sites (Sample No. 2, 11 & 12) indicates the mixing of industrial wastewater in river water. TDS further indicates the salinity behavior of river water. TDS content of river water ranges from 37 to 7421 ppm with a mean of 658 ppm. The water can be classified as non-saline as most of the samples have TDS less than 1000 ppm. However, some samples show TDS content more than 1000 ppm suggesting a brackish nature (Sample No. 11, 12 & 13). The samples showing higher TDS are confined along the area near the channels carrying industrial discharge and urban sewage disposals. Higher TDS in water system increases the chemical and biological oxygen demand and ultimately depletes the dissolved oxygen level in water. TDS in water originates from natural sources, sewage, urban runoff and industrial wastewater. The total hardness (TH) as $CaCO_3$, a measure of Ca^{2+} and Mg^{2+} ions varies from 10 to 1586 ppm, which classifies (Sawyer and McCarty, 1967) the waters as soft (0 to 75 ppm) to very hard (>300 ppm) categories. Among the major cations, Na^+ and Ca^{2+} are predominant with Na^+ ranging from 4 to 311 ppm and Ca^{2+} from 1 to 65 ppm. The Mg^{2+} concentration is ranging from 1 to 30 ppm and K^+ from 0.4 to 68 ppm. The concentrations of HCO_3^-, Cl^- and SO_4^- are ranging from 1 to 848 ppm, 7 to 37 ppm and 0.2 to 133 ppm respectively. The samples collected from the locations near the townships like Vadayar and Thalayolaparambu (Sample No. 12 & 13) also show higher values of Na^+, Ca^{2+}, HCO_3^-, Cl^- and SO_4^{2-} in water. Poor quality water is also noticed in the mouth of the river.

Table 3: Chemical analysis data of river water samples (ppm)

Sample No.	pH	EC (μS/cm)	TDS	TH	Na^+	K^+	Ca^{2+}	Mg^{2+}	HCO_3^-	Cl^-	SO_4^{2-}	Fe	Zn	Cu	Cr	Mn	Pb
1	7.49	60	40	14	6	1	3	3	7	1	21	1.01	0.08	0.17	0.17	0.05	0.004
2	7.71	950	48	17	6	1	5	1	9	1	25	35.52	0.01	0.003	0.13	0.45	0.0013
3	7.3	90	37	12	4	1	2	2	21	7	0.4	1.07	0.05	0.001	0.21	0.05	0.005
4	7.33	120	116	19	3	1	29	2	37	36	8	2.30	0.01	0.001	0.21	0.05	0.003
5	7.38	120	41	12	6	1	1	2	21	10	0.4	0.41	0.03	0.0002	0.22	0.02	0.001
6	7.68	130	57	19	6	1	2	2	34	12	0.4	0.89	0.16	0.0016	0.20	0.03	0.001
7	7.39	240	110	24	8	1	4	1	24	15	0.3	5.83	0.01	0.002	0.23	0.29	0.001
8	7.62	70	59	10	9	1	3	4	21	21	0.2	0.38	0.03	0.003	0.19	0.01	0.0001
9	7.83	210	88	17	21	0.4	2	4	24	32	5	1.81	0.01	0.001	0.17	0.06	0.0099
10	7.39	370	281	14	5	0.4	4	1	17	7	0.4	0.44	0.04	0.0019	0.18	0.03	0.001
11	6.4	3200	1330	291	15	1	2	3	24	29	5	0.54	0.05	0.024	0.38	0.03	0.0001
12	7.27	8700	7421	1066	61	2	2	2	24	33	4	0.58	0.03	0.003	0.24	0.06	0.003
13	7.11	360	1350	24	311	1	3	30	24	848	133	20.83	0.05	0.001	0.24	0.02	0.0019
14	7.34	450	405	1586	3	68	65	9	21	192	47	1.38	0.05	0.003	0.22	0.05	0.016
15	7.43	220	327	19	48	3	7	9	21	192	47	1.01	-	0.002	0.22	0.03	0.003
16	7.21	227	46	21	6	1	4	3	23	8	1	1.19	0.02	0.005	0.15	0.02	-
17	7.2	230	50	21	7	1	5	2	25	9	1	0.25	-	0.002	0.2	0.03	0.001
18	7.5	210	44	26	6	1	5	3	25	8	1	0.27	-	0.001	0.3	0.03	0.001

Besides, the major ions, the role of heavy metals in water samples attain great importance as their presence helps in understanding the human activities in the river basin. The heavy metal concentration of 18 river water samples is given in Table 3. The heavy metals such as Fe vary from 0.252 to 35.52 ppm, Zn from 0.01 to 0.16 ppm, Cu from 0.0002 to 0.17 ppm, Cr from 0.13 to 0.38 ppm, Mn from 0.01 to 0.45 ppm and Pb from 0.0001 to 0.016 ppm respectively. Average heavy metal concentration at different locations in the river water varied in the order of Fe>Cr>Mn>Zn>Cu>Pb. Sample number 2 has highest value of Fe (35.52 ppm), Cr (0.13 ppm) and Mn (0.45 ppm). This sample was collected from the effluent discharge point of HNL. Majority of the samples (56%) have Fe content exceeding the maximum permissible limit (MPL) of 1.0 mg/l prescribed by WHO (2004) and BIS (1991). Iron is the content of hemoglobin, so it is very necessary for all living organism but in excess promote iron bacteria in water. Only 5% of the groundwater samples have Mn content exceeding the MPL of 0.3 mg/l prescribed by BIS (1991). Cr is found exceeding the desirable limit of 0.05 mg/l in all the samples of the study area. The concentration of heavy metals such as Zn, Pb and Cu are found below the permissible limit for drinking water standard as prescribed by the Indian Standard Institution (BIS, 1991).

The chemistry of groundwater samples collected from the area around HNL and downstream of Muvattupuzha river are displayed in Table 4. Groundwater samples collected from the area near to the solid waste dumping site of HNL are turbid, yellowish in colour and also have an unfavourable smell. pH of groundwater indicate that almost all the samples are alkaline in nature, except one sample (pH=2.8) collected from the area near solid waste dumping site. The concentrations of major ions in the groundwater samples display a wide range for Na^+ (5-367 ppm), K^+ (0.3-17 ppm), Ca^{2+} (2-111 ppm), Mg^{2+} (1-25 ppm), HCO_3^- (41-436 ppm) , Cl^- (6-343 ppm) and SO_4^{2-} (0.4-208 ppm). Samples 7, 8, 10 and 11 show higher concentrations of Na^+, HCO_3^-, Cl^- and SO_4^{2-}. Elevated ionic concentrations in the water can only be attributed to contamination and mixing of foreign waters with natural groundwater. Cation and anion chemistry indicates that the order of dominance as Na>Ca>Mg>K and HCO_3 > Cl>SO_4 respectively. The concentration of TDS ranged from 40 to 1151 mg/l with a mean of 280 mg/l. As per the TDS classification (Freeze and Cherry, 1979), all the groundwater samples belong to fresh (TDS<1,000) water type except one sample (Sample No.8) falling under the brackish (TDS >1,000) water category. The total hardness (TH) as $CaCO_3$ in the groundwater samples ranges from 7 - 334 mg/l (Table 4). In the study area, all the groundwater samples show TH lying below the permissible limit of 600 mg/l as prescribed by BIS (1991). The classification of groundwater based on TH (Sawyer and McCarty, 1967) shows that 52% the groundwater samples fall in the category of soft water whereas 39% of the samples fall in the category of moderate hard and rest (9%) samples belong to hard and very hard water. Hard water (150-300) is found near to the Vembanad estuary. Thus, low TDS, Cl and SO_4 content in groundwater rendering it suitable for drinking purpose as per the standards prescribed by the Bureau of Indian Standards (BIS, 1991).

Table 4: Chemical analysis data of groundwater samples (ppm)

Sample No.	pH	EC (μS/cm)	TDS	TH	Na^+	K^+	Ca^{2+}	Mg^{2+}	HCO_3^-	Cl^-	SO_4^{2-}	Fe	Zn	Cu	Cr	Mn	Pb
1	7.1	200	115	95	10	1	6	20	62	15	0.5	0.06	0.001	0.01	0.22	0.001	0.006
2	6.7	240	129	55	5	0.4	10	8	96	9	0.4	0.33	0.05	0.001	0.20	0.001	0.005
3	7.9	150	69	26	6	0.3	4	4	41	13	0.4	0.07	0.05	0.008	0.24	0.001	0.0007
4	7	210	83	36	7	2	7	5	48	17	0.3	0.83	0.04	0.008	0.22	0.003	0.003
5	7	230	102	41	5	1	10	4	68	14	0.3	0.37	0.01	0.001	0.22	-	0.001
6	7.1	220	73	33	5	1	8	4	38	17	0.4	0.03	0.007	0.009	0.22	0.0007	0.003
7	2.8	1500	536	105	162	3	21	13	-	218	119	0.62	0.36	0.003	0.22	-	0.0009
8	8.14	2200	1151	76	367	3	22	5	396	343	15	22.4	0.06	0.007	0.25	0.001	-
9	7.25	240	121	36	8	1	11	2	85	14	0.3	5.89	0.47	0.002	0.20	0.08	0.004
10	7.4	640	278	55	40	6	17	3	92	78	45	0.98	0.10	0.002	0.20	0.07	0.003
11	7.65	470	150	45	35	2	9	6	21	60	17	1.04	0.03	0.002	0.20	0.005	-
12	7	310	244	43	20	1	14	2	109	21	77	26.59	0.03	0.001	0.24	0.008	0.008
13	7.9	60	40	7	6	0.5	2	1	24	6	0.4	0.52	0.24	0.0007	0.16	0.003	0.006
14	7.45	870	305	98	60	2	18	13	130	119	14	0.83	0.14	0.003	0.21	0.008	-
15	7.17	800	328	74	80	12	16	8	205	68	32	1.76	0.005	0.005	0.23	0.003	-
16	7.49	470	261	86	11	4	23	7	198	18	0.4	0.22	0.06	0.002	0.18	0.008	0.0003
17	7.75	540	201	129	67	3	31	13	34	227	208	0.74	0.34	0.002	0.21	0.002	0.002
18	7.65	670	170	114	20	17	4	25	80	55	0.4	0.02	0.30	0.001	0.20	0.002	-
19	7.5	680	663	76	12	1	20	6	113	17	0.5	14.06	0.19	-	0.18	0.023	0.0008
20	7.7	440	165	334	48	7	111	13	436	47	107	0.11	0.03	0.0079	0.20	0.001	0.0001
21	7.23	470	264	67	12	1	13	8	113	17	1	0.04	0.21	0.0014	0.20	0.005	-
22	7.3	460	409	88	63	5	13	13	130	39	1	0.11	0.06	0.001	0.18	0.0008	-
23	7.41	350	583	152	69	4	34	13	226	621	1	1.04	0.01		0.91	0.008	0.0001

Trace elements are generally present in small concentration in natural water system. Their occurrence in groundwater can be due to natural sources such as dissolution of naturally occurring minerals containing trace elements in the soil zone or the aquifer material or to human activities such as improper disposal of industrial wastes. Selected trace metals such as Fe, Zn, Cu, Cr, Mn and Pb were studied in the groundwater samples of the study area (Table 4). The heavy metals such as Fe vary from 0.02 to 26.59 ppm, Zn from 0.001 to 0.36 ppm, Cu from 0.0007 to 0.008 ppm, Cr from 18-0.91 ppm, Mn from 0.0007 to 0.08 ppm and Pb from 0.0001 to 0.008 ppm respectively. The average abundance of trace elements are in the order of Fe>Cr>Zn>Mn>Cu>Pb respectively. 30% of the groundwater samples have Fe content above the maximum permissible limit (MPL) of 1.0 mg/l prescribed by WHO (2004) and BIS (1991). Iron was found to be higher in locations like 8, 12, 19 and 15 which recorded higher TDS. Heavier amount of iron can cause serious health problems or premature death. Toxicity of iron may damage the liver, heart, and endocrine glands, leading to debilitating and life-threatening problems such as diabetes, heart failure, and poor growth (Nduka and Orisakwe, 2010). Only 13% of the groundwater samples have Mn content exceeding the MPL of 0.3 mg/l prescribed by BIS (1991). Manganese in water can promote the growth of iron bacteria. Chromium is found to occur above the desirable limit of 0.05 mg/l in all the samples of the area. The concentration of heavy metals such as Zn, Pb and Cu are found below the permissible limit for drinking water standard as prescribed by BIS (1991). Thus the water chemistry at low lying areas of solid waste dumping site shows the effect of the waste in the water.

The consumption of waters for domestic purposes around the industrial area cause health hazards to the local residents. Impacts of contamination of heavy metals on animal and human health include muscular weakness, lower score in psychometric tests and symptoms of peripheral neuropathy. Breathing problems have been noted in occupationally exposed populations. Some heavy metals are also considered as human carcinogens. Environmental exposure to these

heavy metals over an extended period of time may lead to adverse effects, and intensive efforts are needed to explore this relationship as well as contain the levels.

4 Conclusion

The present study assesses the water quality of both surface and groundwater samples near HNL, Vellur to downstream of Muvattupuzha river and also waste & waste water from the aeration lagoon of HNL. The results indicate that the effluents from HNL contributes high concentration of major ions such as Na^+, Ca^{2+}, HCO_3^-, Cl^- and SO_4^{2-} and heavy metals like Fe, Cr and Mn to the river water. The analytical results also reveal that the concentrations are comparatively higher in the samples collected near townships, which could be due to the anthropogenic activities in the river basin. Poor quality of water is observed close to the Vembanad Lake due to the intrusion of lake water. Groundwater samples from the area around the solid waste dumping site of HNL contain higher concentration of Na^+, Ca^{2+}, HCO_3^-, Cl^- & SO_4^{2-} and also high Fe, Cr and Mn content. This reveals the impact of pollutant waste in the water. It is therefore, advisable that authorities should take appropriate steps to check the contamination of both surface and groundwater. An overall review and evaluation of the industrial belts with respect to the disposal of waste effluents should be given the highest priority; otherwise, these areas would be left indefinitely as polluted groundwater basins.

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MAPPING OF FLUORIDE ENDEMIC AREAS AND ASSESSMENT OF FLUORIDE EXPOSURE: A CASE STUDY OF THE RISK OF FLUOROSIS IN A SEMI ARID TERRRAIN OF NW INDIA

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Abstract

Prevalence of fluorosis is mainly due to the consumption of more fluoride through drinking water. It is necessary to identify the fluoride endemic areas to adopt remedial measures for the people under the risk of fluorosis. The objectives of this study were to identify the exact location of fluoride endemic areas in different blocks of Jaipur district, Rajasthan and to estimate fluoride exposure level through drinking water for different age groups. A total of 66 groundwater samples was collected during the pre-monsoon period and analysed, which gave a concentration of fluoride in water in the range of 0.4 to 9.3 mgl^{-1}. The possible sources of fluoride are chemical weathering and leaching of fluorine-bearing minerals present in rocks under the alkaline environment in arid to semi-arid conditions. High pH as well as alkalinity and low levels of Ca, Mg and total hardness suggest favourable chemical conditions for the fluoride dissolution process. 62% of the locations fall in moderate to high fluoride endemic zones (Category-III & IV) where F^- concentration above the maximum permissible limit of 1.5 mg/l as per the guidelines of WHO and Bureau of Indian Standards has been noticed. High incidence to dental and skeletal fluorosis has been recorded in such areas and the water is found unsuitable for drinking purposes. The exposure dose level of fluoride for infants, children and adults were estimated to be 0.03 - 0.78, 0.03 - 0.70 and 0.02 - 0.40 mg kg^{-1}day^{-1} respectively. Consumption of maximum fluoride exposure levels of 0.78 mg kg^{-1}day^{-1} for infants, 0.70 mg kg^{-1}day^{-1} for children and 0.40 mg kg^{-1}day^{-1} for adults were found among the respective age group people residing in high fluoride endemic area of the study area. The fluoride exposure dose level decreases with increase of age group from infants to adults. As compared with adequate intake level of fluoride of 0.01 mg kg^{-1}day^{-1} for infants and 0.05 mg kg^{-1}day^{-1} for other age groups, the health risk due to excess fluoride intake to the people of the study area has become evident. The statistical tools indicate that the water fluoride level is a primary pathway for the exposure of fluoride dose. Mapping of high fluorotic areas is useful to plan meticulously to bring safe drinking water from low fluoride areas. An optimal fluoride content in drinking water of 0.67 mgl^{-1} has been suggested and the people are advised to consume drinking water with optimal fluoride to avoid further fluorosis risks.

Keywords
Fluorosis, Fluoride endemic area, Exposure dose, Rajasthan.

1 Introduction

Fluoride in groundwater evokes considerable interest due to its unique character as regards to its impact on physiological system of living beings. Fluoride is an essential oligo-element, beneficial for the development of bone and teeth (Messaitfa 2008). Allowable fluoride concentrations in potable waters as per Bureau of Indian Standards (BIS, 2003) and WHO-recommended guidelines (WHO, 2004) are 1.5 mg/l. These guidelines vary depending on the climate and the total fluoride intake from other sources, since the absorption of fluoride by body fluids depends on temperature. Concentrations higher than this can cause dental fluorosis, mild skeletal fluorosis, and crippling skeletal fluorosis (WHO 2004). Fluorosis is a slow, progressive, crippling malady, which affects every organ, tissue and cell in the body and results in health complaints having overlapping manifestations with several other diseases. Fluorosis is characterized by mottling of teeth enamel, abnormal calcification of spines, joints and ligaments. Dental fluorosis is characterized by lusterless, opaque white patches in the enamel, which may become stained yellow to dark brown, and in severe forms cause marked pitting and brittleness of teeth. Skeletal fluorosis occurs when fluoride deposits in the joint of neck, knee, and shoulder bones and makes it difficult to move or walk. Fluoride is present in water as almost completely dissociated fluoride ion from the parent compounds occurring either naturally or in the form of added salts. Bioavailability of soluble fluoride is largely controlled by acidity in the stomach. Thus, the systemic fluoride absorption from water through the gastrointestinal tract into bloodstream is nearly 100 % by the process of simple diffusion without any intervention of overall water quality (Maguire et al. 2005). Hence, water fluoride level is the primary reason for the cause of fluorosis. Fluorosis at more severe stage causes bilateral lameness and stiffness of gait. Similarly, higher doses of fluoride induce osteoporosis and collapsed vertebrae (Sharma 2003). Reduced intelligence in children is associated with exposure to high fluoride levels in food and drinking water (Xiang et al., 2003). Fluoride at elevated concentration also causes an increase in the concentration of thyroid stimulating hormone resulting in hypothyroidism.

A variety of standards and guidelines for exposure to fluoride have been recommended to aid in the protection against dental caries and/or the development of adverse health effects. The National Research Council has estimated "adequate and safe" daily fluoride intakes to be 0.1–0.5 mg for infants less than 6 months of age, 0.2–1.0 mg for infants between 6 and 12 months, 0.5–1.0 mg for children between the ages of 1 and 3 years, 1.0–2.5 mg for 4- to 6-year-old children, 1.5–2.5 mg for children from 7 years to adulthood and 1.5–4.0 mg for adults (National Research Council, NRC 2001). The global prevalence of fluorosis is reported to be about 32%. The prevalence of fluorosis in man is reported from 22 states of India, affecting more than 40 million people (Susheela 1999). Prevalence of fluorosis disease is rampant among majority of rural habitations of the Jaipur district, Rajasthan where groundwater is the only source for drinking and irrigation requirements.

Geohydrology of the study area. The study area (Fig.1) comprising of Dudu, Phagi and Sambhar blocks falls in Jaipur district, which occupies to the eastern part of Rajasthan state. It covers an area of 4,263 km^2 and is located in between $26^0$25': $27^0$30' north latitude and $74^0$55': $75^0$45' east longitude. The area experiences semi-arid to arid climate characterized by a hot dry summer and pleasant winter. The summer temperature generally shoots up to 41°C and the minimum temperature drops to 1.0°C in winter. The average annual rainfall in this area is about 509 mm. The total annual potential-evapotranspiration (PE) is 1745 mm, which results in water scarcity. Physiographically, the major portion of the study area is occupied by open undulating plains covered by Quaternary alluvial sand. Few ephemeral rivers like Bandi and Mendha and their tributaries drain through the study area (Fig.1). The Sambhar salt lake is situated in the north western portion of the study area bordering Dudu and Sambhar blocks.

Geologically, the area is underlain by Archaean gneisses and schists of Bhilwara Super Group, which cover major portions of Dudu block and south of Sambhar block of Jaipur district. These oldest rock types are overlained by schists, quartzites and conglomerates belonging to Proterozoic Delhi Super Group along with granite and pegmatite intrusives of Post Delhi age. Quaternary fluvial and aeolian deposits have overlain hard rocks in major parts of the study area. The alluvium (Older and Younger) consisting of sand, clay, silt and kankar occupies major portions of Sambhar and Phagi blocks of Jaipur district.

Unconsolidated alluvial as well as aeolion formations and hard rocks form the main water bearing formations of the study area. Gneisses and schists of Bhilwara Supergroup, quartzites of Delhi Supergroup and Post-Delhi intrusives such as granite and pegmatite form major hard rock aquifers in the study area. Groundwater occurs under water table conditions in the low hydraulic conductivity weathered zone and under semi-confined to confined conditions in the high hydraulic conductivity fractured zone. The weathered mantle of hard rock yields good discharge of water. Quaternary alluvium form good aquifers in parts of Jaipur district. The alluvium is rich in illite, montmorillonite and mica group of minerals. Rainfall is the main recharge source for groundwater and the water used for land use activities, domestic and agriculture purposes form the indirect additional recharge source of groundwater. Utilization of groundwater is through dug wells, hand pumps, dug cum bore wells and tube wells. The water table varies from 290 m (amsl, above mean sea level) in the southeast to 400 m (amsl) in the north. The water table is aligned to the general topography of the area and the flow direction, in general, is towards southeast and south of the study area. The premonsoon (May) depth to water level is 3.6 - 51.9 m b.g.l. and post-monsoon (November) it is 1–50 m b.g.l., indicating a fluctuation of 2.6 – 1.94 m. Dudu and Phagi blocks have been categorised as 'Critical' blocks, whereas the Sambhar block is categorised as 'Over-exploited' block where the stage of ground water development is around 268%.

2 Materials and methods

Groundwater sampling and analysis. A total of 66 ground water samples from shallow dug wells, dug cum bore wells, hand pumps and deep tube wells were collected from various locations from the entire area during pre-monsoon period (May, 2005). They were analyzed for major ion chemistry, employing the standard analytical procedures (APHA, 1998). Fluoride (F^-) concentration was estimated using UV/VIS spectrophotometer. The ECR (Eriochrome Cyanine R) method was used for fluoride determination.

3 Results and discussion

Spatial distribution of Fluoride and incidence of Fluorosis. The possible sources of fluoride are chemical weathering and leaching of fluorine-bearing minerals present in hard rocks and alluvial formations under the alkaline environment in arid to semiarid conditions. In the study area, the chief sources of F^- in ground waters are F^--bearing minerals (fluorite, fluorapatite, sepiolite and palygorskite) as well as F^- replacing OH^- in the ferromagnesium silicates (micas and amphiboles), and soil consisting of clay minerals (apophyllite, phlogophite, illite, hydromuscovite) (Vikas et al. 2012). As compared to alluvial formations, fluoride enrichment in groundwater is higher in hard rock areas with the granite gneissic terrain show higher values when compared to those in the schist. The groundwater of the shallow aquifers (soil-clay complex weathered zone) of the area has a higher concentration of fluoride than the deep (fractured hard rock) aquifer, which can be attributed to the low vertical permeability of the shallow aquifer inhibiting easy entry of F^- to deeper groundwater (Vikas et al. 2012). In the study area, the fluoride concentration varied from 0.4 to 9.3 mgl^{-1} with a mean value of 2.71 mgl^{-1} and standard deviation of 2.19 mgl^{-1}. The fluoride concentration in groundwater varied greatly in different villages of block. The minimum F^- concentration (0.35 mgl^{-1}) was recorded for Dosra village in Phagi block while maximum concentration (i.e. 9.3 mgl^{-1}) was recorded from village Pratapura in Sambhar block. Occurrence of fluoride is very sporadic and marked differences in concentrations occur even at very short distances and hence the blocks show variable fluoride concentrations. The spatial distribution of fluoride in the groundwater (Fig.2) of the study area

was attempted to identify regions and locations of widespread fluorosis. It can be observed from the spatial distribution map of fluoride that the concentration of the fluoride is high (i.e., above 3.0 mgl^{-1}) in major portions of the study area. It is confined to the north, west, south and partly towards the east of Phagi block. High F^- concentration values are noticed to the east, northwest as well as central parts of Dudu block and also towards the north, northwest and east of Sambhar block (Fig.2). F^- values ranging between 1.5 mgl^{-1} and 3.0 mgl^{-1} spread major portions of Dudu block and also towards the northeast, northwest and southern part of Phagi block. Similar concentrations are also noticed to the southwest, south and northeast part of Sambhar block. The fluoride concentration below the maximum permissible limit (MPL) of 1.5 mgl^{-1} is seen towards the southeast, southwest as well as northeast of Phagi block and southwest, northeast as well as central parts of Sambhar block. Similar concentrations are also noticed towards the northwest of Dudu block bordering Sambhar lake (Fig.2). The low F^- values noticed in the region adjoining Sambhar lake could be due to the effect of dilution of groundwater by natural recharge process of lake water.

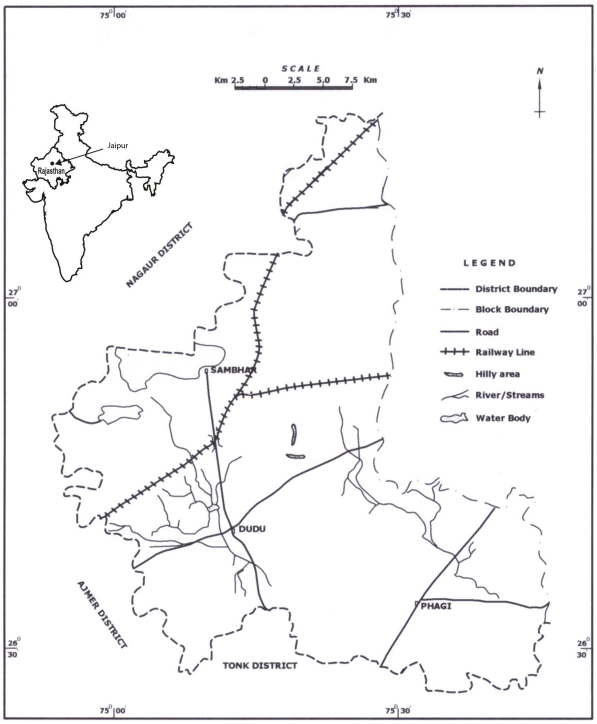

Fig 1. Location map of the study area.

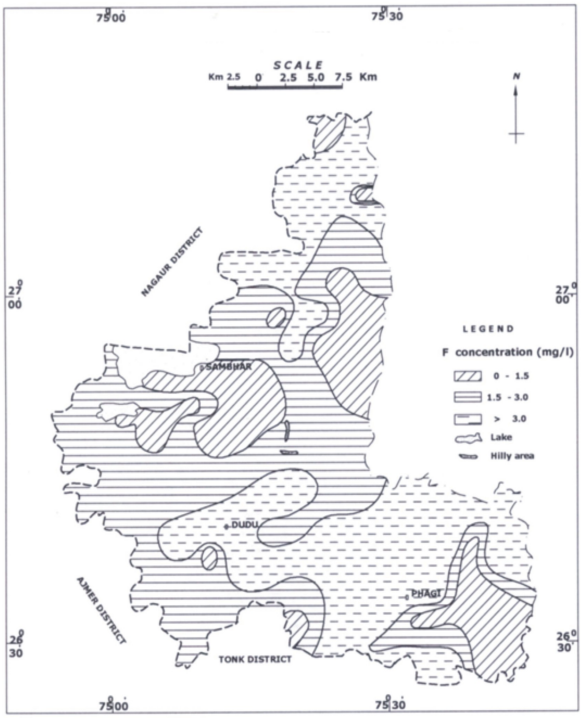

Fig 2. Spatial distribution map of fluoride in the study area.

The values of pH for the majority of the high-fluoride groundwater samples of the study area varied from 7.3–8.5 (mean = 8.1), indicating that the high-fluoride groundwater is commonly alkaline water. In general, relatively high pH conditions have a tendency to displace fluoride ions from the mineral surface into the solution. At higher pH conditions, ionic exchange occurs between F^- and OH^- ions (illite, mica and amphiboles), thus resulting in the increase of F^- concentration in groundwater. The sodium-bicarbonate type water in a weathered formation allows precipitation of $CaCO_3$ from Ca^{2+} and CO_3^{2-} ions with a reduction in TH (in terms of Ca and Mg ions) and thus accelerates the dissolution of CaF_2 and thereby releases fluoride into groundwater. It has been observed that fluoride gives positive correlation with pH (r = 0.6), HCO_3 (r = 0.3) as well as alkalinity (r = 0.2) and negative correlation with Ca, Mg, Cl and TH (r = - 0.4) in the groundwater samples of the study area. These correlations, coupled with high Na and HCO_3 content, reveal that high alkalinity and weathering form one of the sources of fluoride in groundwater of the study area. Since the study area lies in arid to semiarid environment, the very high summer temperature with low rainfall (481 mm), high evapotranspiration (PE = 1745 mm) and insignificant natural recharge thus favours salinisation of groundwater resulting in the precipitation of carbonates, which in turn reduces the calcium content and further promotes the dissolution of fluorite. The positive value of saturation index (SI) with respect to calcite (0.27–1.71), dolomite (0.41–3.87) and aragonite (0.12–1.56) in the groundwater of the study area suggests a precipitation of calcite and dolomite caused by higher rate of evapotranspiration prevailed in this semi-arid environment facilitating absorption of more F^- in to the groundwater. The SI of fluorite varied from –2.05 to 0.89 with an average of –0.69. Water samples are unsaturated with respect to fluorite, indicating the possibility of further increase in fluoride in groundwater.

Groundwater samples of the study area have been grouped into three different categories according to the F^- concentration and associated risk to human population. Groundwater samples with fluoride concentration below 1.0 mgl^{-1} are considered normal and can be represented as low fluoride zones (category-I). The present study reveals that 10 villages (about 15% of the total surveyed locations) in the study area fall in category-I. Bureau of Indian Standards (BIS 2003) prescribe a fluoride concentration of 1.0 mgl^{-1} as the maximum desirable limit (MDL) in drinking water. So the possibility of fluorosis in these villages is less because this concentration of fluoride is essential for the calcification of

dental enamel especially for children below 10-year age. Fluoride, once incorporated into the teeth, reduces the solubility of the enamel under acidic conditions and thereby provides protection against dental carries. Groundwater samples with fluoride concentration between 1.0 and 1.5 mgl^{-1} represent medium fluoride endemic zone and falls in category-II. Out of 66 villages surveyed in the Jaipur district, 14 villages (21% of the total surveyed locations) consume water with F^- concentration between 1.0 and 1.5 mgl^{-1}. In the study area, 23 villages (35% of the total surveyed locations) fall in moderate fluoride endemic zone (category-III) where F^- concentration between 1.5 and 3.0 mgl^{-1} has been noticed (Fig.2). Such concentrations are above the MPL (i.e. 1.5 mgl^{-1}) as recommended by BIS (2003) and WHO (2004). The villagers residing in such areas are prone to dental fluorosis, which is characterized by discoloration in the form of spots or horizontal streaks on the tooth surface. Category-IV represents high fluoride endemic zones where F^- concentration greater than 3.0 mgl^{-1} has been noticed (Fig.2). 19 villages (about 29% of the total surveyed locations) of the study area fall in category-IV where high incidence to dental and skeletal fluorosis has been recorded and the water is found unsuitable for drinking purposes.

Fluoride exposure dose

A systematic clinical survey conducted among the people of different age groups and gender living in the 66 villages of Dudu, Phagi and Sambhar block of Jaipur district revealed the rate of prevalence of fluorosis. The exposure doses to fluoride from ground waters of the study area were estimated for infants, children and adults (Table 2 & 3). The exposure doses were calculated by the following generic equation:

$$ED = (C \times WI) / BW \quad ..... (i)$$

where ED = Exposure dose in mg $kg^{-1}day^{-1}$, WI = Water intake in liter day^{-1}, BW = Body weight in kg, C = Concentration of fluoride in mg l^{-1}.

For the calculation, body weight of infants in the age group of 0 to 6 months was kept as 6 kg and children between 7 year to adulthood as 20 kg body weight and that of adults above 19 years as 70 kg. The water intake level of different age groups was estimated from the household survey. Infants in their budding life drank 250 ml of boiled water per day. In boiled water, fluoride level increases proportionally to the loss of volume, so the concentration of fluoride in tap water is doubled (Grimaldo et al. 1995). The estimated water intake for children and adult was 1.5 and 3.0 l/day, respectively. The minimum and maximum range of water fluoride level in each block was used for minimum and maximum exposure dose calculation.

The exposure doses estimated for the infants was found between 0.03 to 0.58 mg $kg^{-1}day^{-1}$ if only dug well water is used whereas for hand pump and tube wells it was between 0.04 to 0.75 mg $kg^{-1}day^{-1}$ and 0.06 to 0.78 mg $kg^{-1}day^{-1}$ respectively (Table 2). Therefore the maximum exposure dose to fluoride for the infants in the study area is 78 times higher than the minimum risk level (MRL) of 0.01 mg/kg/day calculated by the Agency for Toxic Substances and Disease Registry (ATSDR, 1993). A clear risk for dental fluorosis is evident at these levels in the area. The exposure doses for water were also calculated for children and adults having a body weight of 20 kg and 70 kg respectively. The exposure doses were found to vary between 0.03 to 0.53 mg $kg^{-1}day^{-1}$ for children if water from dug well was used for drinking whereas for water from hand pump and tube wells it was between 0.04 to 0.68 mg $kg^{-1}day^{-1}$ and 0.05 to 0.70 mg $kg^{-1}day^{-1}$ respectively. The exposure doses estimated for the adults was found between 0.02 to 0.30 mg $kg^{-1}day^{-1}$ if only dug well water is used whereas for tube wells and hand pump it was between 0.02 to 0.39 mg $kg^{-1}day^{-1}$ and 0.03 to 0.40 mg $kg^{-1}day^{-1}$ respectively. Children and adults are highly exposed to fluoride through drinking water, as much as 14 and 8 times more than the ATSDR's MRL of 0.05 mg $kg^{-1}day^{-1}$. The fluoride exposure doses were also estimated for the different fluoride endemic zones (category-I to IV) in the study area (Table 3). In the high fluoride endemic zones, the exposure dose level of fluoride for infants was between 0.26 and 0.78 mg/kg/day, children have 0.23 to 0.70 mg/kg/day and adults had 0.13 to 0.40 mg/kg/day of fluoride exposure dose level. Therefore the maximum exposure dose to fluoride for the infants in the high fluoride endemic areas is 78 times higher than the ATSDR's MRL of 0.01 mg/kg/day.

Table 1. Fluoride exposure dose through drinking water for various age groups of people in the study area.

	Source of water	**Average water consumption (l day^{-1})**	**F in water (mgl^{-1})**		**F (mgl^{-1})**		**Fluoride exposure dose level ($mgkg^{-1}day^{-1}$)**	
			(Min)	**(Max)**	**(Min)**	**(Max)**	**(Min)**	**(Max)**
Infants	Dug well Boiled[a]	1.0	0.4	7.0	0.8[b]	14[b]	0.03	0.58
	Hand pump Boiled[a]	1.0	0.5	9.0	1[b]	18[b]	0.04	0.75
	Tube well Boiled[a]	1.0	0.7	9.3	1.4[b]	18.6[b]	0.06	0.78
Children	Dug well	3.0	0.4	7.0	0.4	7.0	0.03	0.53
	Hand pump	3.0	0.5	9.0	0.5	9.0	0.04	0.68
	Tube well	3.0	0.7	9.3	0.7	9.3	0.05	0.70
Adult	Dug well	6.0	0.4	7.0	0.4	7.0	0.02	0.30
	Hand pump	6.0	0.5	9.0	0.5	9.0	0.02	0.39
	Tube well	6.0	0.7	9.3	0.7	9.3	0.03	0.40

a The sources of boiled water for infants are the water used in the reconstitution of milk formula as well as drinking purposes.
b Considering that in boiled water, fluoride level increases proportionally to the loss of volume (Grimaldo et al. 1995), the concentration of fluoride in water was doubled.

It has not been proved that fluorosis is sex dependent but nutritional habits, especially breast feeding and climatic conditions play a major role in the prevalence and severity of fluorosis. The study area belongs to the semi-arid region of NW India with an average summer temperature of greater than 31^{0}C. Normally the people residing in such warm areas consume more drinking water. Moreover, boys and men consume more water than girls and women, which enhances the daily fluoride intake level among boys and men in the study area. The results of the present study indicate that the fluoride exposure dose level decreases with increase of age group from infants to adults. This gives a clear indication for the possibilities of occurrence of various forms of fluorosis and osteosclerosis. However, this estimation, does not take into account other sources of fluoride intake such as from food, fruits, vegetables, milk and beverages. Therefore the real exposure dose in the study area would be much higher than the estimated figures.

Table 2. Estimation of fluoride exposure dose in different fluoride endemic zones of the study area.

Fluoride endemic area	**Fluoride exposure dose level (mgkg^{-1}day^{-1})**							
	F in water (mgl^{-1})		**Infants**		**Children**		**Adult**	
	(Minm)	**(Maxm)**	**(Minm)**	**(Maxm)**	**(Minm)**	**(Maxm)**	**(Minm)**	**(Maxm)**
Low	0.40	0.90	0.03	0.08	0.03	0.07	0.02	0.04
Medium	1.00	1.40	0.08	0.12	0.08	0.11	0.04	0.06
Moderate	1.50	2.60	0.13	0.22	0.11	0.20	0.06	0.11
High	3.10	9.30	0.26	0.78	0.23	0.70	0.13	0.40

Statistical analysis. The correlation between the fluoride content in groundwater with fluoride exposure dose of different age groups was determined and is shown in Fig.3. The analysis reveals a statistically significant very high degree of correlation (r=0.99) for all age groups (Infants, children and adults). The correlation coefficient (r) and regression equations give the high significant linearity and numerical relationship between water fluoride content with exposure dose. The coefficient of determination (R^2) and analysis of variance (ANOVA) indicate a high significant relationship ($P<0.001$) between drinking water fluoride content with the maximum fluoride exposure dose. The statistical analysis reveals that as the fluoride content in drinking water increases, fluoride exposure dose will also increase.

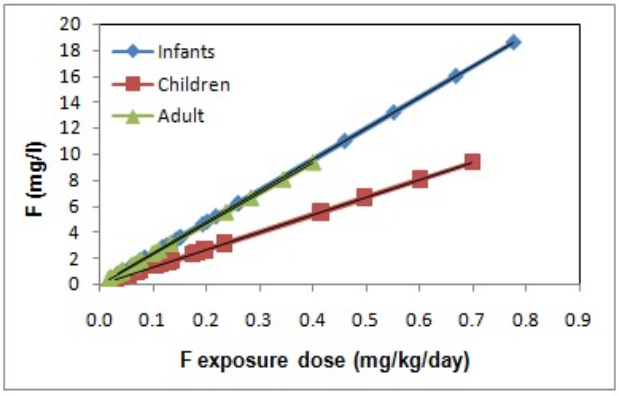

Fig 3. Correlation between water fluoride level and fluoride exposure dose.

Optimum level of fluoride and Remedial measures. In the study area, villagers who consume non-potable high fluoride water suffer from yellow, cracked teeth, joint pains, stiffness in joints and crippled limbs. No quantitative assessment was made for the frequency of dental fluorosis, but it was qualitatively observed that more than half of the population had visible signs of fluorosis from mild via moderate- to severe fluorosis. The serious fluorosis problem in the study area prompted the calculation of a recommended level of fluoride in the drinking water applicable for the area. The recommended optimum concentration of fluoride in drinking water is based on the annual average of the maximum daily air temperature over a minimum of 5 years and is calculated according to the following equation (Messaitfa 2008):

D (mg/l) = 0.34 / [- 0.038 + (0.0062 x Tm)] ……. (ii)
D = optimal amount of fluoride in groundwater (mg F/l) and Tm = maximum average atmospheric temperature (Tm in ^{0}F).

The study area falls in a climatic zone where average summer temperature is greater than 31^{0}C (87.8^{0}F) and the average drinking water consumption is higher than 4 litres per day. Substituting a consumption rate of 4 litres of water per day

and an average annual temperature of 31^{0}C (87.8^{0}F) into the Eq. (ii) yields an optimal fluoride content in drinking water of 0.67 mgl^{-1}. This is below 1.5 mgl^{-1}, which is the value recommended for drinking water by the World Health Organisation and Bureau of Indian Standards.

In the study area, the groundwater quality can be improved by identifying wells with high fluoride concentration, avoiding consumption of water from those wells, reducing the use of chemical fertilizers for agriculture and reducing evaporation by increasing vegetation cover and spreading environmental awareness among the public by organizing campaigns. Deflouradation techniques can be practiced on domestic and village basis. The fluoride levels in groundwater can be lowered by the artificial recharge of groundwater through the rainwater harvesting and by digging deep bore wells as the deeper aquifer samples have less fluoride concentration in the study area. Bore well waters with low concentration (< 0.5 mgl^{-1}) of fluoride can be mixed with waters having higher concentration of fluoride (> 1.5 mgl^{-1}) and supplied (Vikas 2012). As gypsum is fairly abundant in Rajasthan, the gypsum treatment method of alleviating soil alkalinity may be cost effective in the study area to decrease the mobility of F^-. As there is no cure for fluorosis, prevention is the only means of controlling the disease. Based on the present study, the people in fluoride endemic areas are advised to use water with optimal level of fluoride content for drinking as well as cooking and to use Ca-enriched diet and foods rich in vitamin-C to avoid further risks of fluorosis. In view of our results, a public health programme should be designed by taking into account all the fluoride sources.

4 Conclusions

In the study area, the fluoride concentration varied from 0.4 to 9.3 mgl^{-1} (mean = 2.71 mgl^{-1}). The possible sources of fluoride are chemical weathering and leaching of fluorine-bearing minerals present in hard rocks and alluvial formations under the alkaline environment in arid to semi-arid conditions. High pH as well as alkalinity and low levels of Ca, Mg and total hardness suggest favourable chemical conditions for the fluoride dissolution process. 62% of the locations fall in moderate to high fluoride endemic zones (Category-III & IV) where F^- concentration above the maximum permissible limit of 1.5 mg/l as per the guidelines of WHO and Bureau of Indian Standards has been noticed. High incidence to dental and skeletal fluorosis has been recorded in such areas and the water is found unsuitable for drinking purposes. The exposure dose level of fluoride for infants, children and adults were estimated to be 0.03 - 0.78, 0.03 - 0.70 and 0.02 - 0.40 mg kg^{-1}day^{-1} respectively. Consumption of maximum fluoride exposure levels of 0.78 mg kg^{-1}day^{-1} for infants, 0.70 mg kg^{-1}day^{-1} for children and 0.40 mg kg^{-1}day^{-1} for adults were found among the respective age group people residing in high fluoride endemic areas of the study area. As compared with adequate intake level of fluoride of 0.01 mg kg^{-1}day^{-1} for infants and 0.05 mg kg^{-1}day^{-1}for other age groups, the health risk due to excess fluoride intake to the people of the study area has become evident. The present study revealed that fluoride exposure dose level decreases with increase of age group from infants to adults. The statistical tools also indicate that as increased drinking water fluoride level increased the exposure fluoride dose. An optimal fluoride content in drinking water of 0.67 mgl^{-1} has been suggested for the study area. Mapping of high fluorotic areas is useful to plan meticulously to bring safe drinking water from low fluoride areas. Based on the present study, the people in fluoride endemic areas are advised to use water with optimal level of fluoride content for drinking as well as cooking and to use Ca-enriched diet to avoid further risks of fluorosis.

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HOW TO SUSTAIN AGRICULTURAL PRODUCTION IN DROUGHT CONDITION

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Abstract

Disasters are the events of environmental extremes which are inevitable entities of this living world. The impact and frequency of the disasters is augmenting. During last decade, there has been greater focus on the interface between environment, livelihoods and disasters with environment and Disaster Risk Reduction for agriculture especially. Because Indian agriculture is a field which is fully depends on rainfall, temperature fluctuation, climate and other natural factors. The irrigation water is limiting factor of agriculture production. In natural disaster ***Drought*** *is most serious disaster.*

Introduction

43% of total area and 60% of Agricultural area are under Drought forever. 27% of total population of Gujarat state facing Drought Problems permanently. During the 1960 to 1990 (30 yrs) were 18 droughts in Gujarat. This ignored aspect need scientific study. With the help of various references this study was carried out with objectives to know proportion of farmers who adopts High Tech Agriculture systems like Micro Irrigation, Green / Glass Houses, Mulching etc in five Talukas of Junagadh District of Gujarat State. The short questioner giving farmers and data collected was analyzed by simple percentage/ proportion method.

The results are as under,

1. 70 to 80 percent farmers are adopting Drip Irrigation systems and 25 to 40 percent farmers adopting sprinkle irrigation which saves 35 to 70 percent and 25 to 35 percent of water respectively.
2. 50 to 60 percent farmers are adopting mulching to maintain soil temperature and soil moisture in horticultural crops. It reduces 25 to 35 percent water requirement of crops during drought condition.
3. 30 to 35 percent farmers are adopting low cost Greenhouses which reduce 20% of water requirement in controlled condition and increase 18 - 24 % agricultural production.

So the suggestions are,

1. Every farmer of arid region should adopt any Micro irrigation system to minimize water requirement of crops during drought condition.
2. Every farmer should adopt mulching practices to maintain soil moisture and soil temperature in water deficiency.
3. Green House may be used as and when require to create controlled atmospheric condition to sustain crop yield in any disaster.

This way with the help of various Advanced Agricultural systems, we can reduce effects of any drought on agricultural productivity. Changes in Earth's climate can occur externally (from extraterrestrial factors) and internally (from Ocean, Atmosphere and Land Systems). The work of climatologist has found evidence to suggest that only a limited number of factors are primarily responsible for climate change and various disasters on the earth. Studies on climate change have discovered a connection between the concentrations of CO_2 in the atmosphere and mean global temperature. CO_2 is one of the most important gases responsible for the Green House effect. The concentration of CO_2 has been increasing in Earth's atmosphere because of human influences. Human activities like the combustion of fossil fuels, conversion of natural prairie to farm land and deforestation have caused the release of CO_2 into the atmosphere. These changes of climate system affect on agriculture too. Due to climate change, wind velocity, temperature, humidity, soil temperature, rainfall and its distribution, evaporation and transpiration and natural disasters all affect which resulted into decrease in agricultural productions. To maintain production of various field crops, vegetable crops, flowers and fruit crops advance agricultural technologies are useful. Farmers are adopting these advanced technologies like Green Houses, Mulching, Micro Irrigation systems, Photo-thermo tolerant varieties etc are called "High Tech Agriculture".

Junagadh district of Gujarat state cultivating field crops like Groundnut, Wheat, Jowar, Bajra, Maize, vegetable crops like Brinjal, chili, tomato, bhindi, guards etc and fruit crops like mango, banana, coconut, chikoo. The study covers, how many farmers are adopting High Tech Agricultural systems to sustain Agricultural production to overcome any disasters and effectiveness of high tech agriculture for agricultural development. The objectives of this study are as under,

1. To investigate the effects of High Tech Agriculture in any disasters
2. To evaluate the proportion of adopting farmers
3. To evaluate the usefulness of various High Tech Agriculture System against natural disasters.
4. To estimate the benefits of Green Houses, Mulching and Micro irrigation to overcome change to overcome effect of natural disasters.

Review of Literature. Water and fertilizer are the two important and costly inputs; every effort must be made to enhance water and fertilizer use efficiency by reducing their wastage. In recent year's fertilization – a technique of application of both water and fertilizers via an irrigation system was shown to be very effective in achieving higher water and fertilizer use efficiency. In this method water and fertilizer are delivered precisely in the crop root zone as per the crop needs and according to crop developmental phase. Increased growth and yield with drip irrigation has been reported in several crops and increase in yield ranged between 7 to 12% depending on the crops / varieties and method of irrigation. The water and fertilizer saving through drip irrigation have been reported to be 40-70 and 30-50 percent respectively.

The modern irrigation technologies like drip irrigation, which offers efficient and judicious use of irrigation water in drought condition. Drip irrigation continuously reaping soil moist in the rhizosphere has opened near vistas in the scenario for horticultural crops. Studies in several horticultural crops revealed that there were saving in water ranging from 40 to 70 percent due to drip irrigation. Increased yield under drip irrigation has been attributed to better water utilization, decreased salt in root zone, lower chloride levels, higher oxygen concentration in root zone and increased growth and development (Rekha & Mahavishnan, 2008).

Continuously increasing temperature cause disorder of physiological and pre chemical changes in crop plants, which affects much growth process that may lead to a sharp reduction in grain yield. The detrimental effect of temperature stress can be mitigated by developing crop plants with heat tolerance. The high temperature adversely affects photo synthesis, respiration, water relations and membrane stability and also changes in hormones (Gill and Raj, 2009). The concept of landscape irrigation has picked up in the country in last one-two decades. In India with the scarcity of water on the rise day by day and thereby attention given to overcome the limitations of conventional irrigation system. In the conventional method of application of water with hose and hydrant, uninformed application of water is for from achievable besides; there is considerable wastage of water, requirements of more time and labor. Therefore applying the water uniformly and judiciously for landscape irrigation pop-up sprinklers are the most ideal devices. Other benefits of this method are saving water, faster the irrigation, saving labor and power consumption, precise control in water application. It saves 40-50% of water as compared to conventional method. (Deb & Kaushal, 2008). The climatic condition of Ladakh has been changing gradually and from the weather data and trend analysis of temperature clearly indicates that there is rising trend of minimum and maximum temperature in respective seasons. Mountain areas are also particularly affected by drought or heavy rain as relatively small changes in temperature have been severe impacts on water supply agriculture based livelihoods and infrastructures.

This climate change has very serious impacts on the ecosystems of the region. Ladakh and its water sources are almost entirely dependent on the glaciers and snow-mesh and changes in water systems can be directly attributed to changes in glaciers and thus climate change. In Ladakh many obvious changes in the regional climate have already been observed are,

- Changes in rainfall pattern
- Reducing glaciers in the region
- Rising level of glacial lakes
- Unusual floods in July- August (Kumar et.al, 2010).

Adoption of micro irrigation might help in raising the irrigated area productivity of crops and water use efficiency. Investigations was undertaken to assess the influence of plastic mulching with drip irrigation on fruit yield. The result revealed that drip irrigation coupled with plastic mulching, resulted in higher yield. A yield of 104 Kg/tree/year was recorded in the plant having plastic mulch and drip irrigation @ 10 Lit. of water/plant on alternate day against a yield of 68 Kg/tree/year in control. (Mohanla Kshmi et.al. 2010). The experimental results revealed that adoption of drip irrigation along with mulching with black plastic, increase in the yield by 18 to 30 percent, along with water saving to the extent of 32 to 57 percent.

This implies that in water scare area, with drip irrigation, crops can be grown successfully. (Solia et.al.,2010). The important factor for increasing crop production is water. Under drip irrigation, the spatial distribution of soil moisture and consequently crop roots is restricted to a small volume of soil directly below the drippers. The yield of tomato was significantly, higher under liquid fertilizer through drip irrigation than solid fertilizer plus drip or surface irrigation. Application of liquid fertilizers through drip irrigation saved up to 50% of solid fertilizers. (Dhake et.al.,2009). Water is one of the basic impacts for increasing agricultural production and it is becoming scarce and expensive. Proper utilization of water is most essential for sustainable crop production. Micro irrigation is the only option to replace the conventional irrigation method to achieve higher water use efficiently.

Drip irrigation with frequent applications has decreased water requirement and increase a production delivery of nutrients and water in small and frequent amount into effective root zone resulted in high yield. The use of Mulches have been found to conserve soil moisture, control weeds, moderate soil temperature and increase the crop yield. A field experiment was conducted to investigate the effect of drip irrigation, mulch and fertigation on yield of okra. The result of pooled data of 2 years revealed that yield was significantly increased in drip irrigation, lower density of weed were recorded in drip irrigation.

The south-west Punjab falls under semi-arid region, known for cotton growing belt having well developed canal irrigation network. Agriculture of this region is completely dependent on canal water supply because ground water is saline. In last few years, decline in water availability and irregular canal water supply, associated with various pest problems caused reduction in cotton yield and farm income. Farmers are bound to shift to other crops and irrigation method. A study was conducted to compare micro-sprinkler, drip and furrow irrigation system, better crop performance was recorded under micro-sprinkler regime followed by drip and furrow irrigation system. Economic analysis revealed

that using micro-irrigation for potato production in semi-arid environment is a profitable alternation of existing irrigation method. (Kumar et.al,2009)

Any agricultural crop under rain fed condition normally suffers either due to lack of proper distribution of rains or heavy rains and terminal moisture stress. Introduction of micro irrigation systems like drip irrigation can help to bring more area under irrigation and improve the crop yield. Drip irrigation is an option wherever water availability limits conventional irrigation and further it also reduces the risk of yield reduction due to terminal dry spells. Experimental results have widely indicated that drip irrigation would save water and increase crop yield in different region, however the result is very greatly when tested on farmers field. Results are clearly indicates that drip irrigation saves water up to 44 to 57 percent in field condition. (Ramamurthy et.al.,2009)

Extreme weather condition, particularly low temperature during winter season is considered one of the major constraints in improving productivity in any region. In north-west Himalaya, where temperature during winter drops to -3 to -4° C, optimal growing condition can be obtained using green houses. On the contrary, during the summer, air temperature in this region rises to 35°C, which increase temperature over 45 °C, inside the green house without a cooling system. Effectiveness of green houses in developing the congenial environment for plant growth by minimizing the adverse effect of outside environment depends on the structured design and material used in it. Three different green house structures were tested for Tomato cultivation to find out suitable green house for crop production in mid hills of north-south Himalaya. All the 3 green houses could raise the winter temperature from 2 to 3°C than the outside and relative humidity was maintained between 65 to 95%. (Kumar et.al., 2009)

Materials and method

Drought or Heavy rain is a challenge against crop production; either it may be field crops, vegetable crops or fruit crops. Due to this availability of water, temperature and humidity is changed, so that crop many not be able to produce well. In Gujarat, especially in Junagadh district farmers are cultivating cereals like wheat, bajara, jowar, maize, oil seeds like groundnut, til, pulses like green gram, black gram, chickpea cash crop like vegetable crops like brinjal, tomato, chili, bhindi, fruit crops like mango, coconut, papaya etc. The production of these crops is mainly dependent on rainfall, distribution of rain, temperature and humidity. To control these changing climate factors farmers using micro irrigation system to fulfill the water requirement of crops in water stress, mulching to maintain soil moisture and optional soil temperature. Various green houses to maintain temperature, humidity in air. These three technologies are included in **high tech agriculture**.

A short questioner given to the 50 farmers of Mangrol, Talala, Veraval, Vanthli and Junagadh Talukas under Junagadh district of Gujarat state, containing questions related to Micro irrigation systems, Mulching practices and Green house techniques adopted to control adverse climatic condition like drought or heavy rain. The primary data collected from all farmers of five talukas. According to the answer and experiences given by individual farmer, the results and suggestions are drawn. As we know, the climate condition may change suddenly, one could not predict, so that farmer are adopting High Tech Agriculture Systems, in which they adopt Micro-irrigation systems, Mulching and Green Houses. They try to provide preferable conditions to various crops in form of water, moisture and temperature. As the farmers of Junagadh district replied the questions, the result is as follows.

Sr.No	Taluka	No of Farmers
11	Junagadh	10
2	Mangrol	10
3	Talala	10
4	Veraval	10
5	Vanthli	10

Result and Discussion

1. Farmers related with field crop cultivation (Crops like Groundnut, Bajara, Cotton, Wheat the mulching is not applicable, but mulching is more useful in fruit crops like mango, chickoo, coconut, banana etc. Mulching saves water effectively by 30 to 40 percent. 50 to 60 percent farmers are using plastic mulch and farm residual mulching system, which maintain the soil temperature and soil moisture in drought condition.
2. Same tendency of result noted for Green house application. Not a single farmer have applied green houses for field crops but green house technique was applied for vegetable crops like brinjal, tomato, chilies, guards etc. to control temperature and humidity in side it. Due to any type of Green house requirements of irrigation water is reducing to 20 to 30 percent. Farmers are using plastic green house and net houses which are low cost green houses.
3. The farmers are adopting drip irrigation system widely for field crops, vegetable crops as well as fruit crops, because drip irrigation system is useful for saving water and supplying fertilizers. 70 to 80 percent of farmers having own drip irrigation facilities as per Requirement. Method of drip irrigation saves 35 to 70% of irrigation with respect to crop grown, type of soil and temperature of the region.
4. Drip irrigation system is more useful in drought condition for fruit crops because the water requirement of fruit trees are more but drip is given to root zone only, so it requires 2 to 8 lit of water per day. Sprinkler irrigation system is

useful for field crops like groundnut, cotton, wheat etc. which saves water up to 25 to 35%. 25 to 40% farmers having sprinkler set of temporary pattern.

Suggestions

1. Due to climate change like drought or heavy rain the crops would not able to get optimum water. The farmers must adopt micro-irrigation system. Drip irrigation system provides adequate water to crop plants directly to the root zone. We can provide fertilizers with the water. It requires very less amount of water compared to open irrigation. So each farmer has to take advantage of micro-irrigation system to save water and maximum production in changing climate.
2. In changing climate condition soil become dry, soil temperature increased and evaporate soil moisture, so the crop sown in it would not get moisture. So farmers have to adopt mulching technique with the help of plastic or plant residues. Any type of mulch reduces water evaporation, maintain soil moisture and reduce soil temperature. So they can get maximum crop yield.
3. To maintain atmosphere temperature, humidity in air and to protect the crops against heat, wind, chilling, the green house is best technique. Farmers have to follow any type of green house according to material availability. Under green house, we can provide optimum temperature and humidity to crop plants, so they produce maximum.

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DISASTERS AND ACCIDENTS – WHAT SHALL NOT GO WRONG?

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2nd Disaster Risk & Vulnerability Conference

Abstract

Disasters and accidents are stressful situations. After all, a disaster means something horrible has happened on a very large scale. Many of the people at the scene, especially victims, will be distraught. Disasters are seen as the consequence of inappropriately managed risk. In this paper, eight major disasters have been considered for analysis of its causes, consequences and the lessons learnt from it. From this study, it was found that many of the causes for the disasters could have been avoided if properly analyzed for the process safety and thoughts applied. This study suggests that the eradication of all risks and hazards is possible through safe working practices, behavioural and technical based training, hazard analysis such as HAZOP, FMEA, etc., Implementation of these suggestions will help to reduce the potential for accidents and improve the workforce morale and result in a safer environment.

Keywords

Disaster, Accident, Human error, Hazard analysis and Accident prevention

1. Introduction

Within the past two decades, there has been a large growth in the Chemical, Petroleum and Pharmaceutical Industries. They have undergone considerable changes. Process conditions such as pressure and temperature have become more severe. The concentration of the stored energy has increased. Storage has been reduced and interlinking with other plants has also increased. The scale of the possible fire, explosion and toxic release has grown and so has the area which might be affected by such events, especially outside the work boundary[1]. The objective of the study is to analyze the causes for few major disasters and to recommend that "What shall not go wrong?" at least in the future.

2. Disasters

All disasters can be seen as being human-made, the reason being that human actions before the strike of the hazard can prevent it developing into a disaster. All disasters are hence the result of human failure to introduce appropriate disaster management measures[2]. The disasters considered for analysis is presented in the Table 1, with its type and impact.

Table 1. Disasters, types and its impacts

S. No.	Disaster	Type of accident	Impact
1.	Feyzin (January 4, 1966)	BLEVE due to release of LPG	18 killed/81 injured/Extensive property damage
2.	Flixborough (June 1, 1974)	Explosion due to Cyclohexane	28 killed/36 injured
3.	Seveso (July 10, 1976)	Release of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)	Chloracne, (193 cases) cardiovascular/liver function, immune function, neurologic impairment, and reproductive effects
4.	Bhopal (December 3, 1984)	Toxic release of Methyl isocyanate	3787 killed 558,125 injuries including 38,478 temporary partial injuries and 3,900 severely and permanently disabling injuries
5.	Chernobyl (April 26, 1986)	Nuclear	31 killed/ Radioactive release/cancers and deformities are still accounted
6.	Pike River Mine disaster (November 19, 2010)	Explosion (Methane)	29 Killed
7.	Fukushima (March 11, 2011)	Nuclear	70% higher risk of developing thyroid cancer for girls exposed as infants 7% higher risk of leukaemia in males exposed as infants 6% higher risk of breast cancer in females exposed as infants and 4% higher risk, overall, of developing solid cancers for female[1]
8.	Karachi Garment Factory (September 11, 2012)	Fire	289 killed

2.1 Causes for Disasters

The causes for the disasters are well analyzed in literature and are discussed hereunder for all the eight major disasters.

2.1.1 Feyzin. Workers were required to take a routine sample from each of the LPG storage tanks. A team composed of a plant operator; the shift fireman and a laboratory technician were taking a sample from a sphere. The operator, due to the fact that he had only a single valve spanner, opened the valves in the incorrect order. This caused the release of a small amount of caustic soda and a small amount of gas when he opened the lower valve. This prompted the operator to close the valve and then reopen it, leading to only a few drops emerging. The upper valve was then opened fully. This led to a very powerful jet of propane to rush out. This release splashed up the from the drain and gave frost burns to the operator on the face and forearm. As he recoiled from the flow, the operator partly pulled off the valve handle. The fireman, losing sight of the operator, turned on the water supply to the sprays fitted to the sphere and, with the operator, attempted to reposition the valve handle and shut the valve. They failed to do so. The three workers then set off on foot to sound the alarm and seek help (they were afraid of using the telephone or starting up the truck that transported them there in case they set fire to the escaping gas). They were successful in raising the alarm, and traffic was stopped on the nearby motorway. However, the escaping gas ignited. The fire services attended the blaze, but they were not trained in controlling the type of BLEVE fire. While they attempted to cool the surrounding gas spheres, the leaking sphere exploded, killing several firemen. The explosion also caused another sphere to topple and leak gas [3].

2.1.2 Flixborough. The temporary bypass pipe (containing cyclohexane at 150°C, 1 MPa ruptured, possibly as a result of a fire on a nearby 8 inch pipe which had been burning for nearly an hour. Within a minute, about 40 tonnes of the plant's 400 tonne store of cyclohexane leaked from the pipe and formed a vapour cloud 100–200 metres (320–650 feet) in diameter. The cloud, on coming in contact with an ignition source (probably a furnace at a nearby hydrogen production plant) exploded, completely destroying the plant. Around 1,800 buildings within a mile radius of the site were damaged. The fuel-air explosion was estimated to be equivalent to 15 tonnes of TNT (60 gigajoules) and it killed all 18 employees in the nearby control room. Nine other site workers were killed.

2.1.3 Seveso. The chemical-release accident occurred when a batch process was interrupted prior to the completion of the final step - removal of ethylene glycol from the reaction mixture by distillation, due to conformance with an Italian law requiring shutdown of plant operations over the weekend. Other parts of the site had already started to close down as the processing of other batches finished, which reduced power consumption across the plant, causing a dramatic drop in the load on the turbine and a consequent increase in the temperature of the exhaust steam to around 300°C. This much hotter steam then proceeded to heat the portion of the metal wall of the accident reactor above the level of the liquid within it to the same temperature. Not having a steam temperature reading among their instruments, operators of the reactor were unaware of the presence of this additional heating, and they stopped the batch as they normally do by isolating the steam and turning off the stirrer in the reactor vessel. The abnormally-hot upper region of the reactor jacket then heated the adjacent reaction mixture. With the stirrer not running, the heating was highly localised - confined to just the portion of the upper layers of reaction mixture adjacent to the reactor wall, and increased the local temperature to the critical temperature for the exothermic side reaction seen in testing. Indeed, the critical temperature proved to be only 180°C, 50°C lower than believed. At that lower critical temperature, a slow runaway decomposition began, releasing more heat and leading to the onset of a rapid runaway reaction when the temperature reached 230°C seven hours later [5].
The reactor relief valve eventually opened, causing the aerial release of 6 tonnes of chemicals, which settled over 18 km^2 (6.9 sq mi) of the surrounding area. Among the substances released was 1 kg of 2, 3, 7, 8-tetrachlorodibenzodioxin (TCDD). At the nominal reaction temperature, TCDD is normally seen only in trace amounts of less than 1 ppm. However, in the higher-temperature conditions associated with the runaway reaction, TCDD production apparently reached 100 ppm or more.

2.1.4 Bhopal. In November 1984, most of the safety systems were not functioning and many valves and lines were in poor condition. In addition, several vent gas scrubbers had been out of service as well as the steam boiler, intended to clean the pipes. Other issue was that Tank 610 contained 42 tons of MIC which was much more than what safety rules allowed. During the night of 2–3 December 1984, water was being used to flush a blocked pipe, the water entered a side pipe that was missing it's slip-blind plate and entered Tank E610 which contained 42 tons of MIC. A **runaway reaction** started, which was accelerated by contaminants, high temperatures and other factors [6]. The reaction was sped up by the presence of iron from corroding non-stainless steel pipelines. The resulting exothermic reaction increased the temperature inside the tank to over 200 °C (392 °F) and raised the pressure. This forced the emergency venting of pressure from the MIC holding tank, releasing a large volume of toxic gases. About 30 metric tons of methyl isocyanate (MIC) escaped from the tank into the atmosphere in 45 to 60 minute [7, 8].

2.1.5 Chernobyl. On 26 April 1986, reactor four suffered a catastrophic power increase, leading to explosions in its core. This dispersed large quantities of radioactive fuel and core materials into the atmosphere and ignited the combustible graphite moderator [9]. The burning graphite moderator increased the emission of radioactive particles, carried by the smoke, as the reactor had not been encased by any kind of hard containment vessel. The accident occurred during an experiment scheduled to test a potential safety emergency core cooling feature, which took place during a normal shutdown procedure.

2.1.6 Pike River Mine. A series of explosions occurred from November 10 to 24, 2010. The immediate cause of the tragedy was a large methane explosion. Methane is found naturally in coal. It is released during mining and also accumulates in mined out areas. A group of mining experts assembled by the police and the Department of Labour (DOL) concluded that a substantial volume of methane fuelled the explosion. The area most likely to contain a large volume of methane was a void (goaf) formed during mining of the first coal extraction panel in the mine. A roof fall in the goaf could have expelled sufficient methane into the mine roadways to fuel a major explosion. It is also possible that methane which had accumulated in the working areas of the mine fuelled the explosion, or at least contributed to it [10]. Methane is explosive only when diluted to within the range of 5 to 15% in volume of air. Following a roof fall methane would be diluted as it was carried through the mine by the ventilation system. It is not possible to be definitive, but potential ignition sources include arcing in the mine electrical system, a diesel engine overheating, contraband taken into the mine, electric motors in the non-restricted part of the mine and frictional sparking caused by work activities. Effective methane management is essential in an underground coal mine. Undoubtedly there was a failure to control methane at Pike River on 19 November 2010.

2.1.7 Fukushima. The plant comprised six separate boiling water reactors originally designed by General Electric (GE) and maintained by the Tokyo Electric Power Company (TEPCO). Units 2 through 6 were BWR-4, while unit 1 was the slightly older BWR-3 design. All six were housed in Mark 1 containment building designs. At the time of the earthquake, reactor 4 had been de-fueled and reactors 5 and 6 were in cold shutdown for planned maintenance[11]. Immediately after the earthquake, following government regulations, the remaining reactors 1–3 automatically SCRAMmed; control rods shut down sustained fission reactions. Although fission stops almost immediately with a SCRAM, fission products in the fuel continue to release decay heat, initially about 6.5% of full reactor power. This is still enough to require active reactor cooling for several days to keep the fuel rods below their melting points. In Generation II reactors like the GE Mark I, cooling system failure may lead to a meltdown even in a SCRAMmed reactor. Coincident with the SCRAM emergency generators were automatically activated to power electronics and cooling systems. The tsunami arrived some 50 minutes after the initial earthquake. The 14 meter high tsunami overwhelmed the plant's seawall, which was only 10 m high, with the moment of the tsunami striking being caught on camera.The tsunami water quickly flooded the low-lying rooms in which the emergency generators were housed. The diesel generators were flooded and began to fail soon after, their job being taken over by emergency battery-powered systems. When the batteries ran out the next day on 12 March, active cooling systems stopped, and the reactors began to heat up. The power failure also meant that many of the reactor control instruments also failed. As workers struggled to supply power to the reactors' coolant systems and control rooms, multiple hydrogen-air chemical explosions occurred from 12 March to 15 March. It is estimated that the hot zirconium fuel cladding-water reaction in reactors 1-3 produced 800 to 1000 kilograms of hydrogen gas each, which was vented out of the reactor pressure vessel and mixed with the ambient air. The gas eventually reached explosive concentration limits in units 1 and 3. Either piping connections between units 3 and 4 or from the zirconium reaction in unit 4 itself, unit 4 also filled with hydrogen. Explosions occurred in the upper secondary containment building in all three reactors.

2.1.8 Karachi Garment Factory. A private garment factory Ali Enterprises in Karachi, caught fire when a boiler exploded and the flames ignited chemicals that were stored in the factory. Between 300 and 400 workers were inside the factory when the blaze erupted. Officials said that all the exit doors in the factory were locked and many of the windows of the factory were covered with iron bars, which made it difficult for workers to escape at the time of the fire and consequently many of the deaths were caused by suffocation [12].

3. Discussion

On analyzing the causes of the accidents, it is well evident that the accidents are due to unsafe act (human error) or unsafe conditions or design failures. The lessons learnt from the above discussed accidents are given in the Table 2.

Table 2. Disasters and its lessons

S. No.	Disaster	Lessons learnt
1.	Feyzin	Design deficiency/Adequate Training
2.	Flixborough	Design by inexperienced personnel
3.	Seveso	Negligence of Safe Operating Procedures
4.	Bhopal	Failure of several safety systems due to poor maintenance, and safety systems being switched off to save money— including the MIC tank refrigeration system which could have mitigated the disaster severity. Mushrooming of slums in the vicinity of the plant
5.	Chernobyl	Operating instructions and design deficiency
6.	Pike River Mine	Safety measures not used such as, a "tube bundling" gas measurement system, stocks of food and water, breathing apparatus, and a second entrance
7.	Fukushima	Was not designed for such a large tsunami, nor had the reactors been modified when concerns were raised in Japan and by the IAEA
8.	Karachi	All the exit doors in the factory were locked and many of the windows of the factory were covered with iron bars

4. Conclusions

The lessons from the accidents clearly indicate that the causes of the accidents could have been avoided if a systematic approach is made on the following.

- Identification of hazards in processes through analysis like HAZOP, FMEA, etc., for process failures
- Design of process by safety professionals
- Developing safe operating procedures
- Continuous Vigil on the workers involved in the hazardous operations
- Preventive Plant Maintenance
- Adequate training
- Availability of Personal Protective Equipment
- Consideration of safety factors in plant lay out.

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ROLE OF CORPORATE SECTOR IN DISASTER MANAGEMENT: INTEGRATING CSR ACTIVITIES FOR DAMAGE RECONSTRUCTION AND REHABILITATION AS COMPLEMENTING MEASURES TO GOVERNMENT INITIATIVES

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Abstract

The present study is a review of the measures taken by the corporate sector companies in undertaking the post disaster activities, to find out whether they had made any remarkable contributions. The two disasters during last 10 years – Tsunami 2004 and Uttrakhand 2013 – were taken for this purpose. The study reveals that, during disasters, the corporate sector behaved as responsibly as the government and their contributions were, in fact, complementing the government initiatives. The CSR (Corporate Social Responsibility) activities of companies are already in line with the community development and during disasters, it is viewed, they do their best to support the immediate needs as well as developing a livelihood, of the people in the affected region.

Introduction

A **disaster** is a natural or man-made (or technological) hazard resulting in an event of substantial extent causing significant physical damage or destruction, loss of life, or drastic change to the environment. A disaster can be defined as any tragic event stemming from events such as earthquakes, floods, catastrophic accidents, fires, or explosions. It is a phenomenon that can cause damage to life and property and destroy the economic, social and cultural life of people. Researchers have been studying disasters for more than a century, and for more than forty years disaster research. The studies reflect a common opinion when they argue that all disasters can be seen as being human-made, their reasoning being that human actions before the strike of the hazard can prevent it developing into a disaster. All disasters are hence the result of human failure to introduce appropriate disaster management measures. There is no country that is immune from disaster, though vulnerability to disaster varies.

Disaster management (or **emergency management**) is the term used to designate the efforts of communities or businesses to plan for and coordinate all personnel and materials required to either mitigate the effects of, or recover from, natural or man-made disasters, or acts of terrorism. Disaster management does not avert or eliminate the threats, although their study is an important part of the field. Events covered by disaster management include acts of terrorism, industrial sabotage, fire, natural disasters (such asearthquakes, hurricanes, etc.), public disorder, industrial accidents, and communication failures.

Role of Corporate Sector

In keeping with the paradigm shift in the approach of the Corporate Sector to disaster management brought about by the government of India and recurring phenomenon of natural disasters impacting all sectors of Socio-Economic life, including the corporate sector and inflicting heavy economic losses focused attention has been given to risk mitigation endeavors to systematically reduce the vulnerabilities. The Corporates in every country have always played a major role in post-disaster relief, rehabilitation and reconstruction efforts in the affected regions. The ability of corporate sector in terms of its Corporate Social Responsibility (CSR) has also increased as the value and reputation of the company is being increasingly adjudged by its social behavior and by its contribution to the economic well-being and development of the communities in which it operates.

Corporate social responsibilty

CSR (also referred as **Corporate Conscience, Corporate citizenship, Social performance,** or **Sustainable business/ Responsible business)** is a form of corporate self-regulation integrated into a business model. CSR policy functions as a built in, self-regulatory mechanism whereby a business monitors and ensures its active compliances with the spirit of law, ethical standards, and international norms.

CSR and Disaster Management

CSR permeates every aspect of the functioning of the corporate sector. The corporates always looks for the ways and means to enhance the brand value of their company and their products. It is in this context that corporate social responsibility makes good business sense. It is a business strategy that works. By integrating CSR into its business strategy as a core value, the corporates not only make a significant contribution to a better society but are also recognized for doing so. This has obvious benefits for the company. It can play a leading role in supporting and building, the knowledge, capacity and skills of the community in comprehensive risk-based disaster management activities ranging from prevention, mitigation and preparedness to response and recovery. It can offer human and financial resources and also be a precious source of technical know-how, as for example in case of identification and research on technological solutions to prepare for and respond to natural disasters. As an ineligible part of CSR, the corporate sector can play an essential role in leading and supporting the community in comprehensive risk management activities. On the whole, corporate sector has the potential for strengthening and promoting its own safety and protection against natural catastrophes as well as in assisting the community in large in reducing its vulnerability to disasters.

The involvement and association of the corporate sector with national risk reduction and risk management initiatives and with dissemination of appropriate and practical structural and non-structural disaster prevention and mitigation measures necessary for their safe and disaster-free functioning has been accorded priority as part of a strategy to systematically mainstream holistic disaster management into the functioning of the corporate sector. Recognizing the importance of integrating the corporate sector and their nodal organizations in disaster prevention, mitigation, and preparedness agenda, the National Disaster Management Framework drawn up by the Ministry of Home affairs, Government of india envisages "involvement of corporate sector in awareness generation and disaster preparedness and mitigation planning" through sensitization, training and co-opting of the corporate sector and their nodal bodies in planning process and response mechanisms. Thus the Corporate sector has the potential of assisting both the business and industrial community in protecting itself and the community at large in increasing its resilience to disasters.

In this study, two main disasters are taken into consideration which recently affected India badly. They are:

1. Tsunami 2004
2. The Uttrakhand Tragedy 2014.

Tsunami 2004

The word 'Tsunami' is of Japanese origin, which means, "harbour wave". Tsunami are large waves that are generated when the see floor is deformed by seismic activity, vertically displacing the overlying water in the ocean. The quake occurred at a place where several massive geological plates push against each other with massive force. Tsunami has very low height while traveling over Deep Ocean. The deadliest natural disaster caused by the tsunami generated from an undersea earthquake on 26 December 2004 in the Indian Ocean has shaken up the world. The 2004 tsunami generated waves of up to 15 meters in height and even hit Somalia at a distance of about 4500 km west of the epicenter. The 2004 Indian Ocean earthquake was an undersea earthquake that occurred at 00:58:53 UTC (07:58:53 local time) on December 26, 2004. The earthquake originated in the Indian Ocean just north of Simeulueisland, off the western coast of northern Sumatra, Indonesia. The resulting tsunamis devastated the shores of Indonesia, Sri Lanka, India, Thailand, and other countries.

Impact of Tsunami in India:

TAMIL NADU. The state of Tamil Nadu has been the worst affected on the mainland, with a death toll of 7,793. Nagapattinam district has had 5,525 casualties, with entire villages having been destroyed. Kanyakumari district has had 808 deaths, Cuddalore district 599, the state capital Chennai 206 and Kancheepuram district 124. The death tolls in other districts were Pudukkottai (15), Ramanathapuram (6), Tirunelveli (4), Thoothukudi (3), Tiruvallur (28), Thanjavur (22), Tiruvarur (10) and Viluppuram (47).

NAGAPATTINAM DISTRICT. A Coastal District of Tamil Nadu, on the eastern coast, Bay of Bengal, 326 K.M, south of the State Capital, Chennai, 145 K.M from Trichy. A District known for its Rich Religious Heritage and Communal Harmony. Nagapattinam district was carved out by bifurcating the erstwhile composite Thanjavur district on 18.10.1991. Nagappatinam is a unique District with all its historical and cultural significance. This Houses the places of Worship belongs to Major faiths. Nagappattinam is one of the constituents of chola mandalam, acclaimed as the most prominent among the ancient Tamil Kingdoms. Its salient features more than anything else have contributed to the glory of the chola mandalam.

SCALE OF DAMAGE

Total Area	**: 2.7 lakh hectares**	**Traders**	**: 5%**
Total Population	**: 14.88 lakhs**	**Tourist/Pilgrimages**	**: 3%**
Urban Population	**: 3.3 lakhs**		
Rural Population	**: 11.58 lakhs**		
Affected Population	**: 1.96 lakhs**		
Fishermen	**: 87 %**		
Agricultural Laborers	**: 5 %**		

Table 1. Tsunami Damages In India(Source: DiMaRF, India-2005)

FACTOR	ANDHRA PRADESH	KERALA	TAMIL NADU	PONDICHERRY	TOTAL
Population affected	211,000	2,470,000	691,000	43,000	3,415,000
Area affected (Ha)	790	Unknown	2,487	790	4,067
Length of coastaffected (Km)	985	250	1,000	25	2,260
Extent of penetration (Km)	0.5 - 2.0	1-2	1-1.5	0.30-3.0	-
Reported height of tsunami (m)	5	3-5	7-10	10	-
Villages affected	301	187	362	26	876
Dwelling units	1557	11,832	91,037	6,403	1,10,829
Cattle lost	195	unknown	9,116	9,116	9,116

GROUND ZERO – NAGAPATTINAM DISTRICT

Table - Ground Zero : Nagapattinam District

DETAILS	TAMIL NADU	NAGAPATTINAM	PERCENTAGE(%)
HUMAN LOSS	8018	6065	76
MISSING	1126	791	70
UNIDENTIFIED	1769	1733	98
CATTLE LOSS	17404	11983	69
INJURED	3446	1922	56
NO. OF PERSON EVACUATED	4.70 lakhs	1.96 lakhs	42

The damage happened in Nagapattinam district is of **several forms** and they are :

Table - Damages In Brief

SL.NO	KIND OF LOSSES	LOSSESvOCCURRED
1.	Human Loss	Adult – 4289 Children – 1776
2.	Cattle Loss	About 12,821 including Sheep, goat and paultry.
3.	Property Loss	39941 houses
4.	Educational Sector	Elementary / primary Schools – 41 High School – 2 Higher Secondary Schools – 1
5.	Infrastructure Loss	100kms of national, state highways and district roads including six bridge sections.
6.	Livelihood Loss	Catamarans, Fiber Reinforced Plastic (FRP) and Mechanized Boats and also 1000kg of precious Nets.

Let's look the detailed contributions made by both the sectors in order to Rehabilitate and Resettle the divesting state of the Nagapattinam District, Tamil Nadu.

Contributions by the government

The state response

Organizing of Relief and Restoration. The relief operations were organized in three phases: the first phase consisting of search, rescue, evacuation, organizing the cremation / burial of the dead and organization of relief camps, the second phase of providing immediate relief and the third phase consisting of permanent rehabilitation. The entire administration was galvanized by the state into an effective machinery to provide relief and succor to the affected persons. The mobilization of sanitary workers from the entire state to retrieve and identify the dead bodies and arrange for burial or cremation of the dead was instrumental in preventing any outbreak of disease which was feared. Doctors and health workers rushed in to provide excellent service to keep the threat of any epidemic at bay. Lakhs of men, women and children were accommodated in relief camps where food, clothing and shelter were provided. This Government presented a detailed Memorandum detailing the devastation and damages wrought and seeking assistance of Rs$800 crores from the Government to undertake relief and rehabilitation.

The State Government has so far sanctioned Rs.895.18 crores for both temporary relief works. The budget estimate 2005-2006 for Tamil Nadu include a provision of Rs.1000 crores for undertaking relief and permanent rehabilitation measures in the Tsunami affected areas consisting of construction of new pucca houses, livelihood rehabilitation particularly for fisherman and reconstruction of damaged infrastructure.

Compensation to human loss

1. The State Government Sanctioned Rs.1 Lakh per dead person from the Chief Minister Public Relief Fund (CMPRF).
2. A sum of Rs.99 lakh has been given to 123 families with missing persons.
3. A sum of Rs.3.50 has been sanctioned to assist the inured people.
4. The state government has sanctioned more than Rs6.11 crores for the well-being of for the orphans as a fixed deposit in their names to construct orphanages.

Assistance for the construction of houses. The State Government sanctioned a sum of Rs.40 Crores for building temporary accommodation. However, the state government has announced a massive housing programme to build 89,206 permanent shelters in all the affected areas at a unit cost of Rs.1.5 lakhs each.

Assistance for the restoration of infrastructure. The State Government has sanctioned more than 93 coroes for the restoration of Infrastructure facilities like Road, bridges and electricity services in the affected regions. The power and water supply was restored within 48 hours of time in all the affected regions.

Educational assistance in affected regions

A sum of Rs4.22 crores was spent to provide free text books, notebooks and uniforms to the students of 1st standard to 12th standard who were studying in the government and Government Aided schools in the affected regions. In addition to this, the tution fees, special fees and examination fees payable by the student of Tsunami affected families for the period from 01-01-2005 to the end the academic year 2005-2006 were borne by the state Government.

Assistance to agriculture and allied activities

The State Government has sanctioned more than Rs14 crores to the farming community as a compensation to the crop damages, reclamation of sand and saline from the agricultural lands etc,. The State Government has Sanctioned Rs 2.80 crores as relief to the loss of livestock.

Fisheries – damage and relief –

Table - CATAMARAN

Sl.No	Category	No.Damaged	Relief amount/unit
1	Partly Damaged	192	10,000
2	Fully damaged without nets	4662	22,000
3	Fully damaged with nets	912	32,000
4	Net alone lost	4968	10,000

Table - FRP VALLAM

Sl.No	Category	No.Damaged	Relief amount/unit
1	Partly Damaged	1411	15000
2	Fully damaged without nets	147	55000
3	Fully damaged with nets	41	75000
4	Net alone lost	2347	20000
5	Partly damaged outboard engine	1345	5000

Table . MECHANICAL BOATS

SL.NO	No. of Damaged	No.Damaged	Relief Amount/ unit
1	Partly damaged	463	Rs 3 lakhs
2	Fully damaged	213	Rs 5lakhs

CSR : a 'Gap Filling' Strategy of Corporate Sector

CSR is a process with the aim to embrace responsibility for the company's actions and encourage a positive impact through its activities on the environment, consumers, employees, communities, stakeholders and all other members of the public sphere who may also be considered as stakeholders. The Communitarians who are affected by Natural Calamities or disasters are always depended on their respective Governments for the loss they had incurred and fulfilling their "Dreams of Getting back themselves to the former stage." In this Context, the Government would be agreeable to provide the required resources to the people-in-need but always there has been a limitation factor for the Government either in the form of Rules and Regulations or the unavailability of funds which usually create a **GAP** between the Government and the distressed people. And this **GAP** is indentified by the Corporate Sector through their Contributions and Initiatives In the form of "**CORPORATE SOCIAL RESPONSIBILTY"** In reverting back the affected areas to their Original state or form. The Companies Bill, 2012 incorporates a provision of CSR under Clause 135 which states that every company having net worth Rs. 500 crore or more, or a turnover of Rs. 1000 crore or more or a net profit of rupees five crore or more during any financial year, shall constitute a CSR Committee of the Board consisting of three or more Directors, including at least one Independent Director, to recommend activities for discharging corporate social responsibilities in such a manner that the company would spend at least 2 per cent of its average net profits of the previous three years on specified CSR activities. With regard to the Sec 135 of Companies Act 2013, as it is mandatory for the company to contribute towards the CSR activities which would promote higher responsibility rate towards community which automatically leads to Economic Development of the Nation.

Contribution by the corporate sector

TATA GROUP

Wild, wanton waves of the Indian Ocean tsunami lashed the eastern coast of India furiously on December 26, 2004, leaving behind ruin and desolation within a matter of minutes. After that, it took the Tata Group less than 24 hours to go full swing into action, and put together a multi-coloured quilt of essential services, from identifying the worst affected areas to distribution of standardized family kits containing 20 items such as utensils, personal wear, mattresses, bed sheets and blankets. Sixty school kids stranded at the Port Blair airport were brought back home to Kolkata, while relief material was reached to Nagapattinam within 36 hours.

- **Housing**

The minister handed over to 828 families the home keys to their new life. The Tata Colony at Nagapattinam, which was constructed at a cost of Rs22 crore, includes essential infrastructure such as a sewerage treatment plant and two community amenities Centers, plus extras such as a desalination plant, solar powered street lights, and two village knowledge Centers. The sweeping range of these operations conveyed to the hapless victims the singular Tata Group message loud and clear: "We are with you".

- **Livelihood**

Putting the fishing communities of the region back on their feet has been one of the focus areas of TRC's efforts. The activity here has been primarily of providing boats to the fishermen who lost their only source of income to the tsunami. TRC has received a beneficiaries list for the supply of 60 boats.

- **Rural knowledge centers**

TRC has set up Rural Knowledge Centers (RKC) in all three areas. The first was inaugurated on March 1, in Akkarapettai, Kilamanakudi village and Kadiayapattinamvillage, that were inaugurated in April 2005. Both Centers have received an encouraging response from their respective communities.The objectives of RKC's are :

- Training at least one woman and one man in each coastal village as climate and aquaculture managers (they will become Fellows of the Jamsetji Tata National Virtual Academy).
- Setting up a public address system network or community radio in tsunami-affected villages.
- Enhancing information and knowledge flow among stakeholders on early warning system management.
- Training for fish preservation and export for aged fishermen and women of the fishing community and Providing computer-aided learning to the children of the fishing community

BHARTI ENTERPRISES

Bharti Tele-Ventures announced measures for the relief and rehabilitation programme for victims of the tsunami disaster for a total capital expenditure of Rs 20 crore (Rs 200 million), Bharti will be rolling out Airtel mobile and VSAT network in Andaman & Nicobar before the end of the current fiscal. Besides this, the company also announced setting up of communications Centers near hospitals, police stations, temporary shelters and other public places along the coastal belt of Tamil Nadu to address the needs of the affected. "As the country undertakes the biggest ever relief and rehabilitation operation, let me assure that each one of us at Bharti will be doing our best to serve the affected. He donated Rs 1 crore (Rs 10 million) to the Prime Minister's National Relief Fund. BTVL responded to the Tsunami disaster by undertaking the following initiatives for an immediate relief and rehabilitation to Tsunami victims:

- Building a mobile network in Andaman & Nicobar Islands in less than 3 months to aid rapid rehabilitation of the islands.
- Creating 29 Airtel Crisis Communications Centers in Tamil Nadu.
- Raising resources for Tsunami victims by initiatives such as 'Benefit Cricket Match.'
- Employees contributed through a 'Donation Collection Drive' with a difference

INFOSYS FOUNDATION

Infosys Foundation, the social services division of software giant Infosys Technologies, says it embarked on one of the biggest relief/rehabilitation operations in the aftermath of the tsunami.

- Infosys contributed Rs 5 crore (Rs 50 million) to the Prime Minister's National Relief Fund.
- The company collected an undisclosed amount from employees across its various global offices to make monetary and material contributions towards aid operations.
- Initially, the Infosys Foundation distributed food, utensils and clothes to the victims. But after assessing the needs of those affected, a survival kit was put together, which included essential supplies and medicines. More than 1,500 kits were distributed in six villages of Tamil Nadu.
- Infosys Foundation works in the villages of Tamil Nadu and the Andamans these days, providing shelter to the thousands of homeless people.

LIC – Life Insurance Corporation

Corporate India and public sector units are doing their bit in the relief efforts in the tsunami-ravaged areas. Not just in donations, but also in kind. The Life Insurance Corporation is making insurance claims a simpler process.

- Individual employees are pitching in as well. The employees of Life Insurance Corporation, Air India, Punjab National Bank, Nabard, Bank of Baroda and BPL Mobile among others are donating one-day's salary to the victims of natural calamity.
- Insurance giant, LIC will waive all investigations into death claims arising in the tsunami-stricken areas. It has also waived interest payment on delayed payment of premium for the next three months and will reduce the delayed interest payment for the following three months by 50 per cent.
- LIC issued a circular to all its offices stating that proof of death could be any certificate issued by a government official, and has also empowered some agents to issue death certificates. LIC has also waived the need for any legal title in the event that a nomination has not been made.

NASSCOM

The **National Association of Software and Services Companies** (NASSCOM) is a trade association of Indian Information Technology (IT) and Business Process Outsourcing (BPO) industry. The biggest tsunami rehabilitation initiative from the IT industry was taken up by Nasscom, especially in the worst affected state, Tamil Nadu.Nasscom Foundation joined hands with the Chennai-based M S Swaminathan Research Foundation to build rural knowledge Centers in some of the affected areas.TheseNasscomCenters, known as Village Knowledge Centers, are being built in three districts and 30 villages across Tamil Nadu.VKCs are multipurpose resource Centers and single window service delivery mechanisms for training and capacity building, knowledge and information systems, linked to life skill education, livelihood, e-learning, community-based disaster preparedness activities targetting women, children and young people.Nasscom's partners in tsunami rehabilitation: Hewlett Packard, Tamil Nadu government, UNDP, UNICEF and XANSA.Twenty-four IT companies have participated in Nasscom's tsunami rehabilitation programme.

The Uttrakand tragedy 2013. The Himalayan states of Himachal Pradesh and Uttarakhand were hit by torrential rain and cloudbursts in certain locations on 14th through to 17th June 2013,recording the highest rainfall in 20 years in a three-day period, which triggered landslides and flash floods in multiple locations in these states acompanied by cloudbursts caused grave natural disaster in the hills of Uttarakhand impacting five districts – Uttarkashi, Rudraprayag (kedarnath), Chamoli, Tehri and Pithorgarh.

Physical and Financial Assistance

Contribution in Kind for Uttarakhand Disaster. Employees of Companies like GAIL, BHEL Western Coalfield Ltd, BSNL, SPMCIL and SUNTEC have contributed one day salary for relief efforts. Power sector companies helped in rebuilding much needed infrastructure. Sahara India Pariwar provides more than 1 lac pure drinking water bottles, more than 1 lac juice bottles and food packets, 25 medical health unit vans, household items, constructed 10,000 pre-fabricated houses. HAL provided logistic support for the rescue operations. DELL contributed towards relief effort includes providing shelter, water sanitation and hygiene support, emergency food supply..Armed forces have come forward to help the locals and tourists.

Titan Industries

- Relief Measures andsending food and other items to around 400 families in the affected areas in Pindar Valley.
- Blood donation camps have been organised by the watches and jewellery divisions in Dehradun.
- Employees have volunteered a day's salary and offered their services for the relief effort.

Indian Hotels
Taj Hotels has set up its kitchens at key points in the affected areas. Hotel staff prepared fresh food which was transported wherever required.

Table - Losses at a Glance

Human	Infrastructural	Environmental
Estimated death toll of 5000, and 4700 missing across Uttarakhand; Estimated 1,10,000 people evacuated so far.	600 villages across Uttarkashi, Chamoli, Rudraprayag, Pithoragarh districts have had severe damage (washed away/submerged).	25-30 million tourists/pilgrims visit Uttarakhand each year, which is 2.5 times the population of the entire state.
Severe impact on livelihood; 19,590 business establishments devastated which translates to loss of over INR 5300 million.	760 villages are still absolutely cut off. Limited/intermittent road connectivity to reach supplies to 13,600 villages. 1,000 Bridges damaged.	60 hrs of cloudburst & continuous rain, leading to 330 mm of rain.
16 lakh people affected. 30,000+ households in severely affected villages are in dire need of food, water, shelter, medicines. Several injured, and threat of epidemics.	37,000 sq. miles area affected. Loss to economy is INR.30,000 million. 300+ villages face severe drinking water shortage; Primary Health Centers facing shortage of medicines.	70 Hydroelectric projects in worst affected Char Dham area; 505 dams in Uttarakhand state. 4,640 cases of illegal mining

Contributions made by the TATA group
Table - Contributions of TATA Group

Groups of TATA	CONTRIBUTIONS
TATA CHEMICALS	Provided 5,000 Tata Swach water filters and planned forestation process to restore the flora and fauna that was destroyed in the flood.
Tata Projects	Installed RO plants in the affected areas to avoid a breakout of any kind of water-borne epidemic.
Tata Power	Supplied 5,000 solar power lamps
Tata Motors	supplied vehicles for transporting people and arranged for a godown for storage of relief materials. Besides this, the company's employees donated one day's salary towards rehabilitation efforts.
Tata Consulting Engineers and Tata Housing Development Company	Provide low cost housing solution to provide shelters to those who lost their homes in the floods.
Tata Global Beverages	Procured 7,000 bottles of Tata Water Plus in affected areas.
Tata Communications	Handed over 25 satellite terminals to the Indo-Tibetan Border Police to facilitate faster communication among relief teams.
Tata Steel	Company provided pre-fabricated homes to the people who lost their homes in the floods.
Tata Power Delhi Distribution	Restoration work of 33KV and 11KV lines at location
Tata Steel Processing and Distribution	Collected and bought items like puffed rice, grams, tetra packs of uice, towels, dhotis, etc.

Indian Oil Corporation (Indian Oil)
- Ensure uninterrupted supply of petroleum products and fuel for the relief teams of the Indian Army.
- Indian Oil has also positioned adequate stocks of all vital petroleum products, including petrol, diesel, kerosene and LPG.
- Indian Oil has also moved mobile aviation refuellers over long distances in hospitable terrain

ITC, Nestle and Britannia :has sent relief and food packages to the disaster-affected areas.

Contribution in Cash by Government of India. Dr Man Mohan Singh has announced Rs 1,000 crore for disaster relief measures in flood-devastated parts of Uttarakhand. On June 19, PM had released Rs 145 crore as immediate relief. He had also announced ex-gratia assistance of Rs 2 lakh each to the families of those who had lost their lives and Rs 50,000 each to the injured, from the Prime Minister's National Relief Fund.The government expects Rs 2,500 to 3,000 crore more from the World Bank and the Asian Development Bank for the reconstruction and rebuilding efforts.

Table - Contributions In Cash others towards Uttarakhand Flash Floods

Asian Development Band (ADB)	$200 million (1000 Cr.)
Gas Authority of India Ltd Employees Salary of one day	2 crore 92.25 lacs
National Thermal Power Corporation	10 crore
Indian Oil Corporation. Ltd	2 crore
Oil & Natural Gas Corporation. Ltd.	2 crore
Steel Authority of india Ltd	1 crore
Power Finance Corporation	3 Crore
Bharat Petroleum Corporation. Ltd	2 crore
Hindustan Petroleum Corporation. Ltd	1 crore
Bharat Heavy Electricals Limited	6.38 crore
Honda Group	3 Crore
ICICI Group	15 crore
Central Bank of India	11 Lacs
SBI	2 crore
Coal India Limited	50 crore

Conclusion

"Corporates, particularly the large ones, want to be seen as being responsible bodies. Participating in social initiatives also helps them interact with the local communities at the grass-root level, which is useful for communicating the corporate vision and their role to the local communities." The role of CSR in disaster management, though fairly prominent, is limited to post disaster relief and rehabilitation. It has been realized through the above information and data, the two serious Post-disaster activities had helped the Community to get transform to a "Rejuvenated" State. This had proven successful as the Government and Corporate Sector were complimenting each other for the betterment of the common men in particular and the Society, at large.

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A PREVENTION, MITIGATION AND MANAGEMENT PLAN ON POSSIBLE FAILURE OF THE NEYYAR DAM AND CONSEQUENT FLOODING OF KALLIKKAD PANCHAYAT, KATTAKADA TALUK, THIRUVANANTHAPURAM DISTRICT, KERALA, INDIA

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Introduction

Neyyar Dam is a gravity dam , constructed across the Neyyar River in Kallikkad Panchayat of Thiruvananthapuram district of Kerala, India, and is located on the foot of the Western Ghats, about 30 Km from Thiruvananthapuram city. It was established in 1958 and is a famous picnic spot. The Dam and its area is famous for its natural beauty, the forested surrounding, and also the biodiversity around the locality. Kallikkad is a village of Kattakada Taluk of Thiruvananthapuram district. The place Kallikkad has prominent historical and cultural background. The Neyyar Dam is situated in the . Kallikkad Grama Panchayat, which was formed in 1962 from parts of Ottasekharamangalam Panchayat. Some parts of Kallikkad Panchayat were later merged with Amboori Panchayat. A disaster is a natural or man-made hazard, causing significant physical damage or destruction, loss of life, or drastic change to environment. A disaster can cause a major damage to life and property and destroy the economic, social and cultural life of people. Rapid growth of the population and its increased concentration, often in hazardous environments, have heightened both the frequency and severity of natural disasters, with the tropical climate and unstable land forms, coupled with deforestation, unplanned growth proliferation, Non-engineered constructions are an reason in the making of disaster-prone areas. In disaster prevention, developing countries suffer chronically due to natural disasters.

The topic we have selected for this paper is 'Prevention, Mitigation and Management Plan for a possible failure of the Neyyar Dam and Consequent Flooding of the Region of Kallikkad Panchayat, Kattakada Taluk, Thiruvananthapuram district, Kerala State, India'. Neyyar dam is situated in the Kallikkad Panchayat in the Neyyattinkara Taluk of Trivandrum district. The water that bursts out as a result of dam break may flood the regions of Kallikkad, Ottasekharamagalam, Aryancode, Neyyantinkara, Balaramapuram, Chenkal, Poovarand and Kulathoor.
Even though some kind of destruction will happen to the above mentioned regions, the locality that will be affected the most , due to the breakage of the dam will be the Kallikkad Panchayat, which we selected as our study area. The reason for a potential failure is debatable. However, an earthquake of catastrophic proportion or ageing and weakening of the structure could be the possible reasons. Reservoir Induced Seismicity (RIS) may be another reason, taking in to account the large volume of water being stored in the reservoir.

Objectives

The aim of this project is to suggest preparedness, prevention, mitigation, rescue and relief during the situation that may arise due to the possible collapse of the dam at Kallikkad.
The after effects of the possible collapse are as follows:

- Immediate and instantaneous washing away of natural as well as man- made structures and features including vegetation, adjoining the toe of the dam.
- Quick or gradual flooding of the low lying areas on either banks of the downstream part of the dam.
- Another unique but, possible effect of dam failure will be the release of large number of crocodiles which are presently confined to the Crocodile Rehabilitation and Research Centre, near the dam. Further, the wild animals including lions, being fostered in the Neyyar lion safari park may also perish or may reach the habitations in the downstream part of the river, posing a threat to the people.
- People and property, especially those on the flood plains of Neyyar River, in places like Kallikkad, Ottasekharamangalam, Aryancode, Marayamuttom, Neyyattinkara and Poovar may be affected severely. The place likely to be affected most is Kallikkad and its surroundings.
- The locations like Thirupuram, Arumanoor, Poovar, Pozhiyoor are more likely to be affected by the flood that follows a dam failure. However, in the case of breakage of the dam, the areas confined within the Kallikkad Panchayat will be the most affected. Hence the focus for preparedness and capacity building will have to be within the Kallikkad Panchayat.

Salient features of the Neyyar dam

This dam was built in the year 1958 and is a gravity straight dam. The dam was constructed across the river Neyyar and is capable of holding 1060000000 M^3 of water. The other features of the dam are given in Table No. 1, below.

Kallikkad panchayat

Kallikkad Panchayat falls in Trivandrum district and lies between latitude of $8^0$55'09"N and longitude of 77^0 21'09"E. Kallikkad is divided into 3 villages 1) Kallikkad 2) Vazhichal and 3) Ottasekharamangalam. It covers an area of about 106.27 sq. kms. Further the Panchayat is divided into 13 wards as given in Table No. 2, below. Geographically, the Kallikkad Panchayat consists of forest areas, hilly regions, plains upon the hilly regions, areas confined within the slope areas and plains. The forest area is upon the north-east direction of about 128 hectares, situated at 500-800 meters, above the mean sea level. This region is widely renowned for its biodiversity with a wide range of fauna and flora. The hilly regions spread over 105 hectares of land with Thekkuvilakunnu, Kalipara, Draviapara and Shasthampara as its most elevated areas.

Table 1. Characteristic features of the Neyyar Dam

NAME	NEYYAR
ID	251
Type	Dam
Composition	Straight gravity masonry dam
Purpose	Irrigation
Catchment area	140Km²
Year of Completion	1973
Location	Chembilamoodu, Neyyattinkara Taluk
District	Thiruvananthapuram
Basin	Neyyar
Sub-basin	Neyyar
Longitude	77°09' E
Latitude	8°32' N
Length of the dam	295 m
Crest level	79.55 m
Maximum Water Level	84.75m
Full Reservoir Level	84.75m
Dead Storage Level	54.86 m
Water Spread Area	9.1Km²
Gross storage	106.188 MCM
Live storage	101.146 MCM
Dead storage	5.933 MCM
Spillway Length	34.6 m
Spillway gates	4 Nos
Spillway type	Ogee with radial gates

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Table 2. Wards of the Kallikkad Panchayat

Sl. No.	NAME OF WARD
1	Devancode
2	Vlavetty
3	Perumkulangara
4	Neyyar Dam
5	Kalattukavu
6	Nirappukala
7	Vavodu
8	Kalipara
9	Manjadimoodu
10	Chamavilapuram
11	Mylakkara
12	Perinjamkadavu
13	Kallikkad

The plains upon the hilly regions cover an area of 324.75 hectares, which includes the open prisons, rubber plantations. The slope areas include Kunchimam, Chovalli-Pankad, Puthuveetumuri colony, Nagarathinkuzhi, Malavila, Madavilakuzhi etc. Majority of the population inhabits in the plains of Kallikkad Panchayat which includes Kallikkad, Kottumam, Mylakkara, Vattapara and Konjar.

Population and the resources of kallikkad panchayat. The total population of the Kallikkad Panchayat is 17,024. The number of males is 7517 against the women population of 9507. The ratio of men to women population is 100:111.The number of voters present in the panchayat is 10749, and about 6000 people are below 18 years of age.
The general trends of the past disasters are that women population along with children are the most affected. The possible reasons are they are low in physical strength as compared to men. Additionally, they are mostly confined to their homes and are mostly unaware about what is happening outside, in case of a disaster. In the Kallikkad Panchayat, the number of women exceeds the men, so a possible risk to the population is high during a calamity.

Resource inventory of kallikkad panchayat. There are a number of government offices and public buildings in the Kallikkad Panchayat. It has a panchayat office at Kallikkad, a Krishibhavan (Agricultura Office), Veterinary hospital and a V.E.O office at Mylakkara. The panchayat houses 20 anganvadis, 10 schools, Co-operative college, etc. There is a Primary health center and also a Police station at Neyyar Dam.

Possible manpower which can be used in case of a disaster.

Table 3. List of possible manpower which can be used.

Sl. No.	**Agency**		**Staff strength**
1	Fire and Rescue		
	Stations	Kattakada – 0471 2280101	24
		Nedumangad –9497920031	24
		Neyyattinkara –9497920027	24
		Chenkalchoola –9497920015	
		Chakka	55
2	Open prison	Nettukaltheri – 0471-2850044	248 Prisoners 62 Staffs
3	SICA	Devancode – 9447471037	138 Prisoners 32 trainees 26 staffs

List of available vehicles and machinery.
Table 4. List of available vehicles and machinery.

Sl. No.	**Agency**	**Stations**	**Vehicles**	**Equipments**		
1.	Fire and Rescue		ITEMS	No.	ITEMS	No.
		Kattakada	Mobile tank unit Water lorry Ambulance	1 1 1	Life jackets Life buoys Hydraulic spreader Hydraulic cutter Chain saw Generator	4 4 1 1 1 1
		Nedumangad	Mobile tank unit Ambulance	2 1	Life jackets Life buoys Hydraulic spreader Hydraulic cutter Chain saw Generator	4 4 1 1 1 1

		Neyyattinkara	Mobile tank units Ambulance Mini mobile tank unit	 2 1 1	Life jackets Life buoys Hydraulic spreader Hydraulic cutter Chain saw Generator	4 4 1 1 1 1
		Chenkalchoola	Mobile tank unit Mini mobile tank unit, Emergency rescue tender Recovery van Ambulance Dinghy (rubber boat filled with air) Water mist bullet	2 1 1 1 1 1 1	Life jackets Lifebuoys Hydraulic spreader Hydraulic cutter Chainsaw Generator Scuba	4 4 1 1 1 1 1
		Chakka	Mobile tank unit Crash tender Mini Mobile tank units Ambulance Water mist bullet	1 1 2 1 1	Life jackets Lifebuoys Hydraulic spreader Hydraulic cutter Chainsaw Generator Breathing apparatus	5 2 1 1 1 1 1 1
2	Open prison	Nettukaltheri	Jeep Spacio Ambulance Tipper Tractor Bike	1 1 1 1 1 1	JCB	1
3	SICA	Devancode	Spacio Mini Bus Bike Tractor Lorry	1 1 1 1 1	JCB	1

Details of the excavators owned by private owners

Table 5. List of the details of excavators owned by private owners.

VEHICLE NAME	NUMBER OF VEHICLES	OWNER	MOBILE NUMBER
Bhagavan Earthmovers	1	Pramod	9946665620
Harekrishna Earthmovers	1	Binu	9447389254
Malavika Earthmovers	3		9995966714 9446952139
Anjenaya Earthmovers	1	Satheesh	8606313637
Neyyar Earthmovers	2		9447344456
R R Earthmovers	2	Preman	9446904747
Chandragiri Earthmovers	7		
Kripa Earthmovers	1		

DISASTER MANAGEMENT PLAN

The five important steps that have to be included in a disaster plan are the measures which are to be incorporated into the following stages:- PREPAREDNESS, PREVENTION, MITIGATION, RESCUE, RELIEF

PREPAREDNESS PLAN

- Identify the hazards and inform the public about hazards and emergencies that may affect a person and his family.
- Develop an emergency plan.
- Collect and assemble disaster supplies kit.
- Identify the important buildings in the area and assess the vulnerability.
- Identify shelter area.
- Identify the community warning systems and evacuation routes.
- Get aware about the resources available for aid at times of emergency or in time of a disaster, supplement if they are found to be less in number.

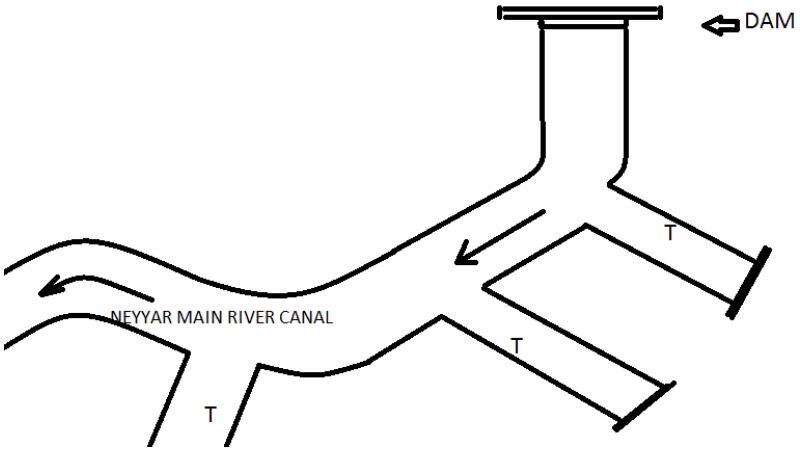
PREVENTION PLAN

There is a saying that 'Prevention is better than cure'. In that saying, concept for a possible natural disaster we can also mention some prevention measures. By suitable prevention measures we can avoid or delay a disaster up to considerable extent. In the case of Kallikkad Panchayat and for the Neyyar Dam we can adopt certain prevention measures. As we know that the Neyyar Dam is an engineering construction. Hence a study of the materials with which the dam has been constructed is of great significance. Neyyar Dam is about 55 years old. Hence the study of loading capacity, the stress-strain aspects, the climatic variations, how long the materials can with stand these factors etc is an absolute necessity. The study of rainfall over the years, in comparison with the capacity of the dam also has to be checked properly to ensure whether there will be a situation of over flooding from the dam. Identifying suitable shelter areas at elevated areas for

evacuating the people in case of a disaster also is an important prevention measure. The resources that need to be used to shift the people also have to be in proper condition in order to avoid uncertainty during an emergency.

MITIGATION

The force of the running water, during a dam failure would be tremendous. The energy of water gushing through the river channel can be effectively reduced by constructing transverse canals (transverse to the main river channel). These canals are to be dug on the eastern or north-eastern bank of the main channel in order to dissipate the energy of the water (refer: Figure below).



T – Transverse canals

Similar phenomenon happened during the Tsunami in 2004 when the Buckingham canal absorbed surplus water and protected the people and habitations along its length in Andhra Pradesh. Tree species with a wide canopy and that does not grow tall can effectively dissipate the energy and prevent overflowing water spurt. This phenomenon too was demonstrated by the mangroves by protecting the coastal habitations during the 2004 tsunami. Hence concerted efforts are to be made to develop plantations of such species along the banks of Neyyar. It is desirable to have an automatic water level monitoring and alerting system. This system should be able to detect an alarmingly high or swift water flow within 50/100 meters away from the toe of the dam in the downstream direction in case of a water surge. This system, in turn, would send a signal to a network in which mobile phones of all the people living in the flood plain as well as lower reaches of the Neyyar River are alerted by a call and an SMS (This works similar to the mobile alerts received by the account holders of banks whenever their account is accessed or a transaction is materialised.)

RESCUE

- The rescue operations include the proper usage of the resources for the transfer of the people of the affected areas with an immediate effect. Schools such as PRWHSS Kattakada, Govt. HSS Kulathummal, Vavod HSS (Lattitude-8^0 30'52"N, Longitude-77^0 8' 48"E), St. Josephs EMUPS Vavod (Lattitude-8^0 30'49"N, can act as shelter points.
- The resources available for rescue operations such as mobile tank units, ambulances, fire fighters, the ropes with police and fire force department, hydraulic equipments, water mist bullets etc, can be used to rescue people with the help of rescue experts.
- The KSEB have to very careful in avoiding further disaster through electric shocks.
- Life jackets, life buoys have to be provided to the rescue operators and to the people.
- The active swimmers of the area have to be invariably provided with safety equipments because they are the first to come for the rescue operations.
- Timbers available from the two major saw mills (Devi and Kappil saw mills) can be used for rescue operation.
- People have to be shifted to the adjacent highly elevated areas like Kalippara, Sasthampara so that they can stay safe from the gushing waters.
- Life jackets available with the forest department, along with life buoys and also the boat have to be used for rescue.
- Mock rescue drills may be arranged with participation of police, forest, fire and rescue, revenue officials and the public.

RELIEF

- Rescue operations are to be followed by relief activities, supply of free ration, compensation to the affected persons etc.
- In Kallikkad Panchayat the places which are in an elevation where no water will reach, can be selected as the spots for setting up relief camps.

The following areas are found to be suitable for relief operations.

- The 200 acres of land in SICA (State Institute of Correctional Administration) and 270 acres of the open prison can be utilized as areas for relief operations. These areas are not very far from the Kallikkad (actually within the Kallikkad Panchayat and is on the upstream part of the dam).
- The availability of resources in SICA (State Institute of Correctional Administration) and Open prison make them more suitable locations for relief camps.
- The resources of SICA and Open prison including staff, (including the prisoners of about 90 numbers), machineries, food items, animal wealth of goats, cows, etc. can be utilized.
- Selection of the area depends upon the facility of transportation or the less time required reaching the place at the time of a disaster. The areas like Kalippara, Sasthampara can also be utilized in this relief program because they are situated at elevated areas.
- Medical help can be provided by the doctors available at the rescue camps. More doctors should reach from the nearby hospitals making use of the transporting facilities available through ambulances, fire forces, mobile tank units or even through helicopters if needed.
- Little Flower school Anthiyoorkonam also the Christian College Kattakada, Lourd Matha College of Engineering, Vikram Sarabhai College of Engineering, Co-Operative College (upstream portion of the dam) can be used as the relief camps.
- The Water Authority office location can be used for starting relief and rescue control rooms.
- The hospitals available for the people who are rescued from the disaster are Govt. Hospital Kattakada, Mamal Hospital, Choondupalaka, PNM Hospital and Pankajakasthuri Medical College.
- NSS, NCC, NYKS volunteers can also be actively in the rescue operations.

Conclusion

Kallikkad Panchayat is situated in a vulnerable area. The reason for the vulnerability is the possibility of breakage of Neyyar Dam, on account of the age of the structure (about 55 years). The dam structure faces a threat from unpredicted earthquakes too (both natural and reservoir - induced). However, the availability of resources, both men and material, are sufficient to meet the rescue and relief operations in that area in case of a dam failure. The manpower and machines available in the open jail, SICA, fire and rescue station in nearby places of Kallikkad may be sufficient to mitigate the consequences of a dam failure and resultant flooding. The resources can be utilized in a quick and efficient manner with the introduction of a warning/alerting mechanism. Hence the revenue authorities have to think seriously about the establishment of an efficient flood warning system for the Neyyar River, in the immediate downstream portion of the dam's toe so as to avoid a possible disaster.

FACING THE UNEXPECTED: DISASTER RESILIENCE THROUGH EDIFICATION

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Abstract

A disaster is a unexpected, catastrophic event that dangerously disrupts the functioning of a society and causes human, material, and economic or environmental losses that exceed the society's ability to cope using its own resources. The foremost people to take action to a disaster are those living in the local area. They are the first to initiate rescue and relief operations. Every nation has to focus on community-based disaster preparedness, which assists communities to reduce their vulnerability to disasters and strengthen their capacities to defend against them. The recovery from a disaster is the outcome of community's skill in managing the disaster. In India, people are not in a position to manage unforeseen disasters. The common people are not aware about the methodical management of disasters. Disasters have a major and long-lasting impact on community long after the immediate effect has been mitigated. Imperfectly planned relief activities can have a significant negative impact not only on the disaster victims but also on future generations. Public awareness on disaster management can save many lives during disaster. It is important that the content of awareness messages should be consistent, clear and context specific and it should be conducted at regular intervals so that the knowledge is kept alive in the community to pass on from generation to generation and ensure that the disaster risk reduction become an integral part of the culture and everyday life of the community. Some educational activities have been started by Indian Government in collaboration Ministry of Education has been working on integration of disaster management into school curriculums. However, there is a need to be conducted at regularly and a few additional activities have to be implemented to enhance the effectiveness. To deepen and inspire greater interest in disaster risk reduction, to encourage the design and implementation of creative and innovative interventions and to anchor the principles that strengthen the Disaster Risk Reduction commitment. Teachers are nation builders. They can play a crucial role in campaigning about disaster risk reduction techniques among the students. This paper highlights on the need for creating awareness among the secondary school teachers about disaster risk reduction techniques and suggests appropriate management options that can be implemented for the scientific disaster resilience through our present edification system. In the present study, investigators adopted Survey Method. The data collected from a sample of 90 secondary school teachers. The data collected through questionnaire. The collected data was analyzed by computing percentage. The major findings of the study reveal that there is an urgent need for creating awareness about disaster risk reduction. Education is a best means to create awareness about disaster risk reduction techniques, among the future generation through their guru.

Introduction

India is a disaster prone nation. Its wide-ranging seashore, snow dressed sky-scraping peaks, high mountain ranges, the perennial rivers in the north and south all combine to add to this problem. India, which has only two per cent of the globe's total geographical area, but has to support 16 per cent of total world population. Naturally, there is a terrific pressure on the natural resources, which directly or indirectly lead to the occurrence of disasters, namely floods, droughts, landslides, tsunami, earthquakes, etc. we are very poor in managing disasters. We have to pass through a long journey to realize the vision of "Disaster Resilient India". United Nations International Strategy for Disaster Reduction (UNISDR) defines a disaster as "A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources." Disasters may occur suddenly in time, or they may develop over a period of time. Most occur suddenly and perhaps unexpectedly. However, some events develop gradually, including some floods and famines related to drought. There is no nation that is protected from disaster, though vulnerability to disaster varies [Jaffin, 2008].

Need and Significance of the Study

We have witnessed a number of major disasters which have caused untold miseries and havoc to life and property. A few recent disasters faced by India include Uttar Kasha earthquake in UP in 1991, Maharashtra earthquake in 1993, Chama earthquake in Gujarat, super cyclone in Orissa in 1999, Buhl earthquake in Gujarat in 2001, Tsunami in 2004 and Mumbai-Gujarat flood in 2005. Besides, India have bad experience of man-made disaster i.e. Bhopal gas tragedy in 1984 and Kumbakonam school fire in 2004. Any disaster can suspend essential services, such as food supply, medical facilities, electricity, water, sewage/garbage removal, transport and communications. The interruption can seriously affect the health, social and economic networks of local communities and countries. So it is important that, facing a disaster is not an individual effort. Local, regional, national and international organizations are all involved in mounting a humanitarian response to disasters.

Managing a disaster is a herculean task. The failures in managing a disaster make the condition more severe. The immediate actions taken by the persons at the disaster front are very crucial and, a foolish untimely action of a person

may elevate the number of victims. The foremost people to take action to a disaster are those living in the local area. They are the first to initiate rescue and relief operations. At Kumbakonam school fire disaster, 94 students between the ages of 5 to10 were burnt to death in their classroom on 16th July 2004 in Kumbakonam town in Thanjavur district of Tamil Nadu. The investigation committee deputed by the state government under Justice K. Sampath to inquire into the circumstances and causes leading to the fire accident revealed that, the role of teachers were highly questionable and most of them found ways to escape themselves rather than saving the children as most of them came out unscathed. Some of the eyewitness by the kids revealed that the teachers asked the children to stay in the classes feeling it is the regular smoke that is emanating out of the kitchen. Teacher's self-centered and irrational behavior raised the number of deaths. The educated community behaves like this. It throws light into the need for creating proper awareness about disaster management.

The Kumbakonam school fire disaster does once again remind us about the need and urgency to 'Centre-Stage' the aspect of 'Disaster Management' in the process of Governance of the nation. It is also a fact that it is not easy for any government to cope with the challenges of management of disasters all by themselves. Educational and Scientific Institutions, Corporate Sector, Community Based Organizations, International Agencies, and the Civil Society have an important role to play in this endeavor. Each will have a prepared disaster management plan. These plans cover prevention, preparedness, relief and recovery. The Red Cross society defines disaster management as, "the organization and management of resources and responsibilities for dealing with all humanitarian aspects of emergencies, in particular preparedness, response and recovery in order to lessen the impact of disasters" [Boin and Rhinard 2012]. Under the chairperson of Indian Prime Minister an apex body named National Disaster Management Authority is established for laying down policies, plans and guidelines on Disaster Management under the Disaster Management Act 2005 . The Kerala State Disaster Management Authority was formed as stipulated in the National Disaster Management Authority Act of 2005 with the Chief Minister as Chairman and the Revenue Minister as Vice-Chairman. District Disaster Management Authority was constituted with the District Collector as Chairman in each district. Disaster management is linked with sustainable development, particularly in relation to vulnerable people such as those with disabilities, elderly people, children and other marginalized groups. In the past two decades, India's public policy on disaster management has shifted from a focus on relief and rehabilitation efforts to holistic management of disasters. This new policy approach incorporates pre-disaster issues of prevention, mitigation, and preparedness, as well as post-disaster issues of response, recovery, and reconstruction.

There is an urgent need for creating awareness about relief-centric response to a proactive prevention, mitigation and preparedness driven approach among society. To build a safer and disaster resilient India by developing a holistic, proactive, multi-disaster oriented and technology driven strategy through a culture of prevention, mitigation, preparedness and response which brings together organizations and individuals from multiple disciplines with the objective of advancing and promoting disaster risk reduction. Every nation has to focus on community-based disaster preparedness, which assists communities to reduce their vulnerability to disasters and strengthen their capacities to defend against them. The recovery from a disaster is the outcome of community's skill in managing the disaster. In India, people are not in a position to manage unforeseen disasters. The common people are not aware about the methodical management of disasters. Disasters have a major and long-lasting impact on community long after the immediate effect has been mitigated. Imperfectly planned relief activities can have a significant negative impact not only on the disaster victims but also on future generations. Public awareness on disaster management can save many lives during disaster. It is important that the content of awareness messages should be consistent, clear and context specific and it should be conducted at regular intervals so that the knowledge is kept alive in the community to pass on from generation to generation and ensure that the disaster risk reduction become an integral part of the culture and everyday life of the community. Some educational activities have been started by Indian Government in collaboration Ministry of Education has been working on integration of disaster management into school curriculums. However, there is a need to be conducted at regularly and a few additional activities have to be implemented to enhance the effectiveness. To deepen and inspire greater interest in disaster risk reduction, to encourage the design and implementation of creative and innovative interventions and to anchor the principles that strengthen the Disaster Risk Reduction commitment. Teachers are social engineers and nation builders. They can play a crucial role in campaigning about disaster risk reduction techniques among the students as well as society. This paper highlights on the need for creating awareness among the secondary school teachers about disaster risk reduction techniques and suggests appropriate management options that can be implemented for the scientific disaster resilience through our present edification system.

Objectives of the Study

1. To find out the Secondary School Teacher's awareness with respect to Disaster Risk Reduction Techniques.
2. To compare the awareness among the Female and Male Secondary School Teachers with respect to Disaster Risk Reduction Techniques.
3. To compare the awareness among the Rural and Urban Secondary School Teachers with respect to Disaster Risk Reduction Techniques.
4. To identify the problems exist in the Disaster Management Programs implemented in the present education system.
5. To suggest appropriate Disaster Management options that can be implemented for enhancing the scientific disaster resilience through our present edification syste**m.**

Methodology in brief. In the present study, investigators appropriately employed survey method. The data collected from a sample of 90 secondary school teachers from Ernakulam District. While selecting the sample due consideration was

given to gender, locale of teachers. The data collected through Disaster Management Awareness Questionnaire which was prepared by the investigators.

Analysis and discussion. The collected data was analyzed by computing percentage. The following tables give a clear picture about the analysis of the comparison of awareness of secondary school teachers regarding Disaster Risk Reduction Techniques.

Table 1. Comparison of Level of Awareness of Secondary School Teachers regarding Disaster Risk Reduction Techniques

Secondary School Teachers	Low		Medium		High		Total	
	No.	%	No.	%	No.	%	No.	%
	28	31.11	47	52.22	15	16.66	90	100

Table 1 reveals the level of awareness among secondary school teachers regarding Disaster Risk Reduction Techniques. The result show that [52.22%] of teachers showed medium level and 31.11% showed low level awareness about Disaster Risk Reduction Techniques. Only 16.66% teachers showed high level awareness about Disaster Risk Reduction Techniques.

Table 2 Comparison of Awareness among Female and Male Secondary School Teachers Regarding Disaster Risk Reduction Techniques

Sl. No.	Gender	Low		Medium		High		Total	
		No.	%	No.	%	No.	%	No	90
1	Female teachers	26	50.00	22	42.30	2	3.84	52	
2	Male teachers	2	5.26	25	65.78	13	34.21	38	

Table 2 shows the comparison of awareness among female and male secondary school Teachers regarding Disaster Risk Reduction Techniques. The male teachers showed high awareness than the female teachers. Hence, it can be concluded that, when comparing the awareness of female and male secondary school teachers regarding Disaster Risk Reduction Techniques , the male teachers showed high awareness than female secondary school teachers.

Table 3 Comparison of Awareness among Rural and Urban Secondary School Teachers Regarding Disaster Risk Reduction Techniques

Sl. No.	Locale	Low		Medium		High		Total	
		No.	%	No.	%	No.	%	No.	%
1	Rural school teachers	13	62.22	23	51.11	9	20.00	45	50.00
2	Urban school teachers	15	33.33	24	53.3	6	13.33	45	50.00
	TOTAL	28	31.11	47	52.22	15	16.66	90	100

Table 3 portrays the comparison of awareness among rural and urban secondary school teachers regarding Disaster Risk Reduction Techniques. The rural teachers have high awareness than the urban teachers. Hence, it can be concluded that, when comparing the awareness of rural and urban secondary school teachers regarding Disaster Risk Reduction, the rural teachers showed high awareness than urban secondary school teachers.

Major findings of the study

1. The secondary school teachers showed medium level awareness about Disaster Risk Reduction Techniques. The result reveal that [52.22%] of teachers showed medium level and 31.11% showed low level awareness about Disaster Risk Reduction Techniques. Only 16.66% teachers showed high level awareness about Disaster Risk Reduction Techniques.
2. The male secondary school teachers have been found to have better awareness regarding Disaster Risk Reduction Techniques in comparison to their counter parts i.e. female secondary school teachers.
3. The rural teachers of secondary schools have been found to have better awareness regarding Disaster Risk Reduction Techniques in comparison to their counter parts i.e. urban secondary school teachers.
4. The teachers revealed that, the existing Disaster Management Education programmes are not much enough to create awareness about scientific Disaster Risk Reduction Techniques through edification.
5. In India, Disaster Management Education programmes have encountered a mixture of problems such as, absence of scientific disaster management machinery, lack of training in Disaster Risk Reduction Techniques, undeveloped physical infrastructure, lack of adequate economic support, fatalistic nature of public; meager public awareness, low literacy rate, political red tapes, lack of political commitment have made the disaster situation more complex.
6. In view of the complexities and diversities of the disaster management, concrete effective and practicable policy is needed for which political commitment and a pragmatic policy formulation is very necessary. It is also believed that lack

of coordination, insufficient fund and resources, and their mobilization problems have to be addressed through the effective implementation of the practicable policy.

7. Various types of workshops, seminars and training programs on disaster management should be given to teachers as in-service programme to enhance awareness on Disaster Risk Reduction Techniques.

Recommendations based on the study

While significant actions are taken by the Indian government to face the future unexpected disasters, there are still formidable challenges exist in the society. To overcome these challenges, following recommendations are made based on the findings of the study:

1. Disaster Education is a major plank to revolutionize the concept of disaster management in the country. Educational planners in partnership with Ministry of Human Resource Development have to take steps to institutionalize the inclusion of Disaster Management curricula in the Higher and technical education fields.
2. Teachers can play a crucial role in campaigning about disaster management in the society through education. So teachers should be made competent to handle Disaster Management Education through in-service training programmes like seminar, workshop, discussion etc.
3. Educative system can act as means for creating consciousness about Disaster Risk Reduction Techniques among the common people. Major country-wide initiatives have to be undertaken by education ministry to create awareness in disaster resilience with Mock Drills in the schools for students as well as parents.
4. To generate awareness at the grass root levels and involve the communities in disaster response, authorities have to organize Mock Exercises at the district and panchayath level on both the natural and man-made disasters.
5. Disaster management policies must incorporate programs to protect the most vulnerable segments of society—the poor, marginalized, women, children, disabled, and elderly.
6. For Capacity Building in Mass Casualty Management, school children from all levels have to provide guidance in basic Life Support and Advanced Trauma Life Support on regular basis. In the field of Preparedness for response to Chemical, Biological, Radiological and Nuclear Emergencies, training has to be initiated in collaboration with concerned resource persons.
7. The Corporate and Industrial houses have to involve in pre-disaster preparedness activities as a part of their Social Responsibility. They are being encouraged to take up such projects in their local community. The support could be in the form of communication facilities, school safety, providing medical ambulances and 'mobile hospitals' etc.
8. Involvement of public media to raise public awareness in cooperation with various Governmental, Non-Governmental and Social Organizations can be effectively utilized for campaigning about disaster management. Public awareness raising programs can be given through radio and television. Besides, posters, pamphlets and notification in the media during the hazardous season can be done to raise public awareness significantly.
9. A task force has to form in every district to examine the problems of disaster management in India by a thorough examination and review of the present acts, rules, regulations, budget and functions and duties of various agencies related to disaster management and to suggest the measures to solve them.
10. In addition, disaster mitigation, early warning, emergency rescue and relief operation, rehabilitation and recovery plans should involve in activities such as training, post-disaster evaluation, monitoring of relief works, review, cooperation and coordination of Central, District and Local preparedness and research etc. Recovery planning should involve in long-term as well as immediate recovery programs.
11. Above and over, international and regional cooperation in this field is of utmost importance. This could help greatly to redress the situation by means of collecting and disseminating information and conducting trainings and organizing meetings. This kind of gatherings at international, regional and sub-regional basis will promote international cooperation, mutual understanding and help among the countries by exchanging ideas and sharing experiences between the fellow participants. Such meeting will also help to learn from each other's experiences. Outcome of this kind of gathering will be and asset for the individual participant and the country as well.

Conclusion

Disasters disrupt progress and destroy the outcome of developmental efforts over several years, often pushing nations in quest for progress back by several decades. Thus, efficient reduction of disaster risks, rather than mere response to their occurrence, has in recent times, received increased attention both within India and abroad. With a vision to build a safe and disaster resilient India, the Government has to adopte a holistic, proactive, multi-hazard oriented and technology driven strategy by promoting a culture of prevention, mitigation, preparedness and response.

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FIREWORKS: A DISASTER AND AN ENVIRONMENT POLLUTANT SOURCE

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Abstract

A disaster can be defined as any tragic event stemming from events such as earthquakes, floods, catastrophic accidents, fires or explosion. It is a phenomenon that can cause damage to life and property and destroy the economic, social and cultural life of people. Fireworks is such a disaster which is usually not given due importance. In Kerala, firework is a part of religious faith. Large quantities of firework items are used in festivals of temples and churches. Even though firework is a part of festivals, it has many environmental impact and hazard. The present study assessed the firework disasters occurred in the past and sites of major fireworks as well as the quantity of materials used, in Kottayam district. The study revealed the use of large quantities of firework materials in the Kottayam district and is increasing year by year. Even though the agencies and churches/temples are taking conventional disaster preparedness and mitigation measures during the firework disaster, it is advisable to go for standard measures. Perchlorate is used as an oxidizing agent used in fireworks, which at concentrations above 24.5ppb in drinking water can result in thyroid disorders. Perchlorate is highly persistent and from soil it can reach groundwater. Perchlorate was detected in high concentrations from soil samples collected after a fireworks display at festivals of Kottayam.

Keywords
perchlorate, pollution, water

Introduction

Disasters are seen as the consequence of inappropriately managed risk. A disaster will seriously disrupt the functioning of the society, cause widespread human, material or environmental losses which exceed the ability of affected society to cope on its own resource or natural or man-made (or anthropogenic) hazard resulting in an event of substantial extent causing significant physical damage or destruction, loss of life, or drastic change to the environment. Fireworks are a known explosive class of chemicals that are designed and produced for use as an explosive. Fireworks are defined as any devices other than a novelty or theoretical pyrotechnic article intended to produce visible and or audible effect by combustion, deflagration or detonation. Major components of fireworks include fuel, oxidizing agent, reducing agent, regulator, colouring agent and binder. Fuel (Charcoal and black powder) is the source of fireworks. Nitrate, chlorate, perchlorate etc. are used as oxidising agents where as the reducing agents are sulphur and charcoal and metals like aluminium, antimony, barium, calcium, carbon, chlorine, copper are used for regulator and colouring agents. Dextrin is used for binder, which holds composition together (Grima et al., 2012).

In Kerala, firework is a part of religious faith. Large quantity of firework items are used in festivals of temples and churches. Thrissur pooram, Nenmara-Vallangi vela, Aattupuzha pooram and Chinakathur pooram are the famous temple festivals in Kerala and are known for firework. Hence fireworks making units are also operating in Kerala state especially in the districts of Palakkad and Thrissur and livelihood of many people are involved with fireworks industries.
Even though firework is a part of festivals, it has many environmental impact and hazard. The fireworks become hazards when uncontrolled explosion occur which in turn lead to the death of many people. In Kerala, there are records of many fireworks disasters occurred in the recent years. Fireworks are one of the major reasons for the environment perchlorate contamination (SERDP, 2005; White, 1996; Dasgupta et al. 2006; Puri et al. 2009). The chemicals present in the fireworks can release pollutants like perchlorates, sulfur dioxide, carbon dioxide, carbon monoxide, suspended particles, and several metals like aluminum, manganese and cadmium, etc. (Ravindra et al. 2003; Wang et al. 2007; Mclain, 1980). The present work reveals the role of fireworks in perchlorate contamination of the environment.

Materials and methods

Study area. Kottayam, one of the 14 districts in the state of Kerala, is located between 9.36° N and 76.17°E. The district has a tropical climate with an oppressive hot season in the plains and plenty of rainfall throughout. Kottayam is also known for some biggest fireworks mainly in churches like Manarcadu, Puthuppally and Athirampuzha. Besides this more than 40 sites which include temples and churches are dealing with fire work materials every year. The study is based on the primary data obtained from the firework agencies, authorities of churches and temples, in Kottayam district. The field work was conducted during 2013 by using a field data sheet. The sites were selected based on the cost of the firework used in churches or temples The respective firework agencies were also surveyed. Perchlorate, the potent thyroid disruptor, used in fireworks was analyzed using Liquid Chromatography Mass Spectrometry (LCMS) technique. Soil and water samples were collected before and after fireworks within 250 meters from the fireworks display ground.

Results and discussion

History of Kerala- fireworks related disasters

The major fireworks related disasters in Kerala have been surveyed. The number of deaths due to firework accidents is on the rise in Kerala even after the High Court of Kerala prohibited the use of dynamites and 'gundu' in the year 2003 and in the subsequent year the High Court imposed restrictions on the sound level of crackers. A total of 392 people were killed in 381 accidents in the last seven years. Maximum number of accidents has been occurred in Palakkad district (12 accidents and 29 deaths in the last three years). The latest one was occurred during the Nenmara - Vallangi Vela on 3 April (2013), where the disaster killed one and 40 causalities were reported. The explosives went off in the holes dug in the ground and large masses of earth fell on those assembled. In February (2013) seven persons were killed at Panniyamkurissy, near Cherpulassery, where the stored explosive material in fireworks manufacturing unit caught fire. In a similar accident at Thrangali, near Shornur, (February 2012), 12 people lost their lives. The high incidence of firework accidents may be due to the large number of 'pooram' and 'vela' festivals in which fireworks display is a major attraction. In 2006, there were 24 accidents in which many people died. The number of accidents rose to 38 in the year 2007 and a death of 42 people were reported. In the subsequent years (2008 and 2009) the accidents rose to 49 and 53 respectively. The number of deaths touched 57 in 2009. On 9th March, 2007 a nine-year-old boy was killed and 20 causalities were reported in an accident during display of fireworks at the Somasekhara temple in Peringottukara, Thrissur. In 2010, there were 53 accidents which claimed 66 lives. It further rose to 58, killing 68 persons in 2011. In 2011, Thrangali, Palakkad firework accident killed a dozen of people. In the year 2012 there was 59 accidents with a death toll of seven. In the first three months of 2013 there occurred 27 accidents which killed 17 people.

Fireworks in Kottayam district

The field work started on March 12, 2013 and covered 40 sites in Kottayam district according to the intensity of firework. The total number of churches and temples are 21 and 17 respectively. The quantity and amount spent for the fireworks by churches and temples are drastic (Table 1). The fireworks in Kottayam district are classified into three: major, medium and minor, based on the cost of explosives used.

1) Major. The cost of major firework is between 90,000 and 5 lakhs. The fireworks of Manarcadu church, Vaikom temple, Pareppally church, St.Thomas valiyappally Pala, Ettumaanoor temple, Aruvithaara church, Kanjirappally church, Bharanaganam church, Athirampuzha church, Koothrappally church Karukachal and Kuruvilangadu church are dealing with large quantity of firework materials.

2) Medium. The medium firework are, that cost between 50,000 to 89,000. The medium fireworks in Kottayam district are conducted by St. Thomas church Punnathura, St. Pauls church Kottayam, Parippukkattu temple Santhipuram, St. Joseph church Changanassery, Eruppackal church Nadungadappally, Chruvally temple Ponkunnam, St. Mary Jacobite church Areeparampu, St.Ignatious chuch Chingavanam, Ponkunnathukavu devi temple, Onamthuruth sreekrishnaswami temple, Kuttiyanikulangara devi temple Neendoor, Holy Family church Mattakkara, Manimala church, Cheruvally temple Pampady, Mar Gregorious church Njaliyakuzhi, Elamkkavu Devi temple, Madappally bhagathi temple, St. Adais church Vakathaanam.

3) Minor. The minor fireworks cost between 25,000 and 49,000 Rs. Moothedath Bhagavathi temple, Aravindeswaram siva temple, Puthuppally temple, Kizhakkedathu sivaparvathi temple Lakkattoor, Njaliyakuzhi Knanaya church, Nedungadappally church, Vakathaanam valiyappally, Mattakkara Devi temple are the sites were minor fireworks are being conducted.

Disaster Preparedness Plans and Mitigation Measures

The present study has interviewed various agencies whom are conducting firework display. They are presently practicing some disaster preparedness and mitigation measures and are as follows; Display site are 300 meter away from viewers, sufficient water and soil stored before firework display, the selection of display site is based on the distance to houses, roads and public places, firework items have a standard height of explosion, the amount of explosives filled in such a way that it should explode at or above 250 meter height from the ground level, there is a barrier between the viewers and firework display site, it will help avoiding contact of viewers like children. Ambulance and first aid facilities are also provided by the organisers. These management measures are not always sufficient because a large number of casualties due to explosion, stampedes and other unforeseen events have been reported. It is important to curb the hazard before it happen. The preparedness plan should be therefore contained plans for production, storage, and display of fireworks and management of crowds. It is not easy to prepare a disaster preparedness or mitigation plan for fireworks in general. Normally individual sites have to be inspected and prepare proper preparedness plans and mitigation measures because it will vary with respect to the sites. But this study focused on the quantification of fireworks in the district and tries to find out the general solutions for a possible hazard as it is a participatory event of a large population. The following are the general preparedness measures to be taken care off. The firework hazards may occur during the time of storage and display. In both cases, the experience of the handling person is important. Hence the firework person should have the license to conduct the same.

At the time of storage. The firework material should be stored in metal boxes, not in paper bags or cardboard boxes, i.e. the firework material should be kept away from the articles that could spread fire. Fire work material should not be stored with caustic substances such as drain cleaners, paint strippers and wood preservatives. The materials should be away from the fertilizers and products containing peroxides. These boxes should be kept in a storage area where standard electrical insulations have done. The area should be excluded from any sources of ignition and should be prohibited the entry of

Table: 1 Data Sheet showing cost and quantity of fireworks used by churches and temples in Kottayam district, kerala

Sl.No	Name	Cost of firework (in Rs)	Quantity of firework (in kg)	Length between viewers and firework area(in meter)
1	Manarckadu church	500000	2400	500
2	Athirampuzha temple	97,000	450	500
3	Nedungadappally church	35,000	250	300
4	E rupakkal church	75,000	370	300
5	koothrappally church	90,000	430	500
6	E ttumanoor temple	115,000	550	320
7	vaikom temple	350,000	500	600
8	Puthuppally temple	40,000	500	300
9	Njaliyakuzhi knanaya church	35,000	300	300
10	Mar Gregorious church Jnaliyakuzhi	50,000	250	300
11	vakathaanam valiyappally	25,000	300	300
12	S t.Adais church Vakathaanam	50,000	300	200
13	S t.Joseph church C hanganassery	80,000	350	300
14	Pareppally C hangassery	125,000	550	300
15	Iravithara church E rattupetta	100,000	500	300
16	Manimala church	50000	300	300
17	cheruvally temple pampady	50000	300	300
18	C heruvally temple Ponkunnam	75000	370	300
19	parippukaattu temple santhipuram	80000	375	300
20	Kuruvilangadu church	90000	430	300
21	Kanjirappally church	100000	500	300
22	S t.Thomas valiyappally Pala	125000	550	300
23	Bharanaganam church	100000	500	300
24	kuttiyanikulangara devi temple,neendoor	60000	320	300
25	Aravindeswaram siva temple	45000	170	300
26	Onamthuruth sreekrishnaswami temple	60000	340	300
27	S t.paul church vettimukal,kottayam	81000	400	300
28	S t.thomas church Punnathura	82000	410	300
29	Holy Family church Mattakkara	55000	250	300
30	Kizhakkedathu sivaparvathi temple Lakkattoor	36000	200	300
31	S t.Mary Jcobite church Areeparampu	70000	350	350
32	Moothedath Bhagavathi temple	45000	175	300
33	E lamkkavu Devi temple	50000	250	300
34	Ponkunnathukavu devi temple	60000	350	320
35	S t.Ignatius church chingavanam	65000	355	300
36	Madappally bhagathi temple	50000	240	350

common people. Also the area should be smoking free zone. The storage area should be kept away from the display site and other buildings such as Schools, hospitals and houses. There should not be any houses <50m from the storage area. The storage area should have the fire fighting equipments and materials. Utmost care should be taken and proper security should be arranged at the storage site. The firework material should be in closed boxes until you are ready to move them into display site.

During the Display. The firework display may cause for two types of hazards; one is due to explosive material and the second is stampede. Hence the preparedness plan shall consist of measures to prevent both. The display site should have facilities for fire fighting, i.e. sufficient water and soil should be stored for rescue operation. Display site should not be very near from the houses, roads and other public places. It should be a minimum of 50m away from these. The display site and viewers gallery should be separated by standard barriers. These barriers should have a height of >30m. The fire work should have standard quality, for example, Standard height should be a minimum of 32m. Normally most of the firework displays are arranged in such a way that, it will explode at 250m above the ground level. Hence there won't be any problem with the barrier. Also it will mask the uncontrolled fireworks which may cause casualties and panic among the gathering. The distance between display site and gathering should be 300 - 500m.The temporary shops in the sites will have to set up far away from the display site that will reduce the risk of fire hazard. The sites with high usage of firework materials should be find out and the authorities should be created awareness on explosives and their hazardous nature among the local people.

The stampede is another kind of hazard caused by firework accident. Even though the fireworks are conducted in open places, the panic created on cohesive crowd (they have no leadership) may lead to stampade. The people will get panic, if anything happened and will try to escape from the site. Hence there should be proper number of entrance and exit and it should be widely opened so that the evacuation of people could be as early as possible. The agency should provide separate facility for ladies and children and should not be very near to the display site. The availability of first aid and ambulances should be confirmed. Nearby hospitals should be informed about the fire work and they should be prepared for any kind of fire work accidents. In Kottayam district most of the fire work sites are very near to the major

hospitals and are well connected with roads. The survey showed that the potential of fireworks hazards in the district is increasing. There are a number of major fire works in Kottayam and are using high quantity of explosive materials. The fireworks of Kottayam districts are mainly done by two agencies. The discussion with them indicated the use of some conventional preparedness measures for fireworks hazard and is discussed above. The major fireworks have got high popularity and therefore the people's participation is very high. This will enhance the risk and may cause for increased casualties in future if a fire work accident occurs in any of these sites. It is advisable to find out the capacity of hospitals in and around the major firework areas for handling firework hazard casualties.

Perchlorate contamination

Unforeseen health disaster and environment contamination rests behind every firework. The soil and water samples collected from certain firework sites of Kottayam district before fireworks showed no perchlorate contamination. But soon after the fireworks samples are contaminated with perchlorate (1000ppb). Perchlorate is highly soluble and resists degradation at normal environmental conditions. It may get absorbed by moisture and there is a chance of getting into ground water, where the advisable limit is only 24.5 ppb, above which can result in decreased thyroid hormones, leading to hypothyroidism. Two ground water samples near St. Mary's church, Athirampuzha, Kottayam, showed perchlorate concentration up to 10ppb immediately after fireworks, which are about 150 meters away from the display site. This may be from the residues that are burst out from the crackers, and is an example of direct environmental contamination (ITRC, 2005).

Conclusion

The joyful moments of festivals can be turned out to a disaster by the careless cracking of fireworks. Utmost care must be taken during manufacture, storage and display of fireworks. Strict laws are necessary to propagate the standard disaster mitigation and preparedness plans. The study urges for the development of preparedness plans for individual sites especially where high quantity of firework materials are using. The higher quantities may cause disaster with higher intensity, and small fireworks are less vulnerable to viewers. Moreover, we have to take precaution not to contaminate our environment and thereby prevent health disasters in future.

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RWANDA LAND RESOURCES DISASTERS: PREVENTION, MITIGATION AND RECONSTRUCTION

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Introduction

Rwanda's tragic event of 1994 genocide where one million Rwandans were killed is the worst disaster in Rwanda's history. Rwanda today is resurgent nation, stable, engaged in innovative activities, ambitious determination and a promising showcase of African development in exceptional post-conflict rebirth impressive success story. Rwanda considers disaster prevention, preparedness, mitigation and reconstruction as a foundation for protecting environment, ensuring equitable economic development and improving quality of life of all citizens. In light of this consideration, disaster management policies are one of the current critical debates in Rwanda. Disaster prevention is a strategic ***'life blood'*** *of sustainable development and prosperity.*

Rwanda context

Republic of Rwanda is a sovereign State in Central and East Africa located in a few degrees south of the Equator. Rwanda is a small, landlocked country situated between $1^0 04'$ and $2^0 51'$ latitude south and between $28^0 53'$ and $30^0 53'$ longitude east. Rwanda has mountainous landscape and that is why it's famous as the 'land of a thousand hills'. Rwanda enjoys a tropical temperate climate with diverse ecosystems. Rwanda is boarded by Uganda, Burundi and the Democratic Republic of Congo and Tanzania. Administratively, Rwanda has four Provinces, the City of Kigali and 30 districts. Rwanda's economy is largely agrarian where by 80% (10.94 million) of population depend on farming land. The total land area of Rwanda is 26,338km^2 of which 11% of the land represent permanent crop land (GoR, 2004). Rwanda's economy is set to grow by an average of 11.5% by 2018 and the GDP per capita income to increase from the current US$ 644 to US$ 1,240 by the year 2020 aiming at reducing the 44.9% overall poverty level recorded in 2011 to below 30% by 2018 (Kwibuka, 2014).

Rwandan population is over 11 million people increasing at nearly 2.8 % per annum of whom 58% are women and is expected to increase to 13million by 2020. Rwanda has the highest population density in Africa. Rwanda's strategic challenges include; the devastating socio-economic and environmental consequences of 1994 genocide, the land-locked handicap increasing transit costs limiting access to the global economy, limited natural resource base and a high population density dependant on subsistence agriculture. Rwanda is one of the first growing economies in the World, one of easy to do business, one of the cleanest countries in the World, less corrupt and a country where women empowerment is the highest in the World e.g. 64% of parliamentarians are women - the highest in world, 45 % of all SME businesses in Rwanda are controlled by women, 39% of accounts in Savings Cooperatives are held by women, 38% of all executive positions are held by women. Four powerful Ministries in the country: Foreign Affairs, Agriculture, Energy, Health and Disaster Management are in women's hands. 43.3% of district and sector level seats are held by women, 97% of all school age going girls see in school, higher than boys at only 95%. Behind these women empowerment levels lay the women potentials, emotions, capacities and resilience to prevent, mitigate and manage all forms disasters in the country.

Common land resources disasters and causes in Rwanda

Rwanda is highly vulnerable to a range of natural disasters. Over the years, the frequency and intensity of natural induced disasters like floods, droughts have increased leading to human casualties as well as economic and environmental consequences (UNEP, 2011). Climate change, unpredictable and irregular rainfall patterns raise the risk of flooding and landslides in Rwanda. Particularly, massive population displacement and resettlement on the country's critical ecosystems specifically forests and wetlands both within and outside protected areas raises concern over likely land resources related disasters. Also, majority of Rwanda population rely on rain-fed subsistence agriculture practised on steep topography. Torrential rains in 2007 caused extensive flooding, destroying crops in Gishwati. The frequency of flash floods often accompanied with landslides has significantly increased in the past ten years since 1998. Rwanda being located in a lift valley is prone to disasters due to an area with uneven altitude characterised by steep slopes of hills facilitate natural and man-made disasters in Rwanda.

Effects of land resource disasters in Rwanda

According to Rwanda Ministry for Disaster Management and Refugee Affairs 2014 report, Rwanda spends about Rwf 1billion in meeting the cost of natural disasters annually and disasters at least claim 100 people, 200 get handicapped, 3,000 houses are destroyed, while 3000 hectares of crops are damaged annually including infrastructures like roads, schools, electricity are damaged costing Rwanda Rwf1 billion on reconstructions each year (Ntigurirwa, 2014). July 2013 Ministry of Local Government of Rwanda reported that out of 47, 680 of households settled high risk zones, 30,822

households (35%) are still in high risk zone and need relocation and developing special rehabilitation plans of the high risk zones (Minaloc, 2013). Also, flooding and landslides pose a major disaster risk in the northern and western regions of Rwanda, flash floods triggered landslides which damaged agricultural land near Cyambara in Western province, torrential rains 2007 caused extensive flooding destroying crops in Gishwati. Flooding in Gishwati in 2007-women headed households were amongst the most vulnerable as they have limited resources to recover from disasters (UNEP, 2011)

Table 1 Summary of disasters in Rwanda from 1974 to 2008

Disaster	Category	Number of events	Total (people killed)	Average per event	Total (people affected)	Average per event
Drought	Drought	6	237	40	4,156,545	692,758
Earthquake	earthquake	2	81	41	2,286	1143
Flood	Unspecified	6	111	19	34,516	5,753
	Flood	2	48	24	1,921,678	960,839
Landslides		1	24	24	2,000	2000
Total		17	501	29	6,117,025	359,825

(Source: UNEP (2013), pp101)

Table 2 Top ten disasters from 1974 to 2003 by the number of people affected

Type of disaster	Date	Total number of people affected
Flood	June 1974	1,900,000
Drought	1976	1,700,000
Drought	March 1903	1,000,000
Drought	November 1999	894,545
Drought	October 1984	420,000
Drought	December 1996	82,000
Drought	December 1989	60,000
Flood	May 1988	21,678
Flood	April 2002	20,000
Flood	October 2003	7,016

(Source: UNEP (2013) pp101)

Mitigation efforts, Strategies and Achievements for Rwanda

Rwanda established a solid framework for environmental governance reflecting high level awareness of the linkages between improved management of environmental assets, development and prosperity (UNEP, 2011). It is in recognition of this environmental leadership that Rwanda was chosen as the host country of the World environmental day of 2010. Rwanda has legislated and implemented laws and policies to prevent, mitigate and manage disasters in a numberal of ways. These strategies include terracing hillsides to reduce vulnerability to flash floods, creation of buffer zones and afforestation around lakes to mitigate disaster and climate change impacts e.g. Lake Karago in Western Province. Rwanda also set up carbon offset schemes that can provide funding for tree planting and environmental impact projects e.g. Carbon offset program for tree nursery installation project at Kadirindimba site in Kayonza district supported by the Clinton-hunter development initiative (CHDI).

Rwanda established annual tree planting campaigns to afforestate the country. Other Rwanda efforts include; massive awareness creation and collective participation to facilitate the process of disaster management by all institutions and all citizens through monthly community work called 'Umuganda'-Rwanda traditional innovation for self-reliance. Rwanda is making successful strides in establishing a comprehensive early warning system to try to minimise the damages like every day weather forecasts in the media, including disaster management studies in both primary and secondary school curricula to widen awareness, focusing on preventive and preparedness strategies and methods. In addition, Rwanda carried out identification and mapping of the high-risk zones to relocate people from high-risk zones to safer land. For example, Rwanda indicated in 2013 that 43,000 households were identified as living in risky zones countrywide meant to be relocated (Ntigurirwa, 2014). However budget and skills constraints still face the efforts to prevent mitigate and manage land resources related disasters. The results include a drafted national operation plan of action plan and districts targets, conducted field visits in all provinces and districts and there are reports, community participation activities like special Umuganda and established data centre with HRZ statistics.

Summary of the status of high risk zones by May 2013

Provinces and City of Kigali	Total number of households in HRZ	Number of households already settled in April 2013	Remaining households	Achievements
City of Kigali	6594	2840	3754	43
Eastern Province	998	907	91	91
Northern Province	5018	1927	3091	38
Southern Province	19386	5648	13738	29
Western Province	15684	5536	10148	35
General total	47680	16858	30822	35

Source: Minaloc (2013) progress report.

Conclusions and recommendations

✓ Fast paced development also carries a number of risks in terms of social and environmental impacts. There is a need for multi-disciplinary assessment aim to provide the scientific advice that will help Rwanda steer an environmentally sustainable course toward the goals articulated in its vision 2020.

✓ There is need to continue mobilising and focusing investments in keys areas including ecosystem rehabilitation, renewable energy, conservation agriculture, innovative water and sanitation technologies and adaptation to climate change.

✓ It is critical that climate change studies are carried out to help guide interventions aimed at reducing vulnerability to potentially adverse impacts. However, this demands cross-sectoral, coordinated approach to disaster risk reduction and adaptation fully integrated in national development plans.

✓ Special attentions to women engagement at all levels and continue to search for innovative indigenous knowledge in disaster management.

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XSLT-BASED PROLIFERATION OF OPENSTREETMAP DATA TO SUPPORT DISASTER MANAGEMENT

DRVC2014
2nd Disaster Risk & Vulnerability Conference

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Abstract

In case of emergency information about the infrastructure of a region is indispensable for planning, execution, and support of rescue operations. OpenStreetMap, a project to create open geodata for the whole earth, already hosts geodata for many parts of the world digitized by volunteers. In special emergencies like the Guinea Ebola Outbreak collaborative mapping is used to refine and to extend the data available in the corresponding regions. The data model of OpenStreetMap is quite simple and flat and is basically encoded in a specific XML-based format which is not an acknowledged standard and cannot be used directly in all Geographical Information Systems. In this article, some basics about the involved XML technologies are described. The OpenStreetMap project itself, and its data structures will be presented. The Extenssible Style Sheet Language (XSL) is used to transform OpenStreetMap data into an encoding according to the international Geographic Markup Language (GML) standard trying to provide rich information for geographical features useful for transportation and logistics in the resonse, recover and rebuild phase in the disaster management. The XSL techniques are presented and an outlook for the usability of the GML data will be given.

Introduction

XML as basic encoding standard in geospatial information technology. The eXtensible Markup Language (XML, Bray et al. 2010) is fundamental to information and communication technology (ICT) and widely used in geoinformatics. It is applied to define data structures, encode the data itself, and provide metadata, as well as store configuration parameters and for client-sever communication. All types of alphanumerical data can be identified and put together as an *elements* which is simply a way to structure information within a pre-defined namespace. Elements are principal building blocks of XML data objects. Figure 1 shows the basic three-part structure of an XML element: start tag, element content and end tag. Together, the three parts form a "nested" structure. The element name appears in both tags, in the latter preceded by a slash character. These two tags bracket the element content. The content can be either empty, contain text, and/or contain other XML elements.

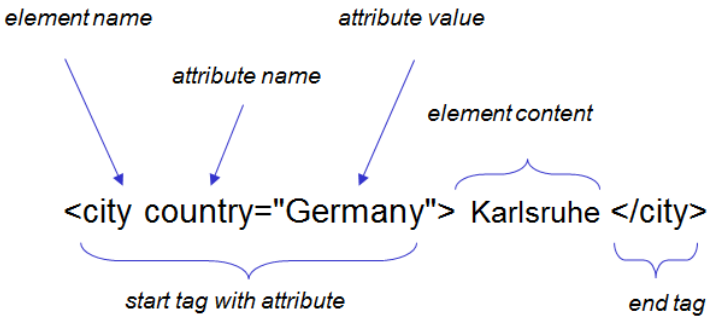

Figure 1: Basic structure of an XML element.

For the sake of brevity, an empty element may be written in the following abbreviated form:
<name />
Element content, however, is subject to some restrictions. It may not contain certain characters reserved for the markup language, such as < or &. These must then be coded as entities, for example, < instead of <.

In addition to being part of the element content, information may also be provided in the form of attributes in the start tag. Attributes are made up of pairs of keys and values (KVPs) separated by an equal sign. Keys are alphanumeric symbols (letters and numerals) chosen to label aspects of the properties of an element, and values are the specific names or numbers the keys represent. Values must be embedded in single or double quotation marks. In Figure 1, "country" is the

name of an attribute of the element “city” and with the attribute value “Germany”. Another important feature of XML is that one element may itself contain text and other elements. This characteristic enables elements to support additional and more interesting tasks, but it also increases the complexity of revising and correcting compositions. Hence, it is essential that so-called “nesting” be carried out methodically. Inconsistency in structuring elements not only leads to errors at inception, but inhibits the ability to process the XML instance later. The element that encloses the other elements used to document a data object is called the root element. In other words, the code which introduces and finalizes a particular document is actually just one element that surrounds all the other elements in a document. In general, when an XML data object is coded according to the conventions used to define elements as indicated above, it is considered “well-formed” and called an XML document or XML instance. The term XML stands for a large group of different markup languages and concepts, the vast majority developed or coordinated by the World Wide Web Consortium (http://w3.org/). Of these, the most important concepts and standards used in the field of geoinformatics are (Behr et al. 2011):

- XML Namespaces,
- Document Object Model (DOM; World Wide Web Consortium 2005),
- Document Type Declaration and XML Schema,
- XLink – XML Linking Language and XML Pointer,
- Scalable Vector Graphics (SVG),
- Cascading Stylesheets (CSS) and the Extensible Stylesheet group of languages (XSL).

XML is the basis of additional standards like the Geography Markup Language (see section) and other specific application extensions used in geoinformatics. XML is also employed in communication interfaces for geo-web services, such as Web Map Service (DE LA BEAUJARDIERE 2006), Web Feature Service (Vretanos 2010a and ISO 19142) and Coordinate Transformation Service (WCTS, Whiteside et al. 2007).

Namespaces

XML namespaces (http://www.w3.org/TR/REC-xml-names/) provide the means to specify element and attribute names in a simple and unequivocal manner. Names are connected to namespaces (vocabularies) by a prefix through unique Unified Resource Identifier (URI) references. Thereby, even if elements belong to different schemas, through the definition and use of prefixes, elements can have *qualified names* and can be used simultaneously. For example, the namespaces “cri”, “xs”, and “gml”, indicated below, are given for the xs:schema root element and following elements. An URI reference, e.g., http://www.opengis.net/gml/3.2 identifies the namespace gml (which is typically used for the Geography Markup Language) which, in turn, connects to the names “AbstractFeatureType”, and “centerOf”. Similarly, the elements “schema”, “element” and “complexType” are derived from the namespace xs.

```
<xs:schema xmlns:cri="./cri.xml"
        xmlns:xs="http://www.w3.org/2001/XMLSchema"
        xmlns:gml="http://www.opengis.net/gml/3.2"
        targetNamespace="./cri.xml"
        <xs:element name="HelicopterLandingSite">
                <xs:complexType>
                        <xs:complexContent>
                                <xs:extension base="gml:AbstractFeatureType">
                                        <xs:sequence>
                                                <xs:element ref="gml:centerOf"/>
                                                <xs:element ref="cri:Condition" minOccurs="0"/>
                                                <xs:element name="length" type="xs:double" minOccurs="0"/>
                                                <xs:element name="width" type="xs:double" minOccurs="0"/>
                                        </xs:sequence>
                                </xs:extension>
                        </xs:complexContent>
                </xs:complexType>
        </xs:element>
```

A namespace without declared namespace prefix can be used as a default namespace, associated to all elements without qualifying prefix.

XML Schema

XML Schema Definitions (XSD, http://www.w3.org/XML/Schema) permit detailed classifications of objects by defining their names, their structure and their attributes. An XML schema essentially operates on two levels. At the core, the root element of the schema contains namespace declarations and the attribute of the target namespace.

```
<xs:schema
        xmlns:cri="./cri.xml"
        xmlns:xs="http://www.w3.org/2001/XMLSchema"   xmlns:gml="http://www.opengis.net/gml/3.2"
...
```

This root element is then supported by a structure of geo-objects designated through their own specific elements. Thereby, whether simple and pre-defined or complex and self-defined, data types can be used on the basis of the same well-established concepts as used in object-oriented programming languages. The basic data types used in XML Schema are the same as those used in other programming languages, i.e., string, decimal, but also data types like date and time. Elements

are then easy to define. For example, an element named Easting can be indicated as having a data type double defined in the namespace xs:

```
<xs:element name="Easting" type="xs:double"/>
```

New complex types may be developed based on previously defined types. The data type “PointType” below has two properties (data type double), which describe the location of a point. The third element indicates the id used to identify the object:

```
<xs:complexType name="PointType">
  <xs:sequence>
    <xs:element name="Easting" type="xs:double"/>
    <xs:element name="Northing" type="xs:double"/>
    <xs:element name="id" type="xs:nonNegativeInteger"/>
  </xs:sequence>
</xs:complexType>
```

Complex data types by extension

In GML it is common that complex data types are defined by extending previously defined data types. In the example below, the data type of the element HelicopterLandingSite extends AbstractFeatureType (obtained from the gml namespace) by adding the properties gml:centerOf, cri:Condition, lentg, and width. In the XML instance, these will be child elements of the HelicopterLandingSite element.

```
<xs:element name="HelicopterLandingSite">
        <xs:complexType>
                <xs:complexContent>
                        <xs:extension base="gml:AbstractFeatureType">
                                <xs:sequence>
                                        <xs:element ref="gml:centerOf"/>
                                        <xs:element ref="cri:Condition" minOccurs="0"/>
                                        <xs:element name="length" type="xs:double" minOccurs="0"/>
                                        <xs:element name="width" type="xs:double" minOccurs="0"/>
                                </xs:sequence>
                        </xs:extension>
                </xs:complexContent>
        </xs:complexType>
</xs:element>
```

The attribute “ref” indicates that the elements are defined somewhere else.

Restrictions

With facets it is possible to create new data types by restricting existing ones. In the following example a simple type is defined as a restricted enumeration of different road surface properties encoded as strings.

```
<xs:simpleType>
        <xs:restriction base="xs:string">
                <xs:enumeration value="paved"/>
                <xs:enumeration value="unpaved"/>
                <xs:enumeration value="gravel"/>
                <xs:enumeration value="ground"/>
                <xs:enumeration value="unspecified"/>
        </xs:restriction>
</xs:simpleType>
```

Geography Markup Language

Geography Markup Language (GML) is a broadly recognized markup language used for the modeling, transport and storage of geographic information (Lake et al. 2004, Open Geospatial Consortium 2007). The basic definitions for elements, attributes and data types of the most recent version 3 of GML are provided in more than 30 XML schema documents, called basis schemas.

Because of the complexity of this standard for many essential tasks that involve GML an application specific schema, or *Application Domain Extension* (ADE), is created. An ADE provides a formal description of all relevant features and relationships used for that particular task or field of work. Such a schema can define separate geographical objects or features with their corresponding elements and properties. Such an ADE is described in section for the proliferation of geodata for rapid mapping.

The essential building blocks of GML are geo-objects or features. Features are made up by the many data types used to specify non-geometric and geometric characteristics. They are meant to represent objects in the real world, such as streets, bridges, and, in case of disaster management, further features needed to model infrastructure and logistics, all anchored within the specific context of the given application. The current GML 3 standard supports almost all kinds of two- and three-dimensional properties, as well as coordinates reference systems, time properties, dynamic features, topology, spatio-temporal coverages, observations, units of measure and some rules on presentation style. GML features may have

several geometric properties, each one embedded in a child element, which specifies the data type responsible for specific geometric property (e.g. centerOf, centerLineOf, curveProperty, surfaceProperty). The child element of a property element is one geometric element (e.g. Point, LineString, Polygon, etc.) or an XLink reference to a remote element. The following example shows the geometry of a point element:

```
<gml:centerOf>
        <gml:Point>
                <gml:pos>3512280.93 5410246.16</gml:pos>
        </gml:Point>
</gml:centerOf>
```

In GML, the specific system of coordinates chosen must be explicitly designated through a Coordinate Reference System (CRS) . This eases the combination of geodata delivered in different spatial reference systems.

Features are commonly aggregated into *feature collections*, in a manner similar to the layer concept used in GIS. A feature collection can be empty or contain an unlimited number of feature members and may have spatial properties as well. Furthermore, a collection can itself also be a feature. It is even possible to have feature collections of feature collections. In the example below, extracted from the Crisis Mapping GML Profile, the element wrapper aggregates an unlimited (unbounded) number of the elements Bridge, Railway etc..

```
<xs:element name="Wrapper">
        <xs:complexType>
                <xs:complexContent>
                        <xs:extension base="gml:AbstractFeatureCollectionType">
                                <xs:choice maxOccurs="unbounded">
                                        <xs:element ref="cri:Bridge"/>
                                        <xs:element ref="cri:Road"/>
                                        <xs:element ref="cri:Railway"/>
                                        <xs:element ref="cri:HelicopterLandingSite"/>
                                        <xs:element ref="cri:HazardousArea"/>
                                        <xs:element ref="cri:WeakSignalArea"/>
                                        <xs:element ref="cri:IDPCampSite"/>
                                        <xs:element ref="cri:FreshWaterSource"/>
                                        <xs:element ref="cri:MedicalFacility"/>
                                </xs:choice>
                        </xs:extension>
                </xs:complexContent>
        </xs:complexType>
</xs:element>
```

The data source: OpenStreetMap

Project overview

OpenStreetMap is a collaborative approach to create a free map of the world (Ramm, F., Topf, J. & Chilton S. 2010). Data collection is done entirely by a community of volunteers by surveying with GPS, digitizing aerial imagery, and collecting and integrating existing public sources of geographic data. Also data management, and proliferation is based on voluntary work of individuals and single organizations. Very specific to this approach is the encoding how geodata are provided from OpenStreetMap's geodatabase. It's data model is specifically simple and yet powerful way to represent geographic information (see Figure 2).

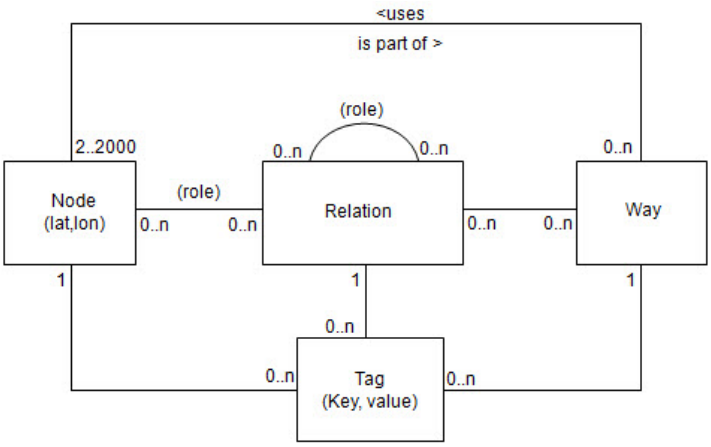

Figure 2: Simplified schema of the OSM data model (Source: Ramm, F., Topf, J. & Chilton S. 2010)

The basic element is the *node* consisting of geographical coordinates (latitude, longitude), timestamp, user ID, user name of the last elememt update, version number, number of the changeset in which the update was made, and zero or more tags provided in tag elements indicating the meaning of the node:

```
<node id="1631816650" visible="true" version="2" changeset="10856664" timestamp="2012-03-03T11:33:01Z" user="Esperanza36" uid="83557" lat="34.7218468" lon="36.7030568">
  <tag k="name" v="حمص"/>
  <tag k="railway" v="station"/>
 </node>
```

A *way* element references node elements by their id and connects them to a line or to a closed areal feature. The meaning of the feature is indicated again by the *key-value-pairs* provided in *tag* elements, in the example below "highway"..

```
<way id="150829242" visible="true" version="1" changeset="10714894" timestamp="2012-02-17T21:03:25Z" user="673a" uid="604523">
  <nd ref="1637003658"/>
  <nd ref="1637003659"/>
  <nd ref="1637003643"/>
  <nd ref="1637003661"/>
  <nd ref="1637003652"/>
  <nd ref="1637003645"/>
  <tag k="highway" v="residential"/>
  <tag k="source" v="bing"/>
 </way>
```

Node elements and way elements can be aggregated to more complex logical or geographical units using *relations*, similar to the concept of feature collections described above.

Feature tagging

Because OpenStreetMap does not use a clear concept of feature classes, tag elements specifiy the semantics of nodes, ways, and relations. Even if OpenStreetMap's tagging system allows to use an unlimited and arbitrary number of attributes describing and specifying each feature, the community agrees on certain key and value combinations, i.e., having an informal standard which is described in the wiki (http://wiki.openstreetmap.org/wiki/Map_Features).
Specific tags for the humanitarian field were developed by the Humanitarian Open Street Map Team (HOT) based on field requirements.[1]

The Humanitarian Open Street Map Team

The central goal of the Humanitarian Open Street Map Team is to connect the general Open Street Map Community with traditional humanitarian responders (http://hot.openstreetmap.org/about) by providing essential geoinformation for disaster management. For each disaster or crisis that occurs, after activation from an organization involved in disaster management, HOT decides about its engagement. Most of the work is done remotely, for example the collection and organization of existing data sources, processing and creation of data out of existing data. Since 2010 Hot is also providing training locally (for example in Indonesia, see http://learnosm.org/en/), to support mapping initiatives and to help data collection. This helps local communities to get prepared before a hazard strikes, which also means that communities can deal better with their situation during and after the disaster. The earliest project run by HOT that could be found on the HOT webpage was the Mapping Gaza Initiative during the 2008/2009 Israeli-Gaza conflict. Recent initiatives include Syria, the Super Typhoon Yolanda (Haiyan) which hit the City of Tacloban, and the Ebola epidemic outbreak in Guinea.

Other Crowd Sourcing Initiatives in Disaster Management

There are several other crowd-source based activities like the Google Crisis Response (including Google Person Finder, Google Resource Finder and Google Public Alerts). A specific software platform is Ushahidi including a basic web page design, as well as predefined services for receiving messages via email, web form, or text message (SMS) to support crisis management. It is provided by a "non-profit tech company that specializes in developing free and open source software for information collection, visualization and interactive mapping" (http://ushahidi.com/about-us). The goal of the Standby Task Force (http://blog.standbytaskforce.com/) is to provide volunteer online digital responses to humanitarian crises, local emergencies, and issues of local or global concern. MapAction is a non-governmental organisation (NGO) which is able "to deploy a fully trained and equipped humanitarian mapping and information management team anywhere in the world, often within just hours" (http://www.mapaction.org/about.html).

Transforming the OpenStreetMap data

The target XML schema

The XML schema developed comprises a basic set of feature classes essential for disaster mapping. The schema defines the namespace prefixes cri, xs, gml. Element names have to be fully qualified, but attribute do not have to.

---

[1] Details can be found at (http://wiki.openstreetmap.org/wiki/Humanitarian_OSM_Tags and http://wiki.openstreetmap.org/wiki/Humanitarian_OSM_Tags/HDM_preset.

```
<xs:schema
        xmlns:cri="./cri.xml"
        xmlns:xs="http://www.w3.org/2001/XMLSchema"   xmlns:gml="http://www.opengis.net/gml/3.2"
        targetNamespace="./cri.xml"
        elementFormDefault="qualified"
        attributeFormDefault="unqualified">
```

With the import element the whole definitions and declarations of the GML standard are made available.

```
        <xs:import namespace="http://www.opengis.net/gml/3.2"
        schemaLocation="http://schemas.opengis.net/gml/3.2.1/feature.xsd"/>
```

Afterwards the elements, attributes and declared data types are defined:

```
        <xs:element name="Condition">
                <xs:simpleType>
                        <xs:restriction base="xs:string">
                                <xs:enumeration value="destroyed"/>
                                <xs:enumeration value="damaged"/>
                                <xs:enumeration value="undamaged"/>
                                <xs:enumeration value="unspecified"/>
                        </xs:restriction>
                </xs:simpleType>
        </xs:element>
        <xs:element name="Road">
                <xs:complexType>
                        <xs:complexContent>
                                <xs:extension base="gml:AbstractFeatureType">
                                        <xs:sequence>
                                                <xs:element ref="gml:centerLineOf" minOccurs="1"/>
                                                <xs:element name="isPassable" type="xs:boolean"
minOccurs="0"/>
...
```

The element “Condition“ is generic and can be applied to any other elements in order to specify the status of roads, bridges etc. The data type of the Road element extends gml:AbstractFeatureType with the properties gml:centerLineOf and isPassable. gml:centerLineOf indicates that we use a center line to model the geomtry a road feature. The whole structure of the schema is shown in Figure 2. On the left side the element "Wrapper” can be seen (introduced in section). The upper branch on the right side encompasses the srructure inherited to the Wrapper element. In the lower part the feature classes defined so far are listed.

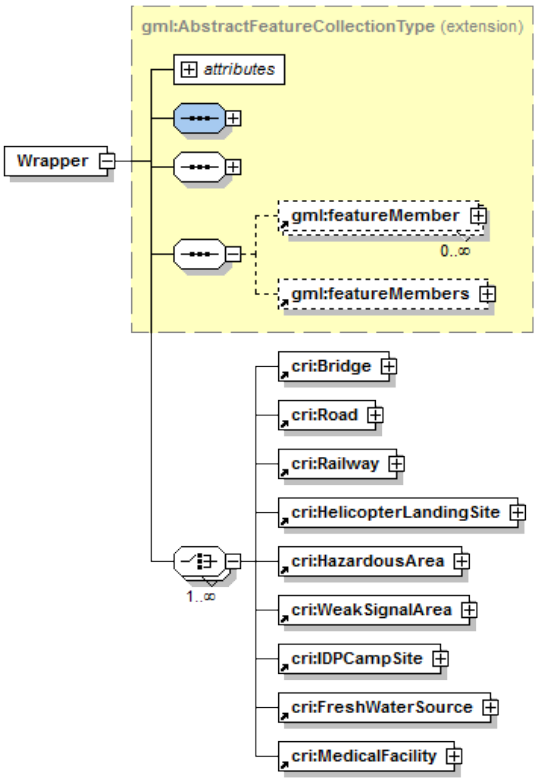

Figure 3: Crisis Mapping Schema (Overview).

XSL

Of particular importance to ICT and geoinformatics is the ability of specialized programs (XSLT processors) to transform XML instances into other instance documents (see Figure 4). XSLT, for example, enables the British Ordinance Survey (Ordnance Survey 2010) to visualize building permits and cadastral data using SVG encoding.

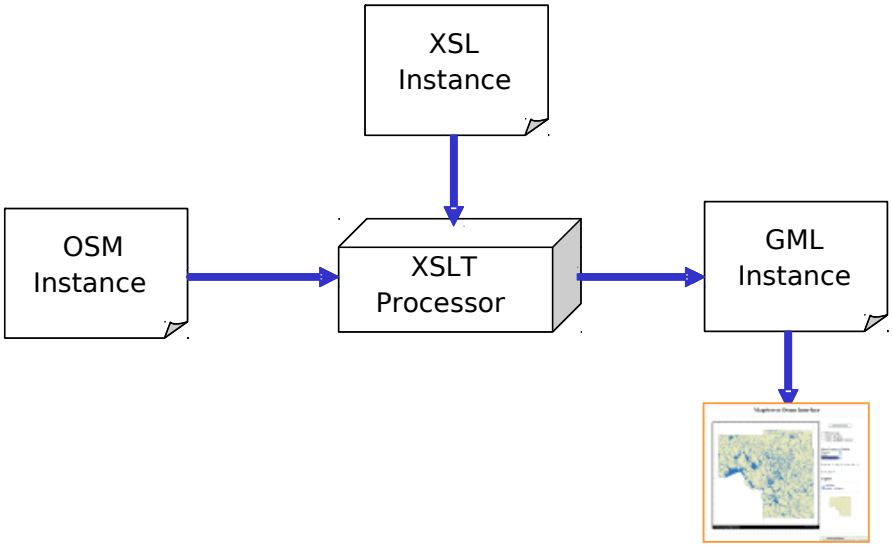

Figure 4: Transformation of geodata encoded on OSM into an GML instance

As shown in Figure 4, XML documents can be transformed into other XML documents (like GML instances in this project). through the application of Extensible Stylesheet Languages (XSL; http://www.w3.org/Style/XSL/). This group of languages includes XSL Transformations (XSLT), XML Path Language (XPath) and XSL Formatting Objects (XSL-FO). XSLT is the tool most often used to transform XML documents, because it supports both the structural transformation of XML objects and schema definitions. Transformation is also possible into data streams or even into other output formats (like PDF).

XPath (http://www.w3.org/TR/xpath) is a related concept used in the process of transforming XML documents. It allows parts of XML documents to be addressed using a separate syntax. It simply indicates where to look for the document fragment by following the nested hierarchical structure of the XML elements. In addition complex selection criteria (so-called node tests) can be specified. In the example below specific elements are selected by their element names osm and node as well as according to a specific key value pair (amenity and hospital):

```
<xsl:for-each select="/osm/node[.//tag[@k='amenity']
                                [@v='hospital']]">
                                <xsl:call-template name="medi"/>
</xsl:for-each>
```

For the elements found, the further transformation is done by the invocation of the medi template.

The transformation developed in this project starts with the XML prolog indicating version number and character encoding. Afterwards the transformation rules start with the root element xsl:stylesheet which includes the necessary namespace definitions.

```
<?xml version="1.0" encoding="UTF-8"?>
<xsl:stylesheet version="2.0"
        xmlns:xsl="http://www.w3.org/1999/XSL/Transform"
        xmlns:xs="http://www.w3.org/2001/XMLSchema"
        xmlns:fn="http://www.w3.org/2005/xpath-functions"
        xmlns:gml="http://www.opengis.net/gml/3.2"
        xmlns:cri="./cri.xml">
```

XML is declared as output format:

```
        <xsl:output method="xml" version="1.0" encoding="UTF-8" indent="yes"/>
```

The transformation process starts typically with accessing the document node which is some kind of entry to the whole document object model.

```
        <xsl:template match="/">
```

Afterwards some elements of the OSM data set are selected in order to retrieve the bounding box parameters needed for the GML output.

```
        <cri:Wrapper gml:id="w1" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="./xml crisis.xsd">
                <gml:boundedBy>
```

```
                <gml:Envelope srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                        <gml:lowerCorner>
                                <xsl:value-of select="/osm/bounds/@minlon"/>
                                <xsl:text> </xsl:text>
                                <xsl:value-of select="/osm/bounds/@minlat"/>
                        </gml:lowerCorner>
                        <gml:upperCorner>
                                <xsl:value-of select="/osm/bounds/@maxlon"/>
                                <xsl:text> </xsl:text>
                                <xsl:value-of select="/osm/bounds/@maxlat"/>
                        </gml:upperCorner>
                </gml:Envelope>
        </gml:boundedBy>
```

The output generated can be seen in section . Then a for-each loop iterates through all way elements tagged as highway and initiates the further processing by calling the road template

```
                <xsl:for-each select="/osm/way[.//tag[@k='highway']
                                        [@v!='pedestrian']
                                        [@v!='path']
                                        [@v!='footway']
                                        [@v!='bridleway']
                                        [@v!='steps']
                                        [@v!='cycleway']
                                        [@v!='proposed']
                                        [@v!='construction']]">
                        <xsl:call-template name="road"/>
                </xsl:for-each>
```

This template evaluates details of the input stream and creates the GML elements in the output:

```
<xsl:template match="/osm/way" name="road">
        <xsl:if test="string(./tag[@k='bridge']//@v)="">
                <xsl:variable name="id">
                        <xsl:value-of select="@id"/>
                </xsl:variable>
                <cri:Road gml:id="ro{$id}">
                        <gml:centerLineOf>
                                <gml:LineString gml:id="ls{$id}">
                                        <gml:coordinates>
                                                <xsl:apply-templates select="nd"/>
                                        </gml:coordinates>
                                </gml:LineString>
                        </gml:centerLineOf>
                        <xsl:element name="cri:roadSurface">
                                <xsl:choose>
                                        <xsl:when test="./tag[@k='surface']//@v = 'asphalt'">paved</xsl:when>
                                        <xsl:when test="./tag[@k='surface']//@v =
'concrete'">paved</xsl:when>
                                        <xsl:when test="./tag[@k='surface']//@v =
'cobblestone'">paved</xsl:when>
                                        <xsl:when test="./tag[@k='surface']//@v =
'asphalt;paved'">paved</xsl:when>
                                        <xsl:when test="./tag[@k='surface']//@v =
'ground'">unpaved</xsl:when>
                                        <xsl:when test="./tag[@k='surface']//@v =
'gravel'">unpaved</xsl:when>
                                        <xsl:when test="./tag[@k='surface']//@v = 'grass'">unpaved</xsl:when>
                                        <xsl:when
test="string(./tag[@k='surface']//@v)="">unspecified</xsl:when>
                                        <xsl:otherwise>
                                                <xsl:value-of select="./tag[@k='surface']//@v"/>
                                        </xsl:otherwise>
                                </xsl:choose>
                        </xsl:element>
                </cri:Road>
        </xsl:if>
</xsl:template>
```

For other feature types similar transformation were implemented.

The generated GML

The transformation process yields a GML instance. The following extract shows the root element which defines the gml and the cri namespace. The definiton of the latter was explained in section . The gml:boundedBy element specifies the coordinate values of the lower left and upper right corner of a box comprising all the data generated, according to the spatial reference system with EPSG code 4326 (geographical coordinates). Afterwards the first geographical feature is listed, a bridge with the id ls150308442.

```
<?xml version="1.0" encoding="UTF-8"?>
<cri:Wrapper      xmlns:gml="http://www.opengis.net/gml/3.2"
        xmlns:cri=".\cri.xml">
        <gml:boundedBy>
                <gml:Envelope srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
                        <gml:lowerCorner>36.6819000 34.6943000</gml:lowerCorner>
                        <gml:upperCorner>36.7648000 34.7597000</gml:upperCorner>
                </gml:Envelope>
        </gml:boundedBy>
        <cri:Bridge gml:id="br150308442">
                <gml:centerLineOf>
                        <gml:LineString gml:id="ls150308442">
                                <gml:coordinates>36.7028091,34.7163265,36.7024070,34.7167718
</gml:coordinates>
                        </gml:LineString>
                </gml:centerLineOf>
        </hum:Bridge>
...
```

The GML data can be loaded into a Geographical Information System where it can be combined with other data layers ().

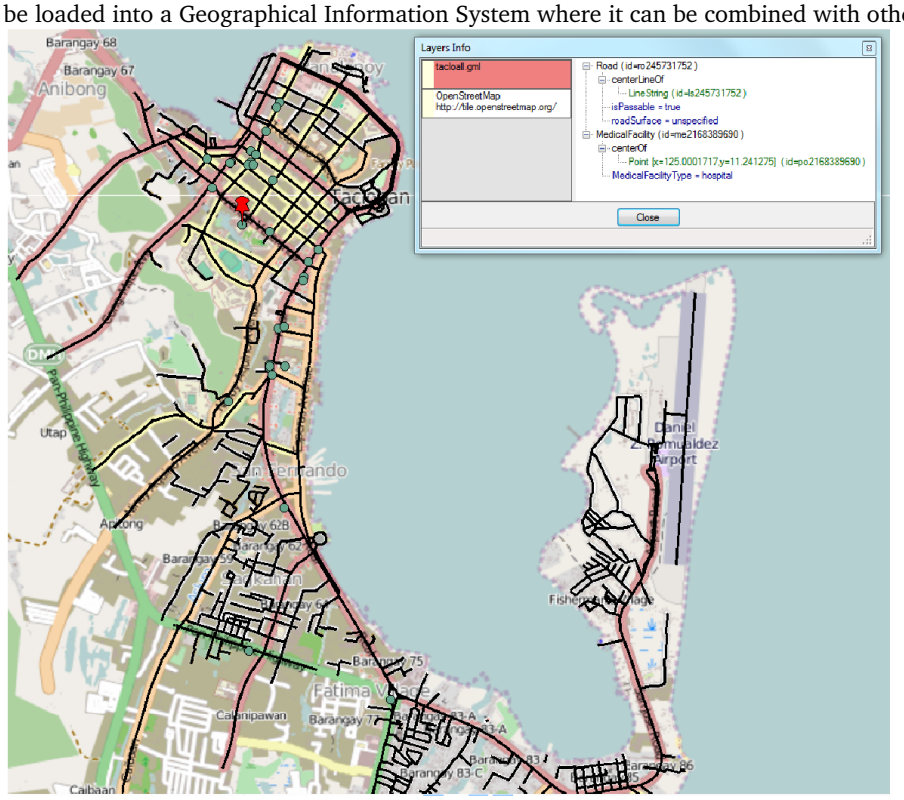

Figure 5: Generated GML data of the City of Tacloban, Philippines, which was largely destroyed by Super Typhoon Yolanda (Haiyan) 8 November 2013.

Conclusion

Open data, collected by volunteered efforts, are gaining more and more importance in the field of geoinformatics. An important project in this context is OpenStreetMap. It has been shown that the geodata provided there can be converted from a simple XML encoding to feature classes defined in GML, an internationally standardized encoding for geospatial data. The transformation is done using XSLT. The generated output smoothes the way for further data dissemination and integration into Geographical Information Systems.

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A PRELIMINARY APPRAISAL OF COASTAL LANDSLIDES IN THE TERTIARY SEDIMENTARY CLIFFS, VARKALA, INDIA

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Abstract

Varkala has a unique place in the geology and geomorphology of peninsular India because of the presence of coastal cliffs which exposes the entire sequence of Warkalli Formation and hence its type area. These cliffs, edging the Arabian Sea, run for a length of 5.5 km with an average elevation of ~30 m. These cliffs are under potential threat of recession due to different types of landslides. Fall, topple, slide and subsidence are the different types of landslides occurring in this cliff. Geology, slope, rainfall, groundwater, tidal action and anthropogenic factors are the different factors facilitating the landslide occurrence. This study deals with a preliminary appraisal of the different types of landslide occurring in this cliff and proposing management practices to minimize the recession rate.

Keywords
Varkala, landslides

1. Introduction

Varkala, a coastal hamlet in Thiruvananthapuram district, Kerala, attracting scores of tourists round the year. The charm of this place is the presence of beautiful wave-cut cliffs and confined beaches. Varkala exposes 3 such wave-cut cliffs, namely Edava Cliff, the North Cliff and the South Cliff (from north to south) with a maximum elevation of ~30 m edging the Arabian Sea and running for several kilometers. The picturesque cliff that stands like an edifice along the coast endows beauty to this paradise is under the potential threat of degradation in the form of landslides.

2. Study area

Varkala is situated about 55 km north-west of Thiruvananthapuram- the capital city of Kerala state (Fig 1). Varkala can be located in Survey of India topographic sheet 58D/10 (1:50,000 scale). This coastal town is well connected by road, rail and air. TS (Travancore-Shoranur) inland waterway, the once important inland water navigation system, passes through this area. Administratively, the area falls in Varkala village of Chirayinkil taluk in Thiruvananthapuram district. Papanasham, a ritual place for performing ablutions for ancestors; Janardhana Swamy temple, called Banarus of South India; Sivagiri, a pilgrim centre of Narayana Guru and Anchuthengu Fort, a coastal edifice are the other main tourist destinations near Varkala.

3. Geology and geomorphology

Varkala and adjacent areas form a part of Kerala Khondalite Belt (KKB) of the Southern Granulite Terrain (SGT). The Precambrian crystalline of this area are unconformably overlained by Tertiary sequence of Warkalli (as spelled by earlier people for Varkala) Formation with no representation of Palaeozoic and Mesozoic. Varkala cliff is the type area for the Warkalli Formation of Mio-Pliocene age (King, 1882), where the cliff exposes all the lithounits of this formation viz. unconsolidated sands, variegated clays, white plastic clays and carbonaceous sandy clays enclosing impersistent seams and lenses of lignite (GSI, 2005). These beds are almost horizontal in nature. On the basis of lithology and spatial distribution, Rao (1968) suggested the Warkalli Formation as shallow water shoreline littoral deposits. The regional geological map of this area is shown in figure 2. The modified generalized stratigraphy of this area, as suggested by Paulose and Narayanaswami (1968) is:

Recent (Kadappuram Formation) Beach sand
Recent to sub-recent Laterite
Current-bedded friable variegated sandstone interbedded with plastic clay and variegated clays
Tertiary (Warkalli Formation) Carbonaceous and alum clays with lignite seams
Gravel and pebble beds. Base marked by gibbsitic clay
~~~~~~~~~~~~~~~~~~*Unconformity*~~~~~~~~~~~~~~~~~~
Archaean Crystalline rocks

The sedimentary cliff is a unique geomorphological feature (Fig 3a) on the otherwise flat Kerala coast. This cliff is carved out by a combination of fluvial and marine processes. The coastal landscape forms a part of the lowland planation surface.
~~~~~~~~~~~~~~~~~~

The narrow confined beaches usually submerge during high tides. North Cliff runs for a length of 1.65 km and attains a maximum elevation of 30m. The numerous springs emerging from the cliffs (Fig 3b) form rivulets and join the Arabian Sea. A few stretches of marshy land are also seen near the north cliff.

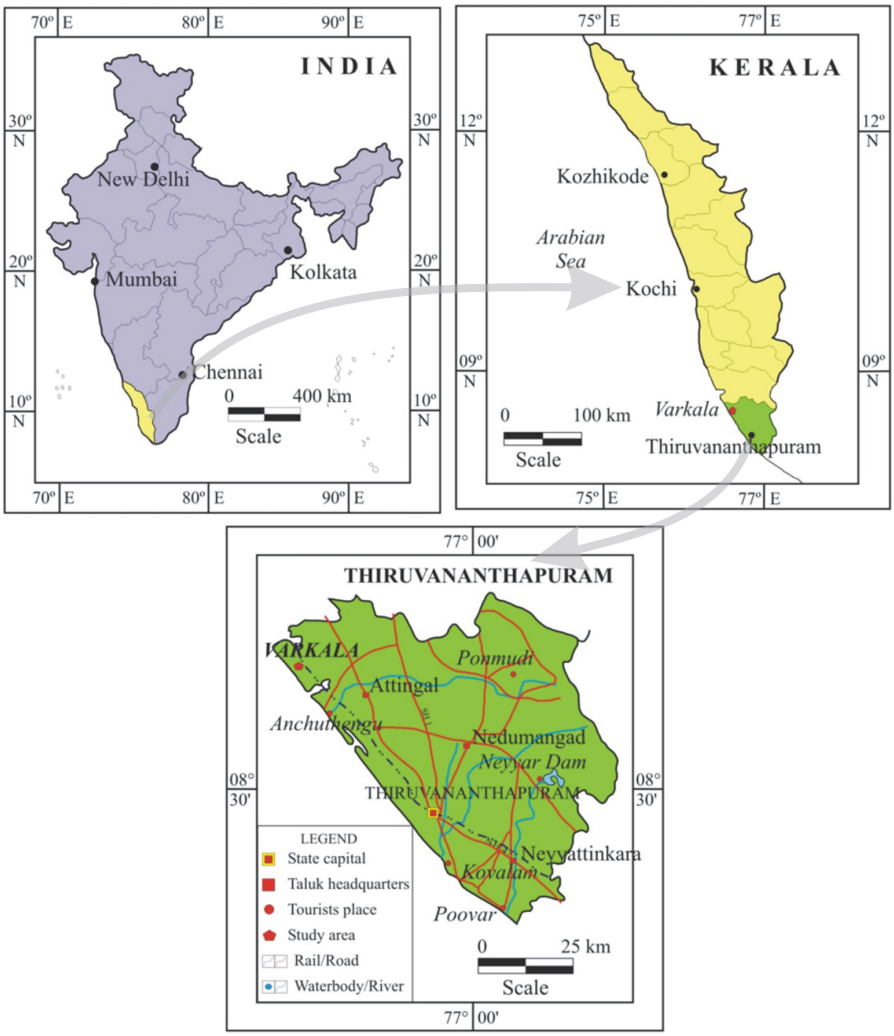


Figure 1 Location map of the study area

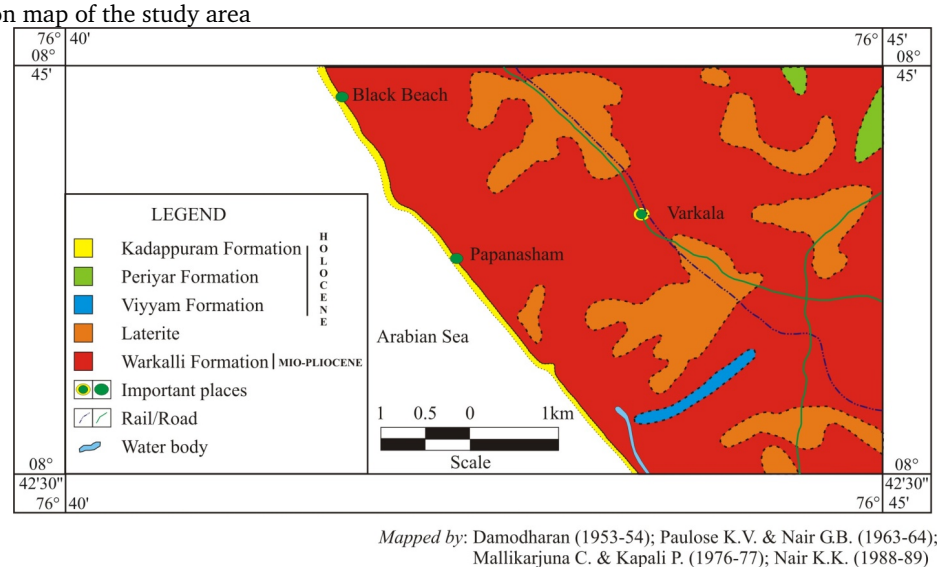


Figure 2 Regional geology map of Varkala and adjacent areas

Figure 3(a) Panoramic view of North Cliff, Varkala 3(b) Groundwater emerging as springs in North Cliff, Varkala

(a) (b)

4. Landslides in Varkala

Varkala Cliffs experience landslides round the year irrespective of the climatic conditions. Fall, toppling, slide and subsidence (Fig 4a-c) are the most common forms of landslides seen in this area.

(a)

(b)

(c)

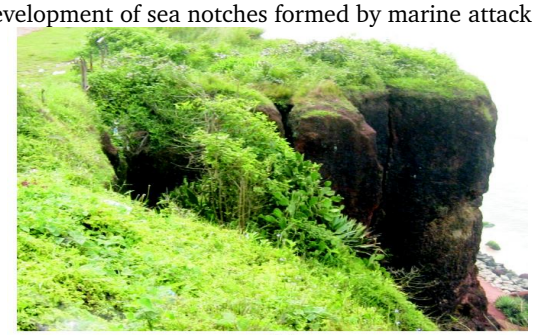
Figure 4 Different types of landslide (a) Fall/toppling (b) Slide and (c) Subsidence.

Fall and toppling are initiated by tension cracks. Presence of tension cracks facilitates water percolation and hence an exertion of hydrostatic force which ultimately lower the factor of safety. Usually the top laterites are more prone to fall and topple and such lateritic boulders are seen strewn all along the slope of the cliff and at places, this often acts as sea wall.

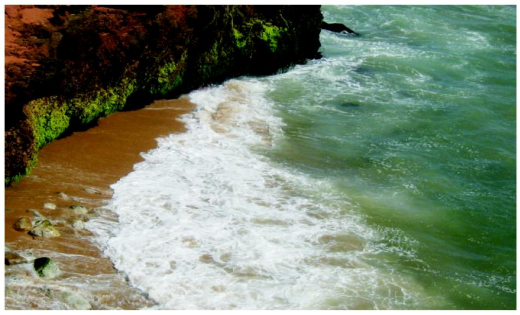
Slide and subsidence occurs mainly due to undercutting by the removal of toe portion especially by marine attack. The sliding plane of the slide will be an irregular plane formed haphazardly and the geometry of the plane is determined by the style of tension cracks. After the slide, this plane will be the new surface for the nature to act for a future landslide. Subsidence is common in this area. In strict sense, they are not circular in form but are arcuate in shape. In the subsided area, the top surface of the failed portion as well as the undetached portion remains parallel with elevation difference.

The failure occurs in two different fashions

1. From top to bottom due to the development of tension cracks (Fig 5a) and
2. From bottom to top due to the development of sea notches formed by marine attack (Fig 5b).



(a)



(b)

(c)

Figure 5(a) Development of tension cracks in the Varkala Cliff; 5(b) Sea notches formed in the toe portion of the Varkala Cliff; 5(c) Constructional activities upto the brim of the cliff

5. Factors influencing landslides

Landslides in this area are usually influenced by a combination of factors such as geology, wave action, anthropogenic activities, slope, groundwater and rainfall conditions.

5.1 Geology

Varkala Cliff exposes all the lithounits characteristic of Warkalli Formation. The soft and friable litho units and the overlying laterite are prone to failure due to both natural and anthropogenic factors. These soft friable sandstones and the weak carbonaceous clay are easily eroded by seawater, often forming wave-cut notches and making the top laterite in a hanging condition. Bromhead and Ibsen (2004) also report such wave-cut notches formed all along the coastal cliffs between Axmouth snd Thames Estuary. Due to anthropogenic factors tension cracks are developed in the top of the cliff which leads to the collapse of overlying laterite.

5.2 Anthropogenic activities

Being an important tourist destination and the main attraction being the cliffs, the influx of tourists to Varkala is increasing year after year. Constructional activities in the form of resorts, restaurants and other shops has encroached upto the brim of the cliff (Fig 5C). Vehicular movements along the edge of the cliff and parking of vehicles in the helipad area have added vulnerability to this cliff.

5.3 Wave attack

Varkala Cliff is exposed to continuous wave attack. A study on the temporal changes of Varkala Coastline over a period of ~100 years shows a landward recession of the cliff for about 45m. This was done through comparison of sea cliff position from different toposheets and imageries of different periods starting from 1915 (Fig 6). The recession has resulted in demolition of beautiful cliff, loss of various small scale coast protection measures like groynes and slipways and risk of further losses of property, roads and infrastructure.

Figure 6 Temporal changes of Varkala coastline

5.4 Slope

Slope gradient is a critical factor controlling the distribution of landslides as failure occurs only on slopes exceeding the critical angle for the materials to be moved (Thomas, 1974). A landslide occurs when the downslope component of the force exceeds the shearing strength of the material (Panicker, 1995). According to Thomas (1974), in tropical areas, mass movements are generally confined to slopes 30° and 60°. As the slope increases, shear stress in soil generally increases as well. Varkala cliff is exactly a vertical cliff (85-90°) facing sea formed due to west coast faulting. The present day slope is as a result of the modification by mass movements.

5.5 Groundwater

Groundwater occurs under confined condition in Warkalli Formation whereas in phreatic condition in the overlying laterite (Muraleedharan et. al., 2012). Bell and Maud (1999) in their studies in Durban, South Africa reveals that excess groundwater is one of the major causes of slope instability. Wilson and Wieczorek (1995) have suggested that precipitation can induce the formation of a saturated zone and the subsequent rising of the water table, especially where shallow bedrock exists. In Varkala the sandstone above the carbonaceous clay acts as an aquifer and the carbonaceous clay acts as an impermeable zone. Groundwater emerges as spring at numerous locations in the cliff section where the permeable sandstone is in contact with the impermeable carbonaceous clay. Seepage through spring is seen throughout the year and a spring line exists at the contact between sandstone and carbonaceous clay.

5.6 Rainfall

Rainfall plays a fundamental role in the onset of spatial and temporal evolution of mass movements (Sajinkumar et. al., 2011). The landslides occurring in this area are shallow landslides with a maximum depth of ~2m triggered by percolating rainwater in the laterite capping as mentioned by Terlien (1998). This area experiences heavy rainfall, though less when compared to the hilly region of Kerala state, especially during South West and North East monsoons (Sajinkumar et. al., 2013; 2014). The annual rainfall is usually in the tune of ~1900 mm and in some instances plummeting 2500 mm mark (Muraleedharan et.al., 2012). The effects of rainfall in this area are: (i) increase in pore-water pressure and consequent landslide and (ii) augment the groundwater which emerges as spring in the cliff section.

6. Management practices to protect cliff

The Coastal Regulation Zone (CRZ) notification (1991) issued by the Government of India and on the basis of the Supreme Court of India judgement in 1994, the Government of Kerala prepared the Coastal Zone Management Plan (Ramachandran et al., 2005). As per this plan the area from high tide level (HTL) to 500 m inland is classified as CRZ. The CRZ rules say that "the area up to 200 m from the HTL is to be earmarked as 'No Development Zone'. No construction shall be permitted within this zone except for repairs of existing authorized structures not exceeding FSI (Floor Space Index), existing plinth area and existing density and for permissible activities under the notification including facilities essential for such activities". Implementation of this CRZ rules will reduce the human pressure in the cliff. Being an important tourist destination and the main attraction being the cliffs, the tourist influx is increasing year after year (Rajan, 2011). Constructional activities in the form of resorts, restaurants and other shops have encroached up to the brim of the cliff. Vehicular movements along the edge of the cliff and parking of vehicles in the helipad area have added vulnerability to this cliff. Littering of the area, especially plastic disposal, is a real threat to the cliff.

The other management practices include: i) Prohibition of vehicular movement and shifting of helipad; ii) Construction of surface drainage network; iii) Puncturing groundwater table away from cliff; iv) Seawall construction and strengthening.

7. Conclusions

The initiative made by the Geological Survey of India (GSI) during the 48th CGPB (Central Geological Planning Board), held at New Delhi during August 2011, is identifying and developing geologically important places as 'National Geopark'. This initiative got much applaud from different parts of the country, and the state of Kerala in particular. A few rounds of talks were conducted with the State officials by the GSI and the moot of making Varkala as geopark was popularized through newspaper dailies. A grass root level talks with the local communities and population is in pipeline as a matter of bottom-up approach as per the norms of UNESCO. The entire coastal cliffs of Varkala were recently nominated by GSI for developing into a 'National Geopark'. The aim of this project will be providing awareness to the public regarding the importance of this cliff, popularizing the subject "Geology", avoid anthropogenic interference and finally to protect the cliff. Once this area is developed into a 'National Geopark', the final aim will be converting the status of this area as 'Geoheritage Site' under the UNESCO scheme. And hope a new Varkala will emerge in the future.

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DISASTER RISK REDUCTION, ITS EDUCATION: WITH A SPECIAL MENTION ON DRH-ASIA AND THE EDUCATIONAL TOOL DEVELOPED

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Abstract

Disasters that struck various parts of the world in past decades, its management thereafter and its experience taught lessons which insisted the paradigm shift in the management approach from post to pre disaster management. This shift indeed brought a massive influx of management initiatives, policies, framework as well as actions, all rooted in the concept of pre disaster management. Obviously, all these efforts were intended to reduce the level of impacts that future disasters were supposed to bring. Eventhough, the axiom, is ultimate goal of the much renowned shift in disaster management approach can be met only by making the communities resilient. So apart from the management frameworks, strategies and policies developed, the core of molding or empowering a community to a resilient one is rooted in the disaster risk reduction education imparted using various educational tools, mainly through awareness and training programs and other effective ways. For this, reliable information and knowledge resources has to be selected, shared and utilized for rendering disaster risk reduction activities effectively and efficiently. Making the expected users use the resources is also an essential part of the whole process. Conveying the available knowledge resources to the community by transforming it to the way that matches with the local context to build a so called culture of safety is the hardest part to be dealt with. It becomes the responsibility of the disaster management experts, concerned authorities as well as researchers to focus more on disaster education by making the technologies, knowledge resources available to vulnerable communities who are the supposed beneficiaries of all these. This paper elaborates the scope of a web based knowledge base known as Disaster Reduction Hyperbase – Asia(DRH-Asia) and draws in an example of an educational tool developed using DRH- Asia contents to illustrate how it can be used in real world circumstances. Along with this, the paper also emphasizes the significance of disaster risk reduction through community participation and disaster education (using educational tools) in molding disaster resilient communities

1. INTRODUCTION

Disasters have struck mankind throughout its long history. While each disaster may vary in its type, magnitude, and severity, the final result is always the same: devastation. **Victoria(2009)** states that whether a disaster is major or minor, of national or local proportions, it is the people at the community who suffer most of its adverse effects Therefore, the empowerment of such people and communities is imperative in every sense. Empowerment of communities can be done in various ways. Disaster management initiatives, policies, framework as well as activities done by Government, along with other effective stakeholders like Non Government Organizations, Civil Society Organizations all are aimed at empowering communities in one way or other. Materializing the success of any of these initiatives requires disaster risk

reduction in its real sense. **UNISDR(2004)** describes Disaster risk reduction as the conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development

To ensure the sustainable empowerment of communities educating them and making them aware of risks and vulnerabilities they face, and how they can better prevent these adversities through risk preparedness thereby can make efforts to build a resilient community. **UNISDR (2009)** explains that the United Nations International Strategy for Disaster Reduction (UN/ISDR) places considerable emphasis on building the resilience of communities as a necessary component of Disaster Risk Reduction. It is always better to implement the disaster risk reduction activities and community resilience enhancing activities through or along with local bodies (making community the core group) and whoever is working in the grass root level (which may vary with place and region in different regions of same country or country wise) who have more chance to know the geographical, economic and social background in a better way

2. EDUCATION IN DISASTER RISK REDUCTION

Smyth(1996) points out that education should be treated as a sustained learning experience for everyone throughout life. Education can be both formal and informal. Formal being taught by institutions like schools, college , universities or other similar institutions with an established structure(syllabus) but the other being learned through one's own daily activities, extra-curricular activities, traditional knowledge and other experiences in life. Any form of education has the potential to bring changes in the level of one's awareness, changes in the mindset, attitude, critical thinking as well as problem solving capacity

Based on the lessons learnt from the experiences **Shiwaku(2009)** explains: (i) education is a process for effective disaster reduction; (ii) knowledge, perception, comprehension, and actions are the four important steps; (iii) schools and formal education play an important role in knowledge development; (iv) family-, community-, and self education are important for comprehension of knowledge and implementation of risk reduction actions; and (v) holistic education includes actions at local level, as well as its policy integration It has been widely acknowledged that education takes on a pivotal role in reducing disasters and achieving human security in the attempt to achieve sustainable development**(Shaw et al., 2011).**

Petal(2009) points that during the International Decade of Natural Disaster Reduction(IDNDR) in the 1900s significant public education efforts emerged in many nations, and 'hazard education took root in science classes in schools. **UN (2000)** describes that the theme of "Disaster Reduction, Education and Youth" was introduced during the UN World Disaster Reduction Campaign in 2000. **UN/ISDR(2006a)** explains that late in the 2006–2007 "Disaster Risk Reduction Begins at School" campaign, UN/ISDR not only attempted to highlight the importance of integrating disaster risk reduction into formal education, but also emphasized the importance of community participation in order to achieve sustainability within the community.

Besides the education provided to youth which they would get from their formal education in educational institutions, it is widely advocated that education of community is essential to ensure a sustainable disaster risk reduction. **UNISDR (2005)** explains that, in Hyogo Framework for Action (2005-2015) in its priority of action 3, focus on the "use [of] knowledge, innovation and education to build a culture of safety and resilience at all levels", thus emphasizing the

.strength of education and knowledge in disaster risk reduction. **Petal (2008)** suggested that the goal of developing "disaster-resilient communities" is widely understood to depend heavily on the success of disaster risk reduction education.

Disaster Risk Reduction education can be seen rendered in various ways. Along with various ways of execution there are various disaster education materials described as 'educational tools' which will be described further in the next section. As one form of Disaster education, awareness raising programs and awareness workshops are widely seen done or executed by NGOs. Along with the usage of action oriented, participatory techniques, due importance should be provided to indigenous knowledge of respective communities. But the point to be noted is, the level of success of education depends on the efficiency of the mode of execution, how the community conceives it and their level of interest. So selection of the mode of execution is really important. Mode of execution and what to be conveyed(taught) should be chosen only based on the target group, their needs and constraints. Disaster education has to aim at shaping out empowered and resilient communities against disasters making them realize their own potential as well as making them able to find solutions to the problems they face. Partnerships or Collaborations among Government(especially local government) and NGOs in such endures of educational initiatives can bring synergic effects on the results.

3. EDUCATIONAL TOOLS OF DISASTER RISK REDUCTION

UN/ISDR(2006) describes that following the adoption of the Hyogo Framework for Action, various disaster educational materials that are described as "tools," of various forms such as in printed materials (booklets, leaflets, textbooks, handbooks/guidebooks, and posters) and non printed materials (activities, games, and practices) were developed. So far, numerous institutions have been developed DRR educational tools ranging from government agencies, research centers, the UN, NGOs, and IGOs. These tools are expected to be used from international level to local level for the welfare of communities around the word.

United States Federal Emergency Management Agency (1994) and Winser(2006) states that since the turn of the millennium, especially as a result of communication and information-sharing opportunities facilitated by the internet, disaster risk reduction champions have produced a plethora of educational materials for school children and the general public alike**.** UNISDR in collaboration with other partners have developed games like Stop Disasters, Riskland and Educational Toolkit and Magnitude. The question that hails in is, are we utilizing these educational tools in an expected way? So, now the responsibility left behind is the proper management, sharing and usages of these tools in its most appropriate way to make these tools reflect in actions during implementation of disaster reduction activities.

While converting these tools into actions, it should be assured that knowledge and information is flowing in both directions i.e. from practionaires or concerned authorities to community as well as from the community about their indigenous knowledge, local wisdom, needs, constraints etc to concerned authorities in return also. This can help in modifying and improving the tools further. **Petal(2009)** point out that yet, it is only very recently that the value and necessity of exchanging scientific and technical knowledge with indigenous knowledge can be articulated. Sharing of information, educational tools among communities especially those facing similar problems (hazards) even in different corners of the world can help in multiplying the benefits and achieve the goal of each tool to a greater extent

It is also important that the type of DRR tool is locality and the underlying risk focused ones, so that to match with the local context as hazard, vulnerability, risk as well as capacity level vary from region to region. So while implementing/using the tool should be altered to make it adapt to that particular context. In this the target audience, their cultural background, vulnerabilities they face major resources available will all be essential factors in deciding the modifications needed.

4. DISASTER REDUCTION HYPERBASE- ASIA APPLICATION(DRH-Asia)

Disaster Reduction Hyperbase- Asia application (DRH-Asia or simply DRH) is a web based knowledge base of disaster reduction technology information. The development of DRH was initiated by the launching of DRH Project based on the proposal of the Japanese Government at the UN World Conference on Disaster Reduction (WCDR), 2005. **Kameda(2011)** states that DRH addressed international promotion of 'Disaster reduction portfolio'; effective information platforms form disaster risk reduction. The proposal was intended to contribute to implementing the Hyogo Frame of Action for 2005-2015 adopted at the WCDR. Thus the product DRH-Asia was designed as a vehicle to compile and disseminate useful disaster reduction technology and knowledge and to facilitate its implementation. DRH-Asia is operated at http://drh.edm.bosai.go.jp from 2008.

The basic structure of DRH-Asia incorporates the following components:

DRH Database (Helps to Find technologies): Disaster reduction technology information (DRH contents) is available in this . DRH contents are specified as the categories IOT,PT, TIK.

DRH Forum(To propose a technology/ Discuss technologies): In DRH Forum registered DRH members can submit DRH content proposals, submitted manuscripts are discussed for enhancement(facilitation), and the completed proposals are sent from here to DRH Database

DRH Links(About DRH partners): Effective links are provided here to over twenty relevant initiatives for disaster information platforms. New initiatives can join the group through their manipulation on the web.

DRH Project (DRH project activities): This page allows you to draw exhaustive information on the activities of the DRH Initiative. Information available includes major documents and records of workshops that have led to diverse conceptual as well as practical developments of DRH.

Expected users of DRH are:(i)Practitioners(ii)Community Leaders (iii)Policy Makers (iv)Motivated Researchers(v)Educators in disaster risk reduction. They are the people who serve to fill gaps between research and practice (notion referred as 'implementation strategy'). DRH system compiles 'implementation technology' which involves a set of Implementation Oriented Technology (IOT: product), Process Technology (PT: procedure), and Transferable Indigenous Knowledge (TIK: wisdom).

DRH explains the definitions of the above attributes as follows: *(*a) Implementation Oriented Technology (IOT): Products from modern research and development that are practiced under clear implementation strategies(b)Process Technology (PT): Know-how for implementation and practice, capacity building and social development for knowledge ownership(c)Transferable Indigenous Knowledge (TIK):Traditional art of disaster reduction that is indigenous to specific region(s) but having potential to be applied to other regions and having time-tested reliability.

DRH-Asia already have 38 DRH contents which have been contributed by researchers and NGO practitioners from Algeria, Bangladesh, China, India, Indonesia, Iran, Japan, Nepal, Peru, Philippines and Sri Lanka

4.1 DRH- EDUCATIONAL TOOL DEVELOPED

Disaster Management Technology Database / DRH Exercise [code: U-Y-03], is one of the interdisciplinary seminar under the GCOE-ARS (Global Center for Excellence – adaptation, resilience, for a sustainable/society) program offered by Kyoto University. Students enrolled in this U-Y-03 seminar after getting acquainted with the DRH contents have to develop their own Disaster Risk Reduction educational tool. This section explains about the educational tool developed for conducting an awareness workshop using DRH –Asia contents that can be used by any NGO or any awareness raising organizations by bringing in appropriate modifications.

Title of the educational tool: Awareness Workshop: A Step Towards Enhancing Community Disaster Resilience

1.Objective: To develop an educational tool for the coastal community to enhance their knowledge about - disasters they usually face, significance of disaster reduction approach and how it can be done

2 Elements selected and the reason

(i)Hazards:Cyclone/Typhoon, Flood, Epidemics-These are the disasters that usually affect coastal communities

(ii)Type of Tool: Education/Training- As the main purpose is to generate awareness, instead of self-learning, Education/training will be more effective

(iii)Type of Education/Training: Lecture, Field Trip, Group Discussion

a) Lecture – Lectures can be used in generating awareness about hazards, especially those which are prevalent in that specific area. It is also important to include lessons of disaster reduction methods and its significance in th e lectures rendered. Lecture should in such a way that it could invoke knowledge, Interest, Desire among community towards disaster, its management and disaster risk reduction approaches and processes.

b) Field Trip – vulnerabilities of the area can be identified and assessed by conducting a Field Trip for the participants. Field trip is actually an action oriented approach.

c) Group Discussion- Group Discussions can help in bringing out new ideas from the participants.

(iv)Media/ material: Presentation, Photos, Pamphlet

Presentations: Always presentations can help in describing things more deeply and making the audience understand things clearly and remain in their memory for a long time than an oral talk

Photos: As it is always said 'A Photo can speak a thousand words

Pamphelt: They can always be an information capsule in a simplified form

3. Awareness Workshop Structure

Workshop Duration – 3 days

Major Activities

Day 1 (9:00 – 16:00hrs)	Lecture(presentation), Group discussion based on lecture
Day 2 (9:00 – 16:45hrs)	Field visit, Group Discussion, Presentation
Day 3 (9:00 – 14:00hrs)	Formation of Disaster Management Group and Group Discussion

Awareness Workshop – Guidelines for conducting the Workshop

Day 1 (Lecture(presentation),[60 minutes], Group discussion based on lecture

(a)Introductory session(9:00-9:30hrs): Self Introduction by participants and any of the organizing members can Explain briefly about the workshop activities

(b)Distributing questionnaire among participants and making them answer (From 9:30- 10:15hrs)

Sample questions for the questionnaire:

(1)List out the natural disasters that affect your village

(2) Mention whether they affect annually or not? If not anually when did that disaster occurred for the last time (mention the year)

(3)If it occurs every year in almost which month or months do they occur?

(4)Which spots in your village do you think is the most dangerous?

(5)List other dangerous spots in your village?

(6)Name some safe places in your village that can be used for evacuation/ evacuation shelter

(6)Name the latest severe cyclone (any other major hazard common in that particular area) that affected your area

(7)List 3 Safety measures for each disaster you listed

Part I(to generate knowledge)(10:30- 13:00)

(c)Lecture- For awareness generation about hazards

Topics that has to be covered include(i)What are disasters? How and why it occurs(ii) Common disasters in that particular place and their timings;usually in which time of a year those disasters would strike that area like flood during which month etc(iii)Safety tips for each disasters common in that particular place

Make sure that Part I of lecture covers answers for all the questions you ask in your questionnaire

Part II(14:00- 15:30)

Topics that has to be covered include(i)Familiarizing existing mechanisms in other parts of the world eg: conference mechanism(DRH51),Cyclone early warning dissemination at community level, Bangladesh(DRH19).

This would help participants to understand that around the world how people are facing adversities because of disasters and how they are coping with such adversities. This would give new ideas or help develop their own disaster management methods or can adopt methods following by people in other parts of the world. This can generate aan attitude /will power among them that they can also cope with disasters.

(ii)Significance of Disaster Risk Reduction- This can make them aware how Disaster Risk Reduction approach can bring a huge difference in the impacts they have to face after usual disasters they face

(iii)What should be done for ensuring Disaster Risk Reduction- This can help the community to increase their coping capacity

Part III (15:30- 16:00)-Formation of groups for Field Trip

Field trips can help explore the disaster related risk and vulnerability issues in the target area and reinforce what they have learned through lectures.For making everyone participate efficiently it would be better to to divide the total participants into small groups(eg: 5 participants in each group+1 supporting person(NGO member or others)**).** While forming groups ensure or atleast try to evenly distribute participants from all categories (eg:male, female, student, elder) in each groupMake preparations based on the already prepared checklist (Base Map, Markers, Camera, Pen, Pencil, Stick notes etc)

Day 2 Field visit, Group Discussion, Presentation [Action]

Part I - Field Trip (9:00- 12:00)- Divide the whole Target area (eg: part of the village) into 4 areas. Each group will have predetermined time duration (eg:45 minutes) for visiting and examining situations in each area (division of the target area and time duration for the visit can be altered based on the number of participants and the size of target area).

Activities to be done in the field

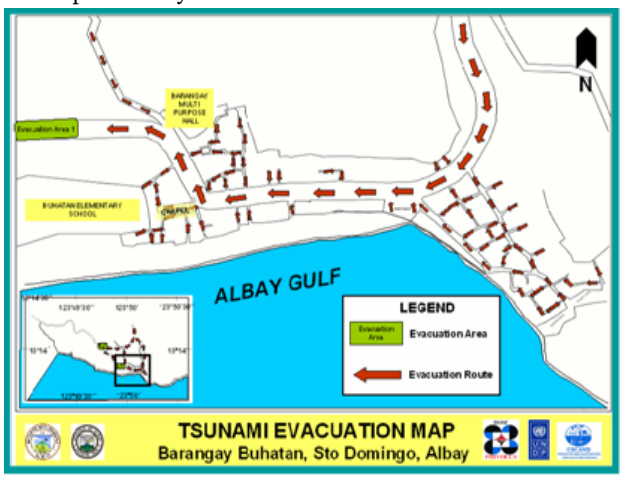
- Identifying the vulnerabilities / dangerous areas(spots)
- Identifying safe spots
- Understanding local issues(sanitation issues, waste management issues etc)


Photos: (Left)River mouth is a vulnerable area (Right) Improper Waste Disposal (Photos by Asharose)

Part II- Discussion and Presentation (13:00-14:30 and 14:45 – 16:05)

Based on the field visit, discussion should be done within each group about'

- What they have watched,
- What can be done to reduce Disaster Risk in the target area
- Evacuation route to the safe places they have identified



Evacuation Map (Photo from DRH 49)

After the discussion within each group, each group should present what they have discussed and their conclusions and remarks.After that, main facilitator can make the concluding remarks based on all the presentation of all the groups and general discussion for further clarifications and intrepretations can be conducted (16:05- 16:45)

Day 3 Formation of Disaster Management Group and Group Discussion

A workshop for 2 or 3 days will not be able to assure community resilience in its full sense. For molding a disaster resilient community it further requires actions both by the community and the experts in the field. Formation of permanent Disaster Management Groups in the community can lend help in this regard.

Part I – 9:00- 12:30

- Selection of members and formation of disaster management group for that particular community
- Group Discussion on how to make the group and work together, and role allotment for selected members

Part II- 13:30- 14:00

- Making them answer the previous questionnaire again(To check the change in their awareness level)
- Distribution of pamphlet

[Contents: Points from Lecture like - About Disasters common in that particular area and their safety tips]

4. Ensuring sustainability- For ensuring sustainability of disaster resilience of the community it is important to work further through all possible ways and with innovative ideas. In school level continuity of the activities done can be maintained through formation of DM(Disaster Management)Clubs in schools, collection of materials regarding disaster preparedness, mitigation, vulnerability assessments , response, management strategies etc. from newspapers, internet or other sources and presenting it or preparing posters out of it, competitions(poem writing, essay writing, slogan writing), games(like cross word, UNISDR developed games like Stop Disaster etc.).In whole community level continuity can be maintained through monthly meetings of direct and indirect users and review on activities done, planning about preparedness to be taken before usual flood season etc., as well as updation of information.

Eventhough there are disaster preparedness measures and safety tips. to bring all that into effect it requires working it out with them and making it further familiar to the community through their participation. With regions, the disasters, it vulnerability, resources everything varies. So it is advisable to prepare work /action plans specific for each vulnerable area under the supervision of concerned authorities or stakeholders

DRH contents used: DRH17, DRH19, DRH28, DRH48, DRH49, DRH51, DRH53

Conclusion

Disaster Risk Reduction and its education are both complementary to each other. Living in an era of technological breakthroughs, availability of information is handful but sharing of information and proper utilization can only help in replicating the benefits. Efficiency of disaster education lies in sharing of information , cooperation and collaboration among various institutions, agencies , bodies(Government, Nongovernmental etc.) working towards the achievement of same goal, the Disaster Risk Reduction All the available knowledge resources will be fruitful only when it reaches society/community and brings positive changes in them, by bringing up safer communities, more empowered and resilient, with self-help capacities to respond appropriately in the disasters yet to come.

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REAL TIME SEISMIC ANALYSIS USING G-PROGRAMMING

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Abstract

Piezo-actuated beam is used for wireless seismic measurement and indication using Lab VIEW. Principle of piezoelectric materials has been utilized here i.e. Piezoelectric materials deform when a voltage is applied to them and inversely will produce a voltage when they are deformed. For this reason, they can be used as both sensors and actuators. Here, Lab VIEW 2013 version,NI-DAQ,NI ELVIS (Educational Laboratory Virtual Instrumentation Suite) and Bluetooth device connected with PC has been utilized for acquiring and indicating vibration. The developed design is expected to be used universally for the measurement of seismic waves and also for measuring micro vibrations in machineries.

Keywords

Seismic and Vibration measurement, Lab VIEW, wireless communication

1. Introduction

Vibration measurement is an important factor in predictive maintenance. Peizo actuated beam are used for this purpose. A flexible aluminum beam is considered in this paper. Piezo electric sensors are bonded to the surface of the beam. The bonded patches on the surface of the beam acts as a sensor which is connected to a DAQ board. The need of data acquisition is to measure physical phenomenon such as voltage, current, temperature etc... Computer based data acquisition utilizes a combination of application software ,modular hardware, and a PC to take measurements. Data acquisition systems integrate signals, actuators, sensors, signal conditioning, data acquisition devices, and application software. Data Acquisition is the technique of Acquiring signals from real-world, digitize the signals and Analyze, presenting and saving the data.

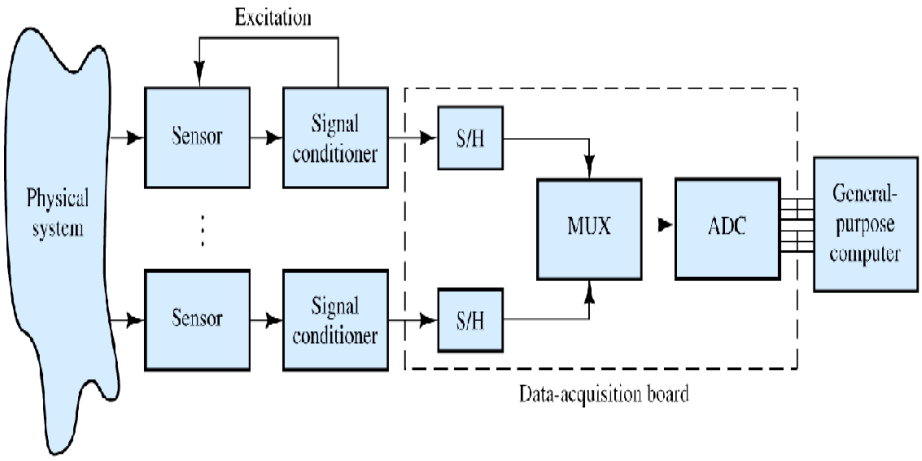


Figure 1 Block diagram of the system

Bluetooth is a wireless protocol for exchanging data over short range of distances (using short-wavelength in the ISM band from 2400–2480 MHz radio transmissions) from fixed and portable devices, creating PANs with high security. Created in 1994 by telecom vendor Ericsson, it was replaced as a wireless alternative to RS-232 wired data cables. It can connect many devices and overcame the problem of synchronization. It is a packet-based protocol with a server-client structure. One server can communicate up to 7 clients in a piconet; all devices share the Server's clock

2. Seismic measurement system

2.1 Main Objective

- The aim of this work is to measure the seismic and vibrations in industrial applications using wireless sensor network and indication using VI.

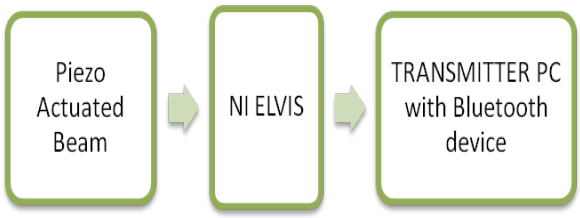
- A VI (virtual instrumentation) system is the use of modular measurement hardware and customizable software to create user-defined measurement system.

- The data acquisition hardware and software modules of National Instruments (NI) LabVIEW has turned into one of the most highly used tools that views, captures, processes and controls. Hence, NI hardware has also been utilized in our project work . Its a recent approach for Wireless based strain measurement.

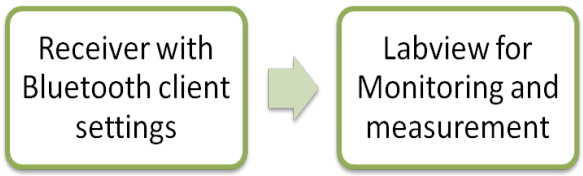
2.2 Block Diagram

The block diagram of the measurement system developed is shown in Figure and the function of each block is explained in detail below.

- TRANSMITTER END



- RECEIVER END



- **BLUETOOTH DEVICE**

Bluetooth is a wireless technology that uses 2.4 GHz RF (radio frequency) to communicate between devices within a 30 to 40-foot range. Initially it was advanced to communicate wirelessly with PDAs, cellular phones, and laptop computers. This simple protocol and ease of its implementation make it an ideal protocol for wireless communication across a different set of products in industries. Engineers are utilising it to develop instrument control applications and remote data acquisition . Lab VIEW 2013 include Bluetooth VIs with which Lab VIEW developers can construct custom Bluetooth applications. This application note illustrates how to construct a Lab VIEW software for communicating with Blue-tooth enabled devices.

Creating Bluetooth master and slave applications in Lab VIEW is likely same as creating master and slave applications for TCP communication. A Bluetooth server (master) makes use of the Service Discovery Protocol (SDP) for broadcasting the availability of the services incorporate and listens for inbound connections. A slave creates an outbound RFCOMM connection to a master. Once the slave and master connect to each other, they share data until the slave or master terminates the connection or unless the connection is lost. There is no inbuilt security in the Bluetooth protocol, although a number of devices include settings that need slaves to log in before accessing Bluetooth services. This technology is a short-range communications technology that is simple and secure everywhere. It is aimed to replace the cables connecting devices, while maintaining high range of security. The key features of this technology are low cost, low power, and robustness.

- SENSOR UNIT

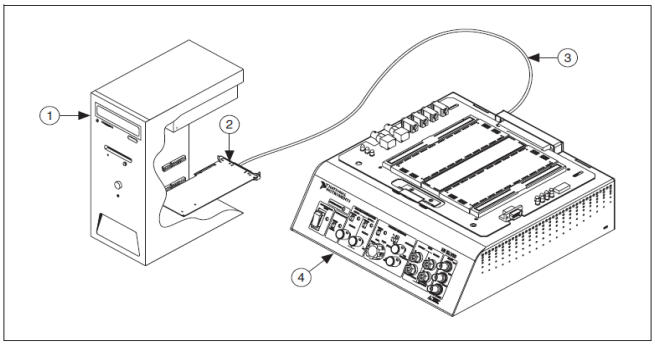
A **piezoelectric sensor** is a device that uses the piezoelectric effect, to measure changes in pressure, acceleration, strain or force by converting them to an electrical charge. Here, it measures changes in vibration / strain and produces voltage. The sensor unit consists of a cantilever beam with piezo-electric sensors sandwiched on their side. The cantilever beam was fixed to a system whose vibrations are to be measured. The vibration is sensed by the sensor which is converted to voltage is measured and monitored in Labview .

- DAQ UNIT:

DAQ card is required for the interfacing purpose. Hardware functionality includes 2 analog outputs, 16 analog inputs, 24 digital I/O, triggering , counter/timers and synchronization circuitry. Data acquisition involves collecting signals from measurement sources and digitalizing the signal for storage, analyzing and presenting it on a Personal Computer. Data acquisition (DAQ) systems comes in many different PC technology forms for good flexibility while choosing your system. Scientists and engineers can choose from USB,PCI, PXI, PXI Express, PCI Express, PCMCIA, Wireless and Ethernet data acquisition for testing, measurement, and automation applications. Five components that are to be considered when building a basic DAQ system are

• Transducers and sensors
• Signal conditioning
• Signals
• DAQ hardware
• Driver and application software
NI ELVIS

NI ELVIS combines hardware and software into one complete laboratory suite. NI ELVIS (Educational Laboratory Virtual Instrumentation) features an integrated suite of regularly used instruments in a single compact form factor constructed for education purposes.



1	Desktop Computer	3	Shielded Cable to M Series Device
2	68-Pin M Series DAQ Device	4	NI ELVIS Benchtop Workstation

Figure 2 Block diagram of the system

- INTERFACING SENSOR UNIT WITH LAB VIEW

Personal computer with lab VIEW 2013 version using NI-ELVIS has been used for acquisition and Indication of strain (vibration) in our present work.

Figure 3 Interfacing with system

3. SETTING UP CONNECTIONS

Any Bluetooth device in *discoverable mode* will transmit the following information on demand:

- Device name
- Device class
- List of services
- Technical information (for example: device features, manufacturer, Bluetooth specification used, clock offset)

Any device may perform an inquiry to find other devices to connect to, and any device can be configured to respond to such inquiries. However, if the device trying to connect knows the address of the device, it always responds to direct connection requests and transmits the information shown in the list above if requested. Use of a device's services may require pairing or acceptance by its owner, but the connection itself can be initiated by any device and held until it goes out of range. Some devices can be connected to only one device at a time, and connecting to them prevents them from connecting to other devices and appearing in inquiries until they disconnect from the other device.

Every device has a unique 48-bit address. However, these addresses are generally not shown in inquiries. Instead, friendly Bluetooth names are used, which can be set by the user. This name appears when another user scans for devices and in lists of paired devices.

3.1 Bluetooth VIs in Labview:

Lab VIEW 2013 include Bluetooth VIs with which Lab VIEW developers can construct custom Bluetooth applications. This application note illustrates how to construct a Lab VIEW software for communicating with Blue-tooth enabled devices.

Creating Bluetooth master and slave applications in Lab VIEW is likely same as creating master and slave applications for TCP communication. A Bluetooth server (master) makes use of the Service Discovery Protocol (SDP) for broadcasting the availability of the services incorporate and listens for inbound connections. A slave creates an outbound RFCOMM connection to a master. Once the slave and master connect to each other, they share data until the slave or master terminates the connection or unless the connection is lost. There is no inbuilt security in the Bluetooth protocol, although a number of devices include settings that need slaves to log in before accessing Bluetooth services. This technology is a short-range communications technology that is simple and secure everywhere. It is aimed to replace the cables connecting devices, while maintaining high range of security. The key features of this technology are low cost, low power, and robustness.

3.2 Sensor unit

A **piezoelectric sensor** is a device that uses the piezoelectric effect, to measure changes in pressure, acceleration, strain or force by converting them to an electrical charge. The prefix *piezo-* is Greek for 'press' or 'squeeze'. Here, it measures changes in vibration / strain and produces voltage. The sensor unit consists of a cantilever beam with piezo-electric sensors sandwiched on their side. The cantilever beam was fixed to a system whose vibrations are to be measured. The vibration is sensed by the sensor which is converted to voltage is measured and monitored in Labview .

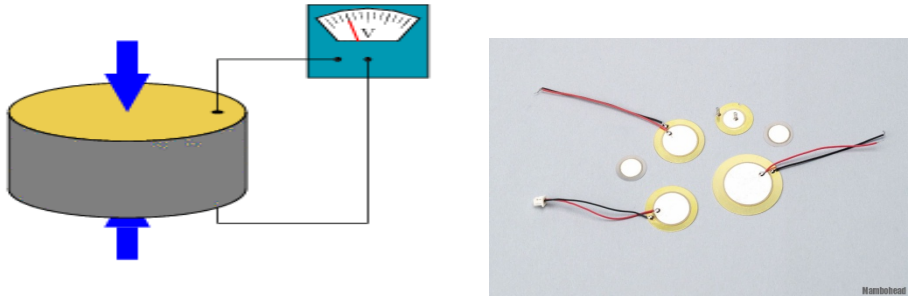


Figure 4. *Piezo disc type transducer*

3.3 Transmitter with DAQ Block Diagram:

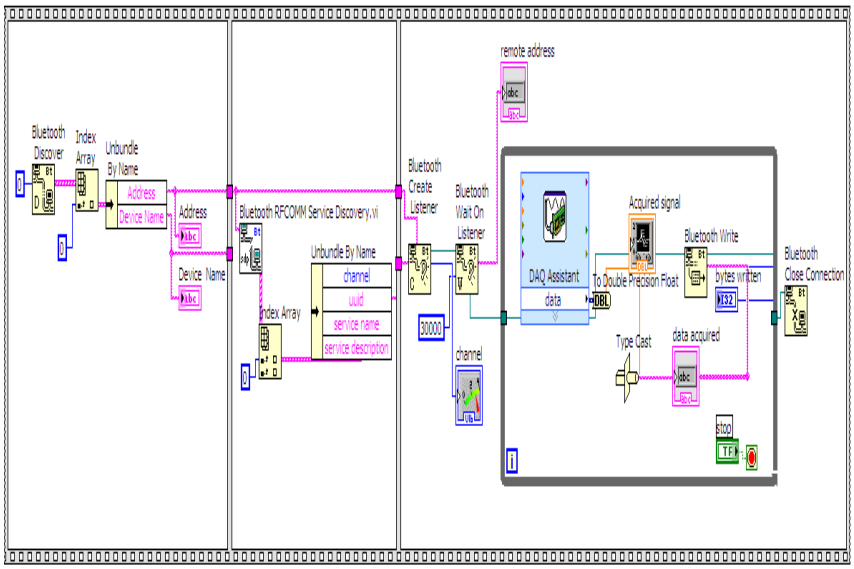


Figure 5 Labview Block Diagram of the system

3.4 Front Panel:

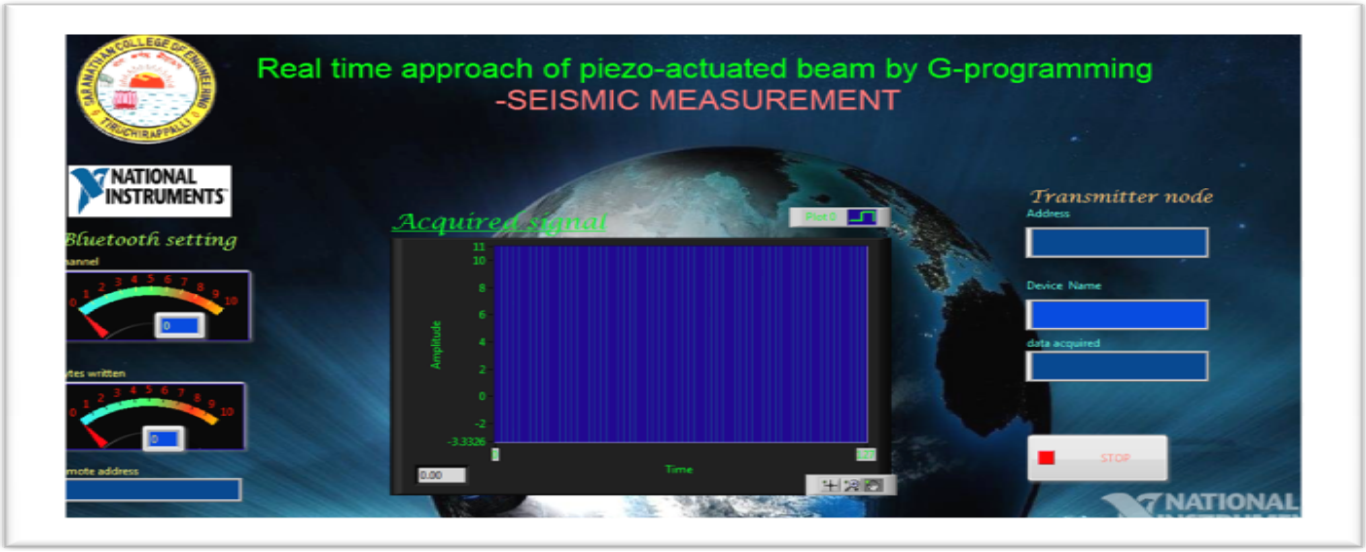


Figure 6 Labview Front Panel of the system

Description of each block in block diagram:
a. The following steps to design a Bluetooth server application.
Creating Bluetooth service – Use the **Bluetooth Create Listener** function to create a Bluetooth service discovered by a Bluetooth uuid. This function retreats a listener ID which refers to this master through LabVIEW software. It also returns a reserved BT channel that the master can use to listen for an inbound connections. A BT channel is a global resource with exactly 30 channels available on any BT device. If no master channel is available, the function indicates an error.

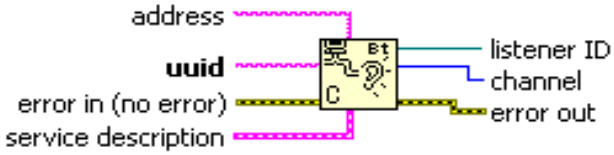


Figure 7 Bluetooth Create Listener

2. Wait for incoming connection request – Use the **Bluetooth Wait on Listener** function to wait for and obtain an incoming connection request from a slave. This function gives a connection ID that is used to share data with the slave

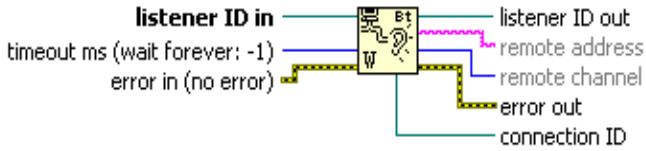


Figure 8 Bluetooth Wait on Listener

3. Read and Write data – Use **Bluetooth Read** and **Bluetooth Write** functions to exchange data with the slave.

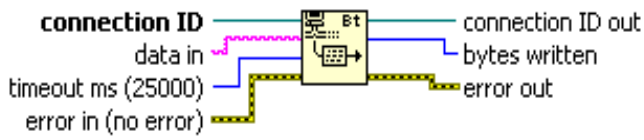


Figure 9 Bluetooth Read and **Bluetooth Write**

4. Signals are acquired using DAQ assistant and for writing data to a Bluetooth network connection they are converted to F-format string using **Number To Fractional String Function.**

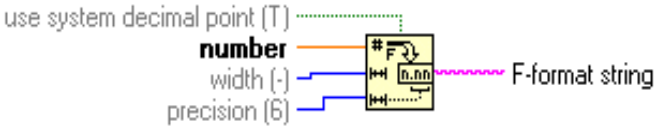


Figure 10 Bluetooth Read and **Bluetooth Write**

5. Close connection – Use **Bluetooth Close Connection** function to end connection to the slave and to terminate listening for incoming connections.

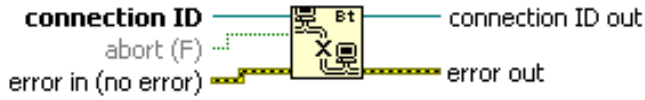


Figure 11 Bluetooth Close Connection

6. Use the **Bluetooth RFCOMM Service Discovery** VI to find available RFCOMM services on a local/remote device. This function returns a number of available services list with the associated channel number. The channel number in the available services list can be used as an input variable of the **Bluetooth Open Connection** function to enable connections to the corresponding services on the remote BT device.

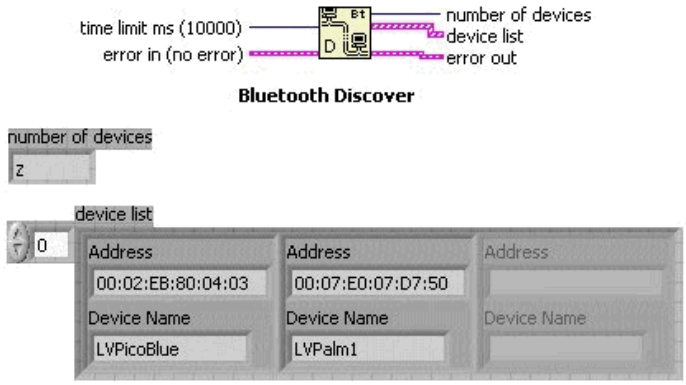


Figure 12 Bluetooth Discovery Function

A Bluetooth system in Palm OS and Pocket PC offers serial-port profile along with virtual serial driver. Bluetooth Serial Port (BSP) profile defines technique that the devices use to rival a RS-232/serial cable connection. Virtual Serial COM ports are mapped to actual BT channels. This Serial Port profile enables to use LabVIEW Serial VIs for opening a connection to and share data with other Bluetooth devices.

The driver at a time recognizes only one active serial channel . The serial channel can be opened as an outbound (slave) port or as an inbound (master) port. When the port is opened as an outbound (slave) port, the driver prompts to select a Bluetooth device (master) to connect to. When the port is opened as an inbound (master) port, the driver keeps waiting to receive a connection request from the slave. BT serial port is based upon RFCOMM, which differs from a physical serial port. RFCOMM requires role of a master and a slave when establishing Bluetooth serial connection. Thus, transmitting acquired signal wirelessly to client (slave) node.

b. Flat Sequence Structure

Contains of one or more sub diagrams, or frames, that sequentially executed. Use this structure to ensure that a sub diagram are executed before or after another sub-diagram. Data flow for the Flat Sequence structure is different from flow of data for other structures. Frames in the structures compiles from left to right & if all the data values which are wired to a frame are available. After execution of the frame the data leaves each frame. This means the input of one frame depends on the output of another frame.

c. DAQ Assistant Express VI

Creates, edits, and runs tasks using NI-DAQmx . This software proceeds further beyond a basic DAQ driver to deliver improved performance and productivity. Signals acquired by NI-Elvis is supported by this and expressed using graph indicators.

PARAMETER	DESCRIPTION
Channel number	Number of the channel which is 1 for transmitting and receiving
Number of bytes written	Number of digits with the output data should be displayed
Address	Address of the client. (Bluetooth address-cc:52:af:86:70:39)
Device name	Indicates the name of the Bluetooth device
Data acquired	The data that is received from the SENSOR
Waveform chart	Continuous plot of time Vs amplitude

Table 1 Description Of Transmitter Front Panel Deices

3.5 Receiver Block Diagram:

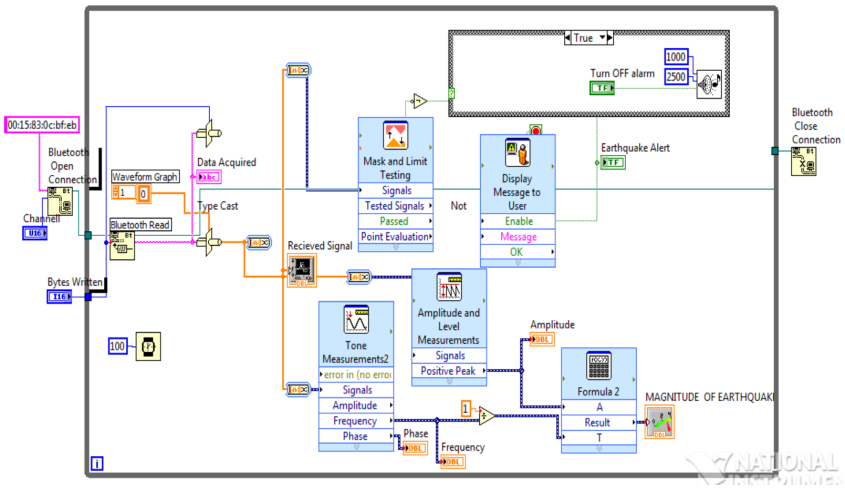


Figure 13 Labview Block Diagram of the system

3.2 Receiver Front Panel:

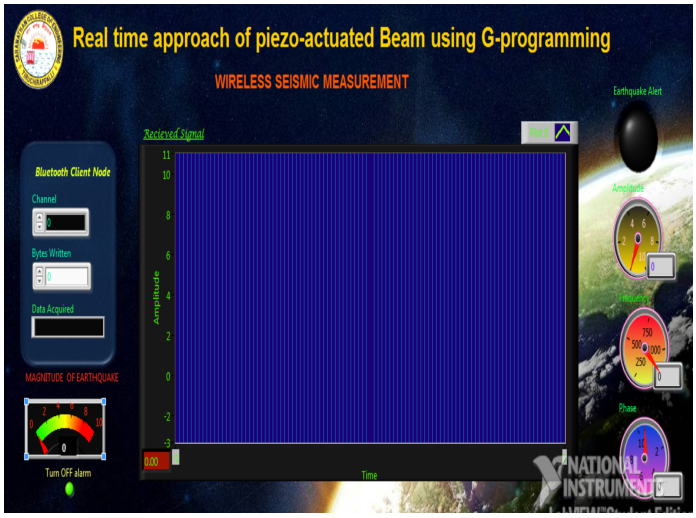


Figure 14 VI Front Panel diagram of the system

PARAMETER	DESCRIPTION

Channel number	Number of the channel which is 1 for transmitting and receiving
Number of bytes written	Number of digits with the output data should be displayed
Data received	The data that is received from the transmitter
Waveform chart	Continuous plot of time Vs amplitude
Amplitude	The amplitude of received data
Frequency	The frequency of received data
Phase	The phase of received data
Earthquake alert LED	Glows if the specified amplitude is crossed
Magnitude of earthquake	Magnitude in richter

Table 2 Description of Receiver Front Panel Device

Description of each block in block diagram:

I. While Loop

This repeats the code within its sub diagram until a specific condition is satisfied. A While Loop always executes at least once.

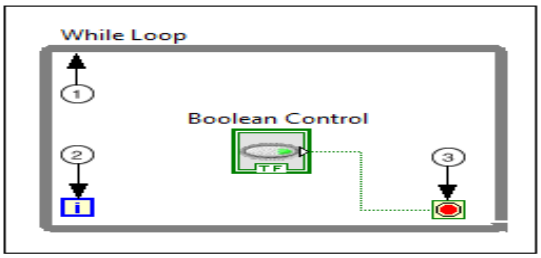


Figure 15 While loop structure

Components of a While Loop

Sub diagram—Contains code that the Loop executes once per an iteration.

Iteration Terminal —Provides current loop iteration count. The loop count starts at 0 for the initial iteration. When the count exceeds 2^{31}-1, the iteration terminal remains at 2,147,483,647 for all upcoming iterations.To keep count of more than 2,147,483,647 iterations, shift registers with a greater integer range can be utilized .

The Conditional Terminal—calculates a Boolean input value to check if to continue executing the While Loop or not. To specify when the loop stops for a TRUE / FALSE Boolean value, configure the continuity behavior of the while loop. While wiring an error cluster to the conditional terminal, one can also determine when the loop terminates.

II. Formula Express VI

Uses a calculator interface for creating mathematical formulas and for performing most math functions that a scientific calculator can compute. Magnitude of earthquake is found using this formula bar. Amplitude is found using Tone Measurements Express VI and time period is found using Timing and Transition Measurements Express VI

III. Mask and Limit Testing Express VI

This VI performs and undergoes limit testing on the Signals. The Express VI compares the Signals with limits that the user sets and returns the output of the comparison at each of the data point. It also returns an array of waveforms that consists the lower limit and upper limit, the failures, and the signal. Using this, earthquake signatures are detected and recorded.

IV. Display Message to User Express VI

Displays a standard dialog box that contains an alert or a message for users. At high seismic's message is displayed to user and alarm is generated using Beep (Windows) VI which causes the system to issue an audible tone whose duration and frequencies can be altered.

V. The following steps to develop a Bluetooth slave application.

1. Request a connection to Bluetooth master – Use the **Bluetooth Open Connection** function for connecting to a service on a Bluetooth master. Fix the channel number to 0 and specify a BT uuid to identify and detect which service to connect to. This function performs an SDP query to connect with the first service that is found with similar uuid. Internally, the output of a SDP query is a RFCOMM channel number to connect with . This query is a tool for translating uuid to a channel number.

If the channel number is known which is engaged with the service earlier , the channel number used is '0'. Specifying a non-zero channel number skips the internal SDP query operation thus decreasing the rate of time it takes to connect with the service. When the channel number is not zero, Lab VIEW ignores or skips the uuid input parameter.

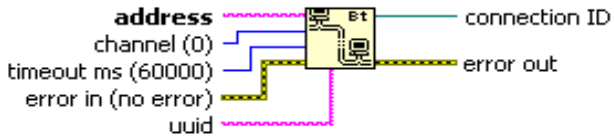


Figure 16 Bluetooth Open Connection

Note: Use the **Bluetooth RFCOMM Service Discovery** VI for finding a valid channel number that is associated with a service on a remote BT device. The VI processes a SDP RFCOMM service which results in a channel number discovery that can be used for connecting with the corresponding service on the remote BT device.

2. Read and Write data – Use Bluetooth Read and Bluetooth Write functions to share data with the master.

3. Close connection – Use **Bluetooth Close Connection** function to close connection to the master.

3.3 Working Of Transmitter-Receiver Seismic Panel

1. The Bluetooth open connection block initiates the connection towards the Bluetooth. It has two inputs: one is the IP address of the server system, the other is the channel number. The channel number here is 1, for receiving. The output will be a connection ID.
2. This will be given to the Bluetooth read block as one of the input. The second input will be number of bytes. The number of bytes is the number of digits with which the data received should be displayed in the receiver front panel. The output will be a connection ID. This will be in the form of string
3. The typecast converts this string connection ID in to numeric form.This received data will be displayed using waveform chart.
4. The output data which is received using typecast will be given to the mask and limit testing block. It prompts the user for the upper and lower limits.
5. If the received amplitude crosses the limits mentioned,the signal output of the mask and limit triggers the display message to the user and generate alarm blocks.
6. The display message to user displays "DANGER-EARTHQUAKE" message if the limits specified by the user has been crossed.
7. The mask and limit block also trigger the case structure to have a true case during the limit crossing. This makes the beep.vi alarm active, which generates a beep sound with the frequency input mentioned by the user.
8. The tone measurements block measures the frequency and phase of the received data. This frequency will be inverted to get the time period of the waveform.
9. The amplitude and level measurements extracts the positive amplitude from the waveform chart according to the vibration sensed.
10. The amplitude and time periods are the inputs for the formula bar. The formula for the conversion of voltage to Richter will be typed in the formula bar. The converted magnitude will be displayed using a dial.

4 Conclusion

Using Lab view vibration was indicated, thus measuring seismic. The LabVIEW measurement platform has dramatically decreased the test times as outputs were automatically registered. This type of vibration measurement system can also be used in industrial applications for measuring vibrations in machineries.

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DISASTER MANAGEMENT EDUCATION: LESSONS LEARNED FROM SCHOOL SAFETY CAMPAIGN IN DISASTER PRONE AREAS OF BHACHU TALUKA OF KUTCH DISTRICT OF GUJARAT

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DRVC2014
2nd Disaster Risk & Vulnerability Conference

Abstract

The world is becoming increasingly vulnerable to natural disasters. Disaster education is aimed at developing a culture of preparedness and safety, besides implementing school DM plans. Education for Disaster Management is a trans- disciplinary exercise aimed at developing knowledge, skill, and values at all levels. The Government of India in its X and XI Five year plan document has emphasized the need to enhance knowledge skills and values to reduce the impact of disasters. Disaster management as a subject in Social Sciences has been introduced in the school curricula for Class VIII, IX, and X by the Ministry of Human Resources Development (HRD), through the Central Board of Secondary Education (CBSE) for empowering the younger generation to safeguard them and the society in the wake of a disaster. State Governments have also designed the curriculum for the inclusion of disaster management through State School Boards. Formal DM courses have been designed for meeting the growing demands of the experts in the fields of Disaster Mitigation, Risk reduction and preparedness (R K Sharma, 2012). The aim of this article is (1) to underline the scope of disaster management education at the academics as well as at the field practice level (2) to highlight the outcomes and the lessons learned from the school level campaign on disaster management carried out in the selected schools in Gujarat (3)suggestions and policy related arguments for the effective implementation of disaster management education at the country level starting from the grassroots level to the optimum level with the active participation of multi stakeholders. The author elaborately discusses the campaigning process and the findings derived from a field setting of Kutch district of Gujarat facilitated by the leading national NGO, Unnathi. There are exemplary stories of children who survived the deadly earthquake because of their knowledge of disasters and related skills to save their own lives as well as of others. Children play a major role in carrying information to the society (UNNATHI). Finally the author pointed out the benefits of integrating Disaster Management in the curriculum of schools, colleges and universities that would make available, an alert force of educated youth, who can combat the ravages caused by disasters with their knowledge, self confidence, and survival skills. The paper concludes with a section highlighting that effective collaboration and participation of appropriate institutions, community organisations and other major stakeholders is crucial for the successful planning, coordination and implementation of disaster management education in the country.

Keywords

Disaster education, Kutch district, UNNATHI, Multi stakeholders

Introduction

Disaster risk reduction education is about building students' understanding of the causes, nature and effects of hazards while also fostering a range of competencies and skills to enable them to contribute proactively to the prevention and mitigation of disaster. Knowledge and skills in turn need to be informed by a framework of attitudes, dispositions and values that propel them to act pro-socially, responsibly and responsively when their families and communities are threatened. *(David Selby and Fumiyo Kagawa, 2012)*. DRR-related curriculum developments that have placed significant emphasis on active forms of learning have had a positive impact on students, teachers, families and communities in a relatively short amount of time *(Georgia and Lao PDR, studies 2 and 9)*. Disaster risk reduction curriculum development and integration will remain an incomplete project unless student learning assessment is more comprehensively addressed. The choice of what to assess expresses a curriculum's priorities both explicitly and implicitly. A number of the skills and attitudinal/dispositional learning outcomes in the list can be construed as DRR-related expressions of what constitutes a sound education for the twenty-first century. There are clear linkages between a comprehensive disaster risk reduction education and quality education *(Aguilar & Retamal, 2009; Anderson, 2010)*.

Many studies across the World highlight the significance of integrating DRR elements in to extracurricular and co-curricular activities. School assemblies in the morning, students club, after school or vacation activities, school trips, drills, exhibitions, special events and ceremonies, competitions and community meetings are the avenues to transmit DRR messages to students at all levels *(Amjad Nazeer,2012)*.According to *Hassanian (2006)*. Children and youth are the part of the population that are most severely affected by disasters, as they can easily panic and become difficult to manage during emergencies or crises, especially when a school or a house catches fire. According to the *NMDC (2010)*, there are schools in South Africa that are situated in disaster prone areas. The National Education Infrastructure Management System (NEIMS) indicates that nearly 15 per cent of all learners in South Africa are taught in environments that expose them to danger and to potential health hazards. Furthermore, at least 1 166 (4.7 per cent) of all schools in the country are at the

risk of flooding. Data on risks that pose a threat to school infrastructure and people collected through the NEIMS is an invaluable source of information for risk profiling and disaster risk reduction planning *(Takalani S. Rambau et.al, 2012)*. Gujarat earthquake of 2001 exposed the vulnerability of children and school system during disasters. The earthquake in Gujarat caused the death of 971 students and 31 teachers. It had also destroyed 8000 houses and damaged 42000 school rooms in Gujarat. Children play a major role in carrying information to the society. As centers of communication, schools play a key role in creating a positive culture. Often, schools also act as temporary relief and rescue centers. Thus DRR education to all children is mandatory. The major cause of loss of lives and injury during an earthquake is due to collapse of houses / buildings built without safety features. During the rehabilitation phase, the buildings were built with the supervision of engineers, so that the safety features were ensured. But, the safety features have not changed the building construction practices. In this context, a campaign on school safety and housing safety would help promote a culture of disaster resilience community. We can't stop and predict any occurrence of disaster. But we can well reduce the risk during disasters by following proper safety measures and preparedness *(UNNATHI, 2012)*.

Children have the right to learn in a safe environment. Statistics show an alarming rate of child deaths during disasters every year. We have come across many natural hazards that have badly affected the school buildings, staff and children for the last ten years. Thus the need to ensure safety of the students and staff in schools is very essential. Among all the stakeholders', children are the most vulnerable groups during any disaster. Similarly during most disasters human lives are lost due to collapse of houses. If the structure of the houses are well designed or well constructed we would be able to resist hazards of various propotions to a certain extent. House construction is an incremental process and in most cases the safety features are often compromised. The project aims to popularise the housing safety audit in the framework of housing vulnerability assessment in the like of CMDRR principles so that the vulnerability reduction process is linked to the local governance mechanism. In 20 villages of Bhachau vulnerability assessment camps were organised included (1) Awareness and education on housing vulnerability, (2) Participatory housing vulnerability assessment, (3) Preparation of action plan to make corrective measures.

It has been identified that majority of the stakeholders do not address the issue of safety. Recognizing the fact that the stakeholders lacks knowledge and skills to cope with various emergency situations there is a need of conducting a campaign on safety measures to promote a culture of disaster safety in communities. The overall objective of the campaign is to create community level awareness to promote a culture of disaster risk reduction in school and communities. An intervention of both structural and non-structural measures to minimize the risk in schools and houses is very important. School authorities, students, parents, community leaders and other stakeholders are the target people in this campaign. The main activities carried throughout the campaign are orientation of school management, awareness and education on safety measures, evacuation, formation of school safety committee and preparation of action plan, awareness on housing safety and vulnerability and corrective measures to be taken for securing the houses etc.

Objectives of the Campaign

1. The objective of the campaign is to promote a culture of disaster preparedness in schools and communities.
2. To sensitize the school authorities, students and other stakeholders on the importance of disaster preparedness and safety measures through direct participation in activities.
3. Creating basic disaster awareness and capacity building.
4. Assisting schools students and the community in preparing for future disasters.
5. Creating awareness on the importance of forming various task forces and Disaster Management Committees in schools
6. Giving emphasis on structural and non-structural mitigation measures.

Methodology

The author applied suitable methods like one to one interaction, meeting and discussion with the key officials in the Village Panchayat, project administrators, the school authority, School principal and the local leaders to gather information related to the programme. The team members selected seventeen villages in the Bhachavu block for conducting the "Campaign on School Safety" and Housing Vulnerability" .

Project Strategies and Activities

A strategic plan was prepared for the program, 'Campaign for School Safety and Housing Vulnerability' with the consultation with the community and the sole objective of the project was concerned about the community level awareness programme for school safety and housing vulnerability was planned for twenty villages of Bhachau block. The key strategies and activities were ;

- Inviting schools and communities to participate in the programme.
- Assess the structural and non structural measures.
- Meeting with school authorities and community leaders and finalize the activity schedule.
- Project activities such as :
  - General discussion on posters displayed
  - Play cards
  - Role-plays
  - Games like snake and ladder
  - Elocutions
  - Drawing competitions
  - Preparation of action plan.

Salient Features of the Campaign-DRR

Pre-Campaign Preparation Guidelines

Contact and Rapport Building- Rapport building and contacts are essential factors while conducting a campaign or programme. Identifying the key persons in the community would help the team to develop more contacts. First comes identification of the key persons in the community, like Sarpanch, Community leaders, SMC, School Principal. Then comes clarification of the purpose of organizing the campaign like briefing the importance of mitigation measures, safety measures etc. Then with the help of key persons conducting meetings among various groups of the community to know about their willingness or interests towards the campaign and for creating the awareness of the entire community about the importance of conducting safety measure programme. For maintaining the contacts, one should conduct regular visits or should communicate to them through telephones and remind them about the programme.
Discussing and Convincing the Team: The team should give a brief introduction about the team, team members, their activities etc to the community. This should be followed by the clarification of the roles and responsibilities of the team to act as a facilitator, convincing the importance of the theme to the community and ensure more participation of the community members in the campaign. Building awareness of the community about the importance of campaign on safety measures for school and houses like, what are their perceptions, knowledge on safety measures, their past experience etc. then discussing the various programmes to be conducted in the campaign like, role play, poster presentation etc from the part of the school so that it will emerge more knowledge among the stakeholders.
Need Assessment for the issues to be discussed during the campaign- First comes the collection of the basic data of the school regarding total number of students, teachers, classrooms etc. Identify the structural and non-structural measures in the school that is, about the infrastructure, open ground, rescue measures, mitigation measures like First Aid, Fire Extinguishers, Alarm Alert etc. This would help the team members to know about the safety measures provided in the schools. Then meetings need to be conducted among various stake holders to identify the currently facing risk such as, poor quality buildings, unsafe environment etc and the needs such as including Disaster Management in their syllabus, forming Disaster Management Committee in schools, safe buildings, training for stake holders etc. After that, prioritize the needs. It is also important to identify the limitation-faced by the school authorities. For example, in some schools the authorities are not able to ensure more participation in the campaign because the children are too young.
Preparation with the School -To decide the theme and content schedule with the school authority about various activities to be conducted on theme basis such as role-play, foot march, elocution, essay competition, drawing competition, mock drills etc. Along with that, the criteria for distributing prizes need to be decided. The team should also ensure more participation of other stakeholders such as parents, community members to the campaign. Division of the roles and responsibilities to be performed by various stakeholders in the campaign is mandatory. Finalizing the programme schedule such as, campaign venue, date and time should also be done. The most important thing that the team should take care off while fixing the venue, date and time is accessibility.
Monitoring and Evaluation-Monitoring and evaluation will help the team to know about the effectiveness of the campaign. Monitoring and evaluation can be made possible by collecting feedback from various stakeholders. Feedbacks can be collected in an oral form or written form that is, interviewing the stakeholders or giving questionnaire to them and collecting the feedback. Process documentation and report writing throughout the whole programme is also important. As it will also helps to understand the drawbacks and achievements of the campaign and it will be a helpful material for conducting a campaign in future.
It is important to discuss the Need Assessment School Safety Parameters both including Structural and Non structural Parameters for the successful implementation of the project.
Safe Building-Selection of the right site: The most important principle is to choose the site correctly. The sites with soil having good bearing capacity should be chosen. Risk varies according to the type of hazards. For example, selecting loose sand site for constructing a building that has a less bearing capacity in an earthquake prone area will easily collapsed during the occurrence of hazard.
Appropriate disaster resilient design codes**:** The structure should be designed considering the appropriate disaster resilient design codes. So that, the stakeholders will have the capacity to cope with the hazard and it will help to reduce the level of risk.
Constructed with quality materials: Good quality materials should be used for construction. Using good quality materials for construction will help to minimize the level of risk and damage of buildings while occurrence of hazards.
Proper maintenance: Recognizing the in capabilities of the existing building structures to resist disasters and should take safety actions to upgrade the disaster resistance of the building is also important . By doing so we can ensure safety features included in the building that would help to minimize risk in future occurrences of hazards. Lack of maintenance weakens the structure.
Proper placing of heavy objects: Heavy objects placed loosely at a height can cause threat to safety. Place heavy objects on the floor for minimizing the risk. It also helps to prevent severe injuries.
Registration status of the building : Government has fixed certain safety standards for the construction of buildings. These safety standards are drawn out from the pre experience of structural conditions of the buildings during the disasters. It would help to minimize the damage or risk. The owner would get the approval from the government only if they follow these safety features.
Design aspect for the easy evacuation: Spacious internal evacuation routes-Design of spaces should be non-obstructive and a quick evacuation should be made possible. Congested internal routes with loose objects can be hazardous and is an

obstacle for quick evacuation. For example, staircase, corridors etc should be designed in such a way that evacuation during an emergency can be done quickly.
Spacious external evacuation routes: In outdoor spaces such as irregular stairs is an obstacle for easy evacuation during emergencies. Therefore, stairs should be designed in such a manner that helps for easy evacuation. All schools must have an open ground. Exit gate or points should not be blocked.
Wire fencing located in evacuation routes: Wire fencing is good but it should not be located in the evacuation routes. Wire fencing located in the evacuation routes will be an obstacle for quick evacuation during emergencies. Open water tanks, ditches: Open water tanks, ditches etc are a hazard during evacuation. Therefore, it should be kept closed.
Huge trees close to the building: We should not plant trees very close to the school building; there are chances of falling of trees to the building during hazards like cyclone, earthquake etc. Trees should be planted at a distance from the building can serve from hazards.
Free standing structures in the school campus: Freestanding structures in the school campus that may fall during an earthquake are hazard should be removed. Heavy components or freestanding structures can be isolated from the building structure and secured.
Scattered buildings: Irregular building plans due to extension or up gradation can make building vulnerable. The building plan should be regular. Regular building plans such as square, circle etc will help to strengthen the building structure.
Adequate number of class rooms: Schools should have adequate number of classrooms. And the classrooms should be designed in a spacious manner and not in a congested manner. It will help to allow the free movements for children. Position of cupboards, boards etc should be in a secured manner.
Separate room for laboratory: Every school should have a separate laboratory. Laboratory should not have inflammable chemicals that can pose to hazards. So having a separate room for laboratory can minimize the risk of hazards. Lab assistant should be given training on fire safety.
Separate room for library: Heavy books kept on the cupboards placed in the classroom could fall on the head of the children and may cause injury.
Store room: Most of the school have a room used to store unwanted heavy objects or other inventories in the classrooms due to the lack of store that can pose to disaster. So having a separate storeroom will help reduce the risk of a hazard.
Separate cooking place: Almost all schools have midday-meal programmes. Cooking place should not be located close to the classrooms that pose to hazards. Cooking places should be located at a distance from the classrooms.
Non-Structural Parameters
School Disaster Management Plan-Disaster Management Committee: Every school should form a Disaster Management Committee consisting of a team of teachers and other staff . The main function of the committee should be to implement disaster preparedness and risk awareness activities.
Creation of basic awareness: Creation of basic awareness on various hazards/disasters and Disaster Management is very essential. Basic awareness on disasters can be built through the dissemination of IEC materials task forces, books, audio/visual movies, school kit etc.
Task forces: Task forces are to formed in schools with an aim to tackle any emergencies. Various task forces setup under Disaster Management Committee in schools are warning and awareness task force, evacuation task force, first aid task force, fire safety task force etc.
Room wise evacuation plan: Room wise evacuation plan should be displayed in the walls of the school. It would help quick evacuation during emergencies.
Disaster management as a subject: School management, students teachers etc are the primary stakeholders. The school should include Disaster Risk Reduction as a part of their syllabus that it will help the stakeholders to gain knowledge on various aspects of disasters like types of disasters, DRR etc.
Regular Trainings: Training modules were developed for the purpose educating teachers and students on disaster profile of the regions, dos and don'ts of various disasters, on safety measures etc.
Capacity Building: Emergency evacuation plans should be displayed in every school. It helps for quick evacuation during emergencies.
Search and rescue: During hazards, there are chances of missing or some students getting stuck in the hazard-affected building. The missing or trapped stakeholders in schools should be identified, rescued and should be provided with first aid.
Fire prevention control: Fire can become a threat in few minutes. Fire safety equipments should be placed in every school as per the norms. In each floor fire extinguisher must be fixed. Authority should be given adequate training like how to operate fire extinguisher etc.
First aid is one of the emergency responses. First aid kits should be provided for each school. Training should be given `to the various stakeholders.
Mock drills are the most useful exercise to check the preparedness of a system in case of any hazard. Students are given trainings to evacuate through safe evacuation routes and reach a safe area.
Updating of emergency equipment is a notable thing. Many schools consist of emergency equipments but they are not aware about the updating of the equipments. For example, expiry dates of medicines in the first aid kit, refilling of fire extinguisher.
Early warning systems: Stakeholders should be made aware of early warning systems that would help them for quick evacuation. For example, alarm alerts, mass media etc. a school centered early warning should be developed.
Existence of insurance scheme: To ensure protection for students and staff. It would be helpful for the stakeholders to afford the cost occurring in the emergencies.

Involvement of stakeholders in the scheme: Try to ensure that all the stakeholders are involved in the insurance scheme like students, teaching and non-teaching staffs etc.
Involvement of SMC& PTA in safety programme: They are the primary stakeholders. They also play a crucial role in the safety measures. Parents should also involve in the safety programme plans which would help them to generate awareness through school and which would reach them via children.

Observations

- Lack of awareness about disaster preparedness, mitigation measures etc.
- After earthquakes, structure of the school buildings have improved but non-structural measures needs improvement.
- Some teachers are aware about the training programme of GSDMA (fire and rescue).
- They are aware about the importance of including Disaster Management in their curriculum.
- Every school were provided with a fire extinguisher but they do not know how to use it and about its maintenance.
- In villages like Vondh and Budarmora, teachers are not satisfied with structural quality of the existing school buildings.
- In some schools buildings were built in a scattered form.
- Lack of emergency numbers and emergency evacuation routes displayed in the school.
- Lack of task forces and disaster management committees.
- Active participation of the schools was there but participation of the community was less.

Reflections

- Various natural disasters can cause different type of damages to the building depending on various factors such as location, material and technology used etc. This campaign mainly focuses on the vulnerabilities of the various hazards like earthquake, flood etc and how to reduce the cause of risk.
- UNNATI had played a vital role in the relief and rehabilitation activities in earthquake affected area like Bhachau. Organization had provided technical and material assistance to reconstruct the houses for the rural poor.
- UNNATIs Reconstruction programme in Bhachau is based on the owner driven process. Instead of giving constructed houses to the people, the organization tries to involve the participation of the stakeholders in the process and they also provided adequate technical and material assistance for the construction process.
- The importance of including Disaster Management in the curriculum, as it would help gain more knowledge on Disaster Risk Reduction. Also the importance of forming Disaster Management Committee in every school.
- Conducting a campaign on housing and school safety will help to create a community level awareness on how to be safe from various hazards and how to minimize the damages etc.

Conclusions

DRR integration across curriculum and grades needs to be systematic and thoughtful. While integrating concepts like prevention, preparation, mitigation, vulnerability and resilience, our understanding should exceed initial science of hazards and safety. Children need to know its causes, consequences and what needs to be done before, during and after a disaster within schools and beyond its' boundaries. Teachers' will and understanding, school environment, curricular and extra-curricular stuff all matter in a bid to protect children. Disasters may occur any time. As we are not able to build disaster safe houses, as it is very difficult to build such houses for everyone, we usually build disaster resistant houses that will help to reduce the risk during a hazard. Aged people, women, disabled, small babies are the vulnerable groups in the community. In the case of houses, weak structural plan is the main reason for the highest impacts of disaster. Children have the right to learn in a safer environment. This can be made possible only by making them aware about the importance of Disaster Risk Reduction.Children play a major role in carrying information to the entire community. Therefore, the Campaign on School and Housing Safety regarding Disaster Risk Reduction is quite significant.

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FLUORIDE TOXICITY IN GROUNDWATER OF BANKURA DISTRICT, WEST BENGAL, INDIA: AN EXEMPLAR OF IMPENDING DISASTER AND ENVIRONMENTAL SYSTEMS COLLAPSE

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Abstract

The United Nations had declared the 1980-1990 decade as the 'Internation mooted with the vision of providing safe and continuous supply of water to people –rich or poor. As part of the above programme, bore wells were dug at random in different parts of West Bengal. Water from these wells was found to be relatively safe from pathogens and available throughout the year. But a severe fall-out of this mission was evidenced shortly. Reports of high incidences of fluoride in drinking water (>1.0 mg/L) and symptoms of fluorosis with skeletal and dental disorders became prevalent in many areas. Many patients got registered with symptoms of goiter and even incidences of cancer. Thus tube wells, that were once sunk to alleviate the public health of the poor rural people by way of providing pathogen free drinking water, inadvertently created another public health disaster. The groundwater contamination mainly occurred from natural dissolution of fluoride minerals from sub-terranean strata. The result of Water Decade became obvious. The Water Decade came to an end; but extensive fluoride contamination in groundwater started plaguing the water users in many parts of West Bengal. This has now become the prime matter of concern for the government at local, regional and national levels.

In view of the recent reports of outbreak of fluorosis, hydro-geological monitoring was carried out in the different blocks of Bankura district, West Bengal (present study area) to find out the level and extent of affectation. The aim of this study is to assess the hydrogeochemical significance and relation between selected water parameters namely pH, iron and hardness that reportedly govern fluoride leaching in the groundwater of Bankura district, West Bengal. Groundwater samples were collected from public tube wells covering all the major hydrogeological units spread over 10 districts of Bankura in the pre-monsoon season of 2011. In the given area, groundwater is available in two major units: (i) the weathered zone and (ii) the hard rock fracture zone. Groundwater extraction is taking place dominantly through medium-to-large diameter open dug wells and limited low duty tube wells. The yield of these low duty tube wells (75 m to 100 m. depth) varies from 20 to 25 metre cube / hour. Analyses results of collected water samples show fluoride concentration ranging between 0.5 to 10.80mg/L, pH 5.1 to 9.4, iron 0.05 to 5 mg/L and total hardness 32 to 4700mg/L. If the pH of the water is slightly acidic, then iron and fluoride usually remain in dissolved state. Fluoride leaching is found most effective under slightly alkaline condition wherein it shows affinity towards iron in the form of unstable complexes (FeF_6^{+3}, FeF^{+2}, and FeF_2^{+}) and get precipitated out of the solution. Hence in presence of high fluoride in groundwater, some portion gets removed by way of adsorption to iron particles and thereby exhibiting negative correlation. On the other hand, TH also shows negative correlation with fluoride due to removal of calcium by way of fluorite and apatite from the system.

Key words: Bankura, contamination, fluoride, hard rock, iron, pH, hardness

INTRODUCTION:

In view of the recent reports of outbreak of fluorosis in many parts of Bankura district, West Bengal, a detailed hydro-geological monitoring was carried out in the different blocks of Bankura to find out the level and extent of affectation. It is observed that the sub-surface environment of Bankura is appreciably contaminated with the deadly poison of fluoride. Out of the 3617 tube well sources surveyed in 10 affected blocks, 612 sources are detected with fluoride above the desirable limit of 1mg/L. in addition, down-the-hole rock drilling were performed in 15 different locations in 8 worst affected blocks of Bankura. Nearly 75% of the drill-hole rock chip samples and 62% of sub-surface water samples collected from different depths is found to bear fluoride above 1mg/L. An attempt has been made to identify the source behind such anomalous enrichment of fluoride in Bankura.
Bankura (latitude 22°46' to 23°38'N; longitude 86°36' to 87°46'E) is the mid western district of West Bengal covering 384496 hectares and having the most varied physiographic features. The district can be divided in three broad geomorphological units:

1. Hilly region / Hard rock area: - The region consists of the areas like Saltora, Mejia, Khatra, Ranibandh, Gangajalghati etc. covering 176915 Hec. Most of this area does not have irrigation facility.
2. Uneven lands / Hard rock ring area: - This consists of the areas like Bankura, Barjora, Chatna, Onda, Simlapal, Taldangra, Raipur, Sarenga etc. It covers 150611 Hec.
3. Even alluvial lands / alluvial area :- This type of land includes the areas like Bishnupur, Sonamukhi, Patrasayer, Indus, Joypur, Kotulpur etc. covering 56970 hec

As per PHED (2009) report, high fluoride in Bankura groundwater is predominantly geogenic in origin with fluorine getting leached into the groundwater system from fluoride rich minerals of host rock. Natural concentration of fluoride in groundwater depends on the residence time of percolating water within fluoride rich litholgical units that lie on its flow path. Other source of fluoride may presumably be due to non point source of pollution arising out of phosphatic fertilizers from agricultural fields. According to World Health Organization, Bureau of Indian Standards (IS 10500, 2009) and Indian Council of Medical Research (ICMR,1975) the maximum permissible limit of fluoride in drinking water in absence of other safe drinking water source is 1.5 mg/L

HEALTH IMPACTS OF FLUORIDE:

Fluoride in minute quantities is an essential component for normal mineralization of bones and formation of dental enamel (Jackson, et al., 1973). However, its excessive intake may result in slow progressive crippling scourge known as fluorosis. Fluorine being a highly electronegative element has extraordinary tendency to get attracted by positively charged ions like calcium. Hence the effect of fluoride on mineralized tissues like bones and teeth leading to physiological alternations is of clinical significance as they have highest affinity for calcium. Due to excessive fluoride intake, tooth enamel loses its lustre. Normally, the degree of dental fluorosis depends on the amount of fluoride exposure up to the age of 8 to10, as fluoride stains only the developing teeth while they are being formed in the jaw bones and are still under the gums (Choubisa and Sompurna, 1974). The effect of dental fluorosis may not be apparent if the teeth are already fully grown prior to the fluoride over-exposure. Therefore, the fact that an adult shows no signs of dental fluorosis does not necessarily mean that his/her fluoride intake is within the safety limit. Skeletal fluorosis affects children as well. However, it does not easily manifest until the disease attains an advanced stage. Fluoride mainly gets deposited in the joints of neck, knee, pelvic and shoulder bones and makes it difficult to move or walk. The symptoms of skeletal fluorosis are similar to spondylitis or arthritis (Dinesh, 1998). Vertebrae may fuse together and eventually the victim may be crippled. It may even lead to a rare bone cancer (osteosarcoma) and finally spine, major joints, muscles and nervous system get damaged. Besides, excessive consumption of fluoride may lead to muscle fibre degeneration, low haemoglobin levels, deformities in RBCs, excessive thirst, headache, skin rashes, nervousness, neurological manifestations (it affects brain tissues and leads to pathological changes similar to Alzheimer's disease),strointestinal problems,depression,urinarytractmalfunctioning,ga nausea, abdominal pain, tingling sensation in fingers and toes, reduced immunity, repeated abortions or still births, male sterility, etc. It is also responsible for alterations in the functional mechanisms of liver, kidney, digestive system, respiratory system, excretory system, central nervous system and reproductive system, destruction of about 60 enzymes (Sharma, et al., 2004).

STUDY AREA:

The present work was carried out over 10 blocks of Bankura district covering an area of 6,882 km^2 (total area of Bankura district)(2,657 sq mi). The area is presently reeling under severe fluoride contamination of groundwater confined to hard igneous and metamorphic rocks of Chotanagpur Gneissic Complex (Archean-to-Proterozoic age). Study of the bore hole samples have revealed Pre-Cambrian metamorphics represented by granite gneiss (Chotanagpur Granite Gneiss), biotite granite gneiss, calc-granulites, ultrabasic and metabasic rocks, meta-sedimentaries including crystalline limestone, hornblende schist, biotite gneiss, pegmatite and quartz-vein. Fluoride bearing minerals such as apatite (more specifically fluoro-carbonate-apatite), biotite, hornblende are reported from this region.

Groundwater, wherever available, is dominantly restricted in cracks and crevices of rocks which are refered as Hydraulically Significant Fracture liniaments (HFL)s deals with high fluoride pollution along with other contamination scenarios in 10 blocks out of 22 blocks in Bankura district, West Bengal. Groundwater and fringe the Western and Central part of the district, on contrary, the Eastern part of Bankura is soft rock dominated which on either devoid or possesses little fluoride toxicity. A total number of 3617 groundwater samples from both public and private tube wells were collected in the pre- monsoon season of 2011 and were analysed for pH, Iron, Fluoride and total hardness using standard procedure.

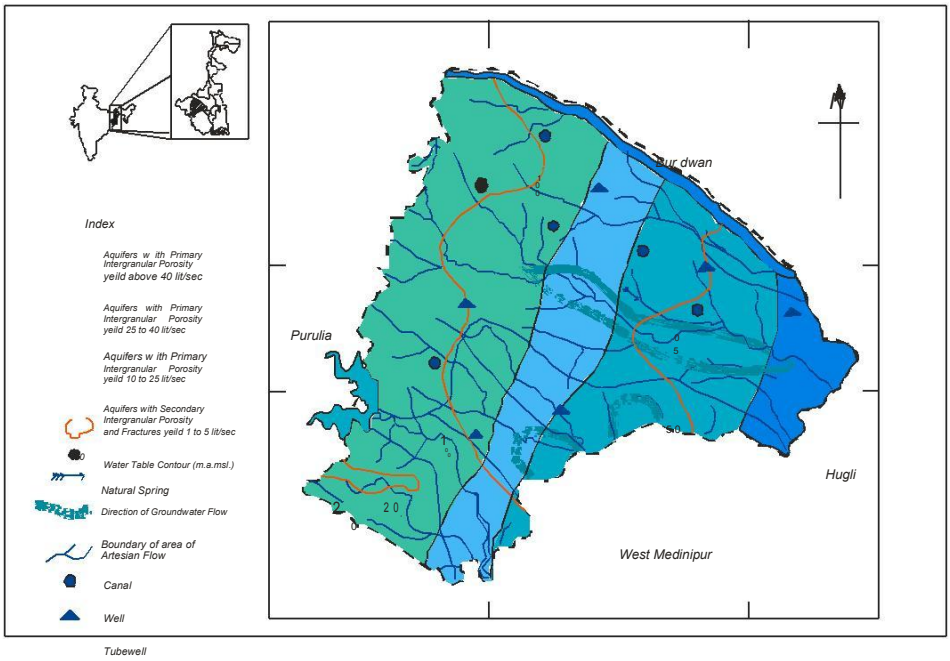
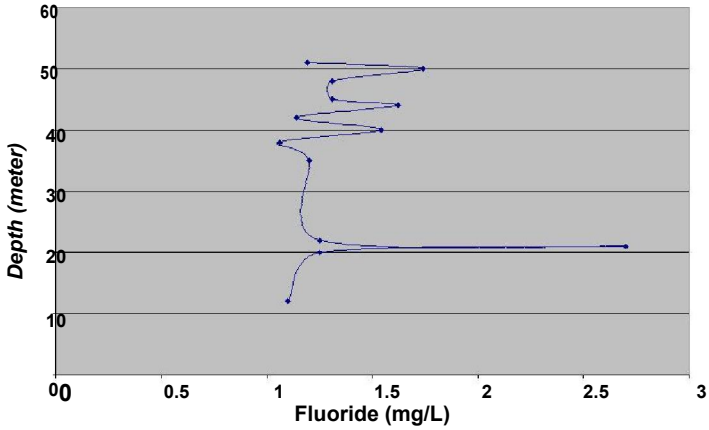


Fig.1: Map Showing Irrigation and Hydrology of Bankura District West Bengal

FIG.2: DEPTH-WISE CORRELATION OF FLUORIDE CONCENTRATION IN STUDY AREA:



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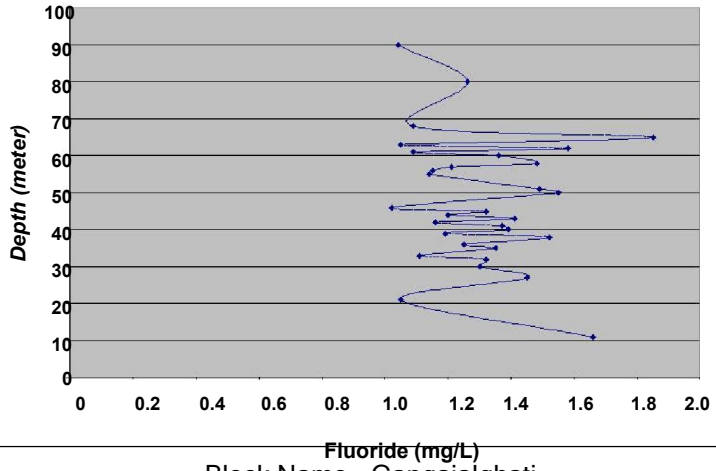

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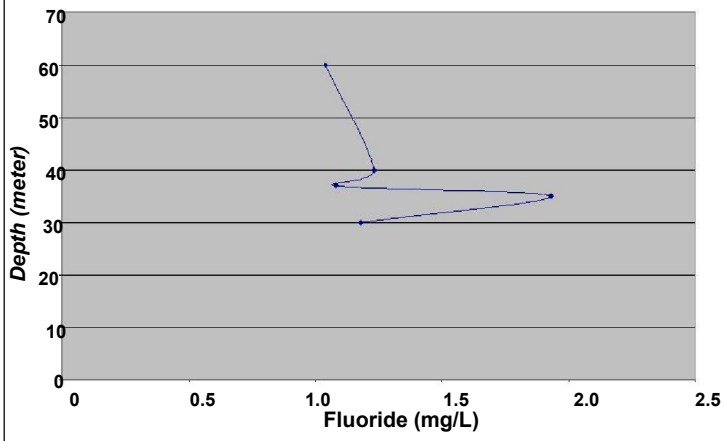

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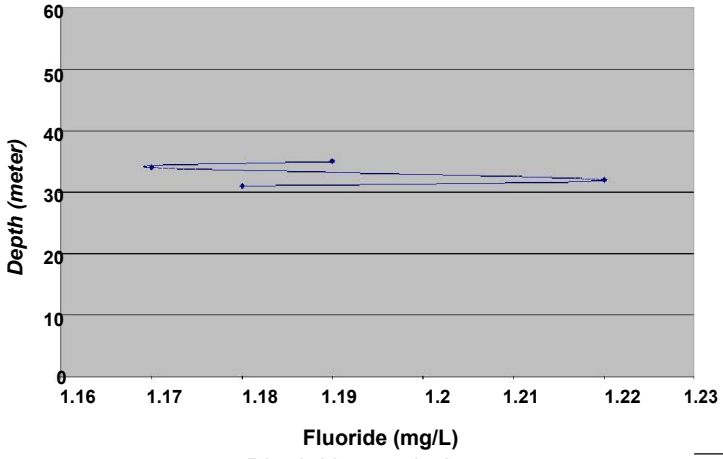

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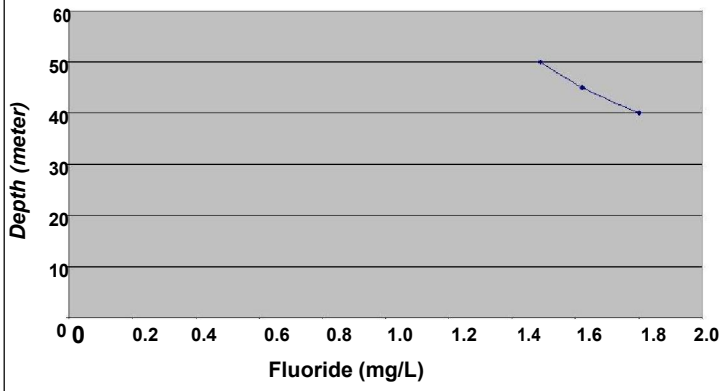
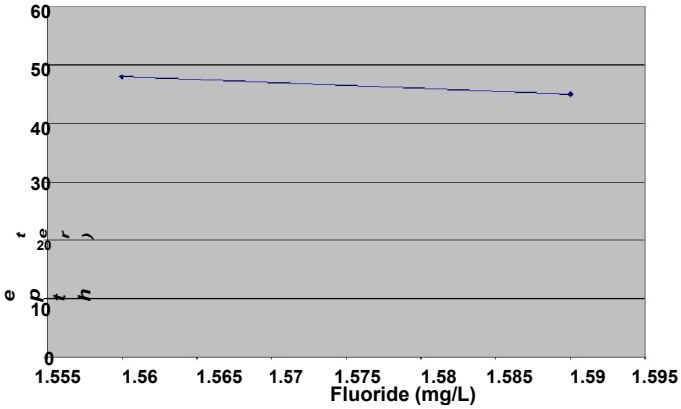
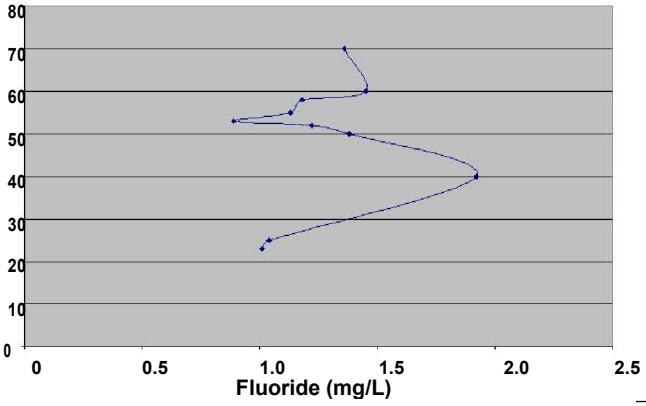


Block Name - Saltora



Block Name - Simlapal



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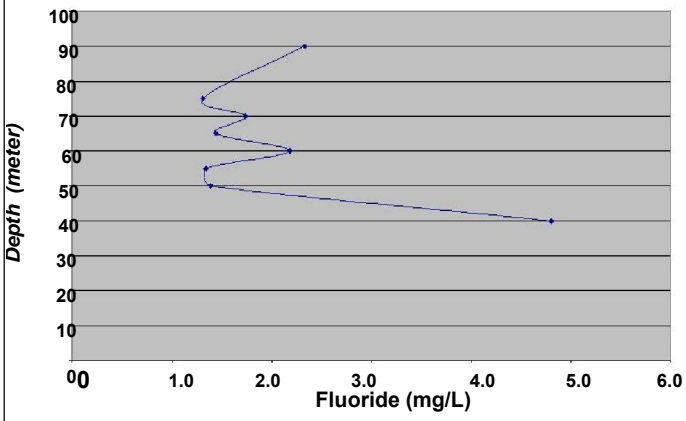

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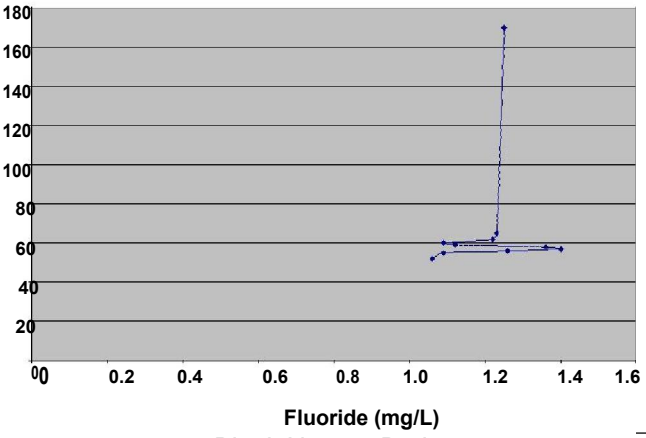

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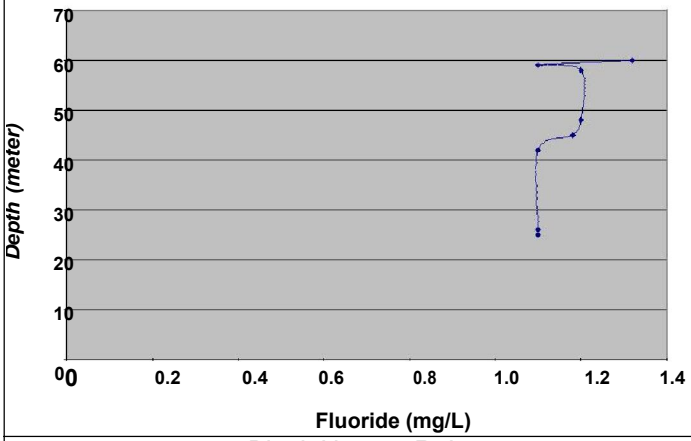


Block Name - Raipur

RESULTS AND FINDINGS:

Hydrochemical studies were carried out by collecting tube well water samples from 10 different blocks of Bankura district. A total of 3617 samples from these blocks were collected in the pre-monsoon period of 2011 which are analyzed to find out the plausible reason for fluoride enrichment. Out of these collected samples, fluoride was reported as above 0.5mg/L in 3617 samples. A closer scrutiny of results further indicates that among the 3617 samples around 17% and 7% of water samples contain fluoride above 1.0 and 1.5mg/L respectively. The maximum fluoride concentration was reported in the block of Hirabandh (10.80mg/L) at a depth of 35meter. On the other hand, iron and total hardness is found to lay above the prescribed limit in almost all (100%) the water samples. The block map of Bankura showing average concentration of fluoride, iron, pH and total hardness in tube well waters under study is shown in Fig.1. The number of water samples recorded under different categories of fluoride gave a dismal picture of contamination with fluoride, iron, and hardness above the prescribed limits in substantial number of water samples. The database and documentary evidence related to present study revealed that 10 out of 22 blocks of Bankura are affected with fluoride; out of these, 5 blocks are dominantly hard rock areas and remaining 5 are underlain by mixed rock formation (with top veneer of softer alluvium over substrate of hard rock). There is no available record of fluoride existing above safe limit in unconsolidated sediments that constitute the eastern alluvial province of Bankura.

For sake of better understanding of the nature of variation in the tested water quality parameters, the water samples were grouped on the basis of increasing fluoride concentration as follows :

Group I (with fluoride > 0.5 mg/L and < 1.0 mg/L),

Group II (with fluoride > 1.0 mg/L and < 1.5 mg/L),

Group III (with fluoride> 1.5 mg/L and < 2.0 mg/L), and

Group IV (with fluoride > 2.0 mg/L)

The synoptic contamination scenario of groundwater in different blocks of Bankura in relation to the studied parameters is given in table 1. From this table, it is observed that 32 water samples have fluoride above 2 mg/L, out of which 11 samples are distributed in Bankura II block. The maximum mean value of fluoride is reported from Hirabandh block (10.50 mg/L), while the same for iron is detected in 3 blocks Hirabandh, taldangra Simlapal and Indpur (2.6 mg/L). In case of total hardness, maximum mean value is observed in Indpur block (2400mg/L). The maximum mean pH was reported in Chhatna block (pH 8.1). Correlation of distribution pattern of the studied parameters suggests that values of iron and total hardness continue to be higher in water samples with fluoride content upto 2 mg/L; thereafter these values show a decline in their concentration. This means as fluoride concentration reaches a particular value in the water system, the concentration of total hardness and iron gets diminished.

The detailed tables showing the statistical variation of water quality parameters in different sample sets are shown in Tables 1and 3,values of tube wells in different blocks of Bankura district in relation to selected parameters viz. pH, iron, fluoride, and total hardness.

A joint survey was conducted with the help of PHED on a total of 8500 tube wells spread over 10 worst affected blocks in the hard and mixed rock provinces. Out of these, 3617 tube wells were found to contain fluoride above 0.5 mg/L. It was noted that 365 sites have fluoride more than 1 mg/L, out of which 215 sites have high fluoride above 1.5 mg/L. These affected tube wells are mostly found to tap groundwater that remains stored in the fracture system of hard rocks. Only in Simlapal and Taldangra blocks, fluoride is reported form the softer Older Alluvium.

From the analysed hydrological parameters correlation graphs have been made (Fig.4) for better understanding of the relation of fluoride enrichment with the other 3 analysed parameters i.e. pH, iron and total hardness. With these correlation graphs it can be stated that if the pH of water is slightly acidic then iron and TH totally remain in the water samples (in Group I). Fluoride leaching is found to be best in slightly alkaline condition. Fluoride and iron have a mutual affinity under slightly alkaline pH condition. So the leached out fluoride immediately forms unstable complexes (FeF_6^{+3}. FeF^{+2}, FeF_2^{+}) with iron and precipitated out of the solution. So in higher fluoride condition iron and fluoride show a negative relation. On the other hand, TH also show negative correlation with fluoride due to precipitation of CaF which is thus prior removed from the system (Chakrabarti and Bhattacharya, 2013).

The dissolution of fluoride takes under favorable conditions that include: 1. Geology and hydro– geological conditions, 2. Geomorphology, 3. Climate, 4. Physical and chemical conditions of groundwater, 5. Long residence time of groundwater in host rock. (Saxena and Ahmed, 2002)

The processes involved are: 1. Weathering of rocks –physical and chemical weathering, 2. Hydrolysis, 3. Dissociation, 4. Dissolution.

According to fluoride content vs depth out of the (Fig.2) 10 blocks of Bankura covered under the present study, fluoride is noted to exist within the maximum permissible limit (1.5mg/L) in only 2 blocks, namely Barjora and Raipur. In the other 8 blocks, fluoride is found much higher than the maximum stipulated value. The appreciable high values of fluoride are dominantly noticed in the fractured hard rock layer (aquifer). This water is under semi confined state and broadly encountered at depth zone of 40-50m within hard country rock. Tube wells sunk below this depth zone to avoid fluoride contaminated water went dry. Hence, groundwater in the study area is in mainly governed by hydrogeochemical-hydrolithostructural criteria. The shallow unconfined groundwater that occurs at the basal contact of deeply weathered bed rock (saprolitic zone), with country rocks, is mostly free of fluoride, except at few places (Chhatna, Gangajalghati).

From the correlation matrix table (Table 2), based on Bankura synoptic table of mean values (Table 1), we can see that in Group I fluoride has the maximum correlation with iron, in Group II fluoride has the maximum correlation with total hardness, in Group III fluoride is mostly correlated with iron and then with pH and in Group IV fluoride has poor correlation with pH, iron and total hardness.

From the correlation matrix table (Table 4), based on Bankura synoptic table of average values (Table 2), we can see that in Group I and Group II fluoride has the maximum correlation with total hardness and then with iron, and in Group III and Group IV fluoride has poor correlation with pH, iron and total hardness.

TABLE 1: SYNOPTIC CONTAMINATION SCENARIO OF GROUNDWATER IN DIFFERENT BLOCKS OF BANKURA (IN RELATION TO SELECTED PARAMETERS) BASED ON MEAN VALUES:

Block Name	Groundwater with Fluoride more than 0.5 mg/L and 1.0 mg/L					Groundwater with Fluoride more than 1.0 mg/L and 1.5 mg/L					Groundwater with Fluoride more than 1.5 mg/L and 2.0 mg/L					Groundwater with Fluoride more than 2.0 mg/L				
	Total No. of Samples (= 3005)	Mean Values				Total No. of Samples (= 365)	Mean Values				Total No. of Samples (= 215)	Mean Values				Total No. of Samples (= 32)	Mean Values			
		pH	Iron mg/L	Fluoride mg/L	TH mg/L		pH	Iron mg/L	Fluoride mg/L	TH mg/L		pH	Iron mg/L	Fluoride mg/L	TH mg/L		pH	Iron mg/L	Fluoride mg/L	TH mg/L
Bankura II	145	7.5	2.5	0.76	680	33	7.6	2.5	1.26	324	7	7.2	2.0	1.78	302	11	8.0	1.5	3.71	122
Barjora	167	7.2	2.5	0.75	580	41	7.2	2.5	1.23	434	6	7.2	2.5	1.67	568	2	6.8	2.6	2.27	206
Chhatna	482	8.0	2.5	0.75	788	43	8.0	1.3	1.25	440	11	8.1	0.5	1.74	560	4	7.8	0.4	3.37	403
Gangajalghati	349	7. 5	2.5	0.75	921	70	7.3	2.3	1.25	706	18	7.3	2.5	1.78	342	2	7.6	1.3	2.26	180
Hirabandh	211	7.2	2.6	0.75	645	49	7.1	2.6	1.21	490	8	7.4	1.1	1.77	620	2	6.9	–	10.50	–
Indpur	381	7.1	2.5	0.75	2400	41	7.3	2.6	1.24	650	3	7.2	0.4	1.63	550	–	–	–	–	–
Saltora	86	7.6	2.0	0.73	468	12	7.6	2.5	1.26	690	4	7.4	0.7	1.70	322	3	7.9	1.0	2.79	216
Simlapal	568	6.5	2.5	0.81	660	32	7.1	2.6	1.40	780	150	7.2	3.1	1.76	770	–	–	–	–	–
Taldangra	289	6.0	2.6	0.75	694	25	7.5	2.6	1.23	426	8	7.3	1.1	1.76	222	8	8.0	1.8	2.87	268
Raipur	327	7.0	0.8	0.76	720	19	7.0	0.9	1.30	620	–	–	–	–	–	–	–	–	–	–
Mean		7.1	1.7	0.77	1434		7.5	1.7	1.26	528.3		7.6	1.7	1.70	501		7.4	1.5	6.39	269
Standard Deviation		0.5	0.6	0.02	555.6		0.3	0.6	0.07	144.4		0.3	1.0	0.05	195.1		0.5	0.66	2.93	83.93
Coefficient of variation		0.07	0.35	0.03	0.39		0.40	0.35	0.56	0.27		0.04	0.59	0.03	0.39		0.07	0.44	0.46	0.31

TH : Total Hardness

TABLE 2: CORRELATION MATRIX OF BANKURA SYNOPTIC TABLE BASED ON MEAN VALUES

(I) For range 0.5mg/L to 1.0mg/L
Total Sample = 3005

	Fluoride	pH	Iron	Total Hardness
Fluoride	1			
pH	-0.43828	1		
Iron	0.048568	-0.02105	1	
Total Hardness	-0.0687	-0.01352	0.139795	1

(II) For range 1.0 mg/L -1.5 mg/L Total Sample = 365

	Fluoride	pH	Iron	Total Hardness
Fluoride	1			
pH	-0.28465	1		
Iron	-0.12838	-0.11702	1	
Total Hardness	0.580047	-0.41992	0.022636	1

(III) For range 1.5 mg/L -2.0 mg/L
Total Sample = 215

	Fluoride	pH	Iron	Total Hardness
Fluoride	1			
pH	0.12728	1		
Iron	0.369829	-0.50021	1	
Total Hardness	-0.20324	0.094451	0.23733	1

(IV) For range 2.0 mg/L and above
Total Sample = 32

	Fluoride	pH	Iron	Total Hardness
Fluoride	1			
pH	-0.4698	1		
Iron	-0.68123	-0.05026	1	
Total Hardness	-0.67653	0.462146	0.151764	1

TABLE 3: SYNOPTIC CONTAMINATION SCENARIO OF GROUNDWATER IN DIFFERENT BLOCKS OF BANKURA (IN RELATION TO SELECTED PARAMETERS) BASED ON AVERAGE VALUES:

Block Name	Groundwater with Fluoride more than 0.5 mg/L and 1.0 mg/L					Groundwater with Fluoride more than 1.0 mg/L and 1.5 mg/L					Groundwater with Fluoride more than 1.5 mg/L and 2.0 mg/L					Groundwater with Fluoride more than 2.0 mg/L				
	Total No. of Samples (= 3005)	Mean Values				Total No. of Samples (= 365)	Mean Values				Total No. of Samples (= 215)	Mean Values				Total No. of Samples (= 32)	Mean Values			
		pH	Iron mg/L	Fluoride mg/L	TH mg/L		pH	Iron mg/L	Fluoride mg/L	TH mg/L		pH	Iron mg/L	Fluoride mg/L	TH mg/L		pH	Iron mg/L	Fluoride mg/L	TH mg/L
Bankura II	145	7.5	1.0	0.7	306.8	33	7.5	0.9	1.24	259.9	7	7.3	1.3	1.78	302	11	8.2	0.6	3.51	88.4
Barjora	167	7.1	1.1	0.68	342.5	41	7.2	1.1	1.17	337.1	6	7.2	1.6	1.65	384	2	6.8	2.6	2.27	206
Chhatna	482	7.7	0.7	0.67	303.4	43	7.9	0.5	1.2	250.6	11	8.2	0.3	1.72	314.2	4	8.0	0.3	3.02	323
Gangajalghati	349	7.2	1.5	0.73	381.5	70	7.3	1.2	1.21	347.5	18	7.2	1.6	1.83	302.9	2	7.6	1.3	2.25	180
Hirabandh	211	7.1	1.7	0.75	491.8	49	7.1	1.5	1.10	499.2	8	7.2	1.4	1.72	572.5	2	6.9	–	10.5	–
Indpur	381	7.2	1.5	0.7	449.9	41	7.3	1.5	1.16	387.1	3	7.4	0.4	1.63	240	–	–	–	–	–
Saltora	86	7.5	0.9	0.69	313.9	12	7.6	1.0	1.2	354.3	4	7.5	0.6	1.69	320	3	7.9	0.7	2.60	169.3
Simlapal	568	7.1	1.8	0.93	730.5	32	7.1	1.7	1.40	732.5	150	7.3	2.7	1.60	764.9	–	–	–	–	–
Taldangra	289	6.9	1.6	0.69	249.2	25	7.2	1.4	1.19	258.3	8	7.0	1.3	1.79	216.8	8	8.2	1.5	2.78	255
Raipur	327	6.9	0.8	0.87	500.2	19	6.9	1.0	1.23	428.4	–	–	–	–	–	–	–	–	–	–
Mean		7.3	1.25	0.80	489.85		7.25	1.1	1.25	495.4		7.6	1.5	1.72	490.85		7.6	1.6	6.38	205.7
Standard Deviation		0.25	0.38	0.09	137.03		0.27	0.34	0.07	141.80		0.21	0.80	0.55	205.80		3.73	0.87	3.05	120.84
Coefficient of variation		0.03	0.30	0.11	0.28		0.04	0.31	0.06	0.29		0.03	0.53	0.32	0.42		0.49	0.54	0.48	0.59

TABLE 4: CORRELATION MATRIX OF BANKURA SYNOPTIC TABLE BASED ON AVERAGE VALUES:

(I) For range 0.5mg/L to 1.0mg/L
Total Sample = 3005

	Fluoride	pH	Iron	Total Hardness
Fluoride	1			
pH	-0.47526	1		
Iron	0.298243	-0.5306	1	
Total Hardness	0.893538	-0.36725	0.480222	1

(II) For range 1.0 mg/L -1.5 mg/L Total Sample = 365

	Fluoride	pH	Iron	Total Hardness
Fluoride	1			
pH	-0.10423	1		
Iron	0.173292	-0.68082	1	
Total Hardness	0.557358	-0.54901	0.682717	1

(III) For range 1.5 mg/L -2.0 mg/L Total Sample = 215

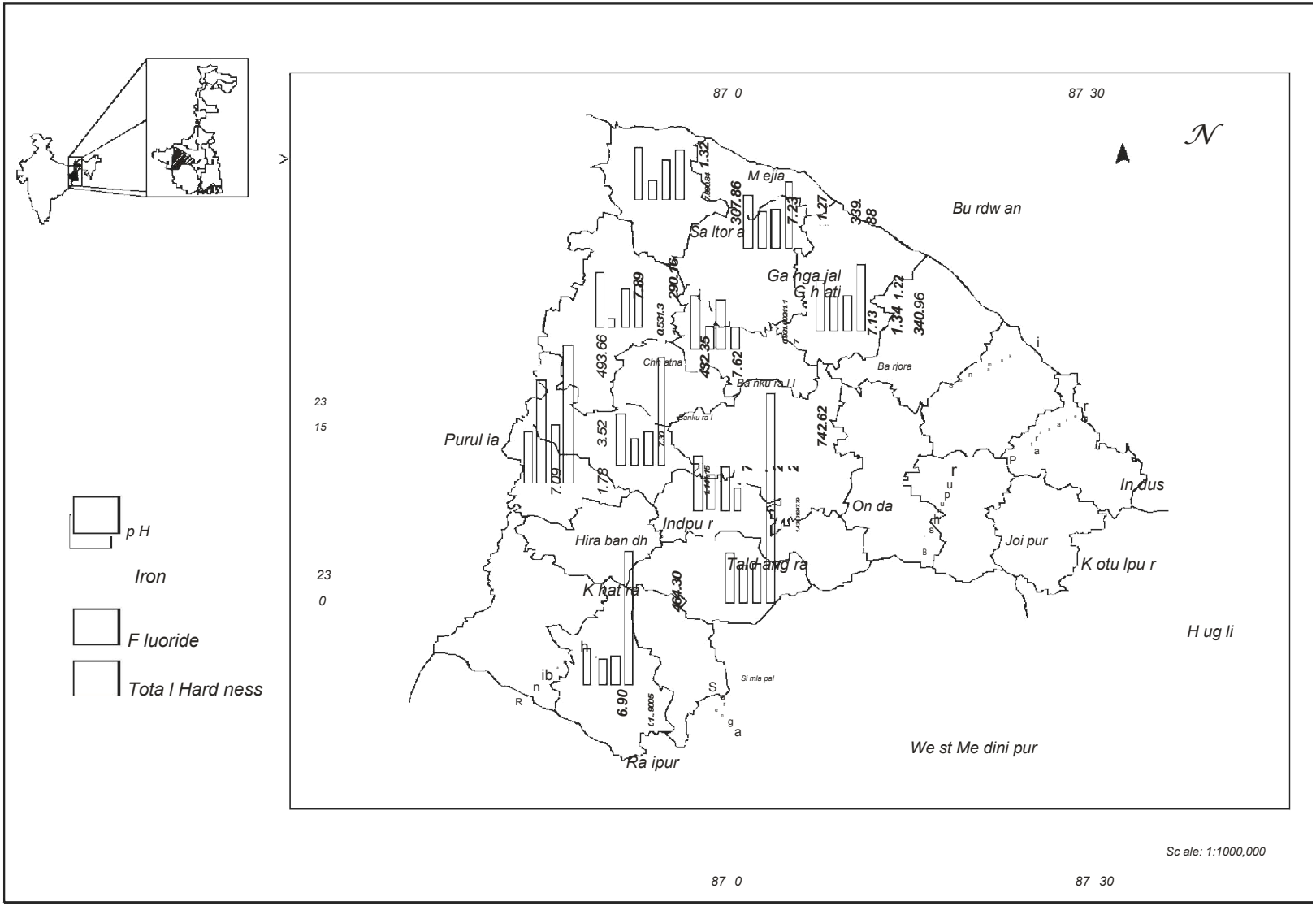
	Fluoride	pH	Iron	Total Hardness
Fluoride	1			
pH	-0.16573	1		
Iron	-0.12518	-0.57222	1	
Total Hardness	-0.51401	-0.09878	0.730099	1

(IV) For range 2.0 mg/L and above
Total Sample = 32

	Fluoride	pH	Iron	Total Hardness
Fluoride	1			
pH	-0.47203	1		
Iron	-0.5815	-0.28668	1	
Total Hardness	-0.73803	0.404547	0.35546	1

TABLE 5: AVERAGE VALUE OF GROUNDWATER QUALITY DATA OBSERVED IN DIFFERENT BLOCKS OF BANKURA DISTRICT (IN RELATION TO SELECTED PARAMETERS)

Parameters	Average Value of Parameters in Different Blocks		
	BANKURA II	BARJORA	CHHATNA
pH	7.62	7.13	7.89
Iron (mg/L)	0.93	1.34	0.53
Fluoride (mg/L)	1.60	1.22	1.31
Total Hardness (mg/L)	241.17	340.96	290.16
	GANGAJALGHATI	HIRABANDH	INDPUR
pH	7.23	7.09	7.30
Iron (mg/L)	1.41	3.52	1.14
Fluoride (mg/L)	1.27	1.78	1.15
Total Hardness (mg/L)	339.88	493.66	432.35
	SALTORA	SIMALAPAL	TALDANGRA
pH	7.59	7.17	7.22
Iron (mg/L)	0.84	2.07	1.43
Fluoride (mg/L)	1.32	1.31	1.39
Total Hardness (mg/L)	307.86	742.62	247.79
	RAIPUR		
pH	6.9		
Iron (mg/L)	0.9		
Fluoride (mg/L)	1.05		
Total Hardness (mg/L)	464.30		



FigFig.3. : Block Ma p o f Bankura Showing Aver age C on cen tra tion of Fluor ide , Ir on, pH an d TotalHa rd nes s in Tu be We ll Water Und er Stu dy

Fig.4: Plots of Correlation between Different Water Quality Parameters of Studied Spot Sources (Tube wells) Spread Over Bankura District

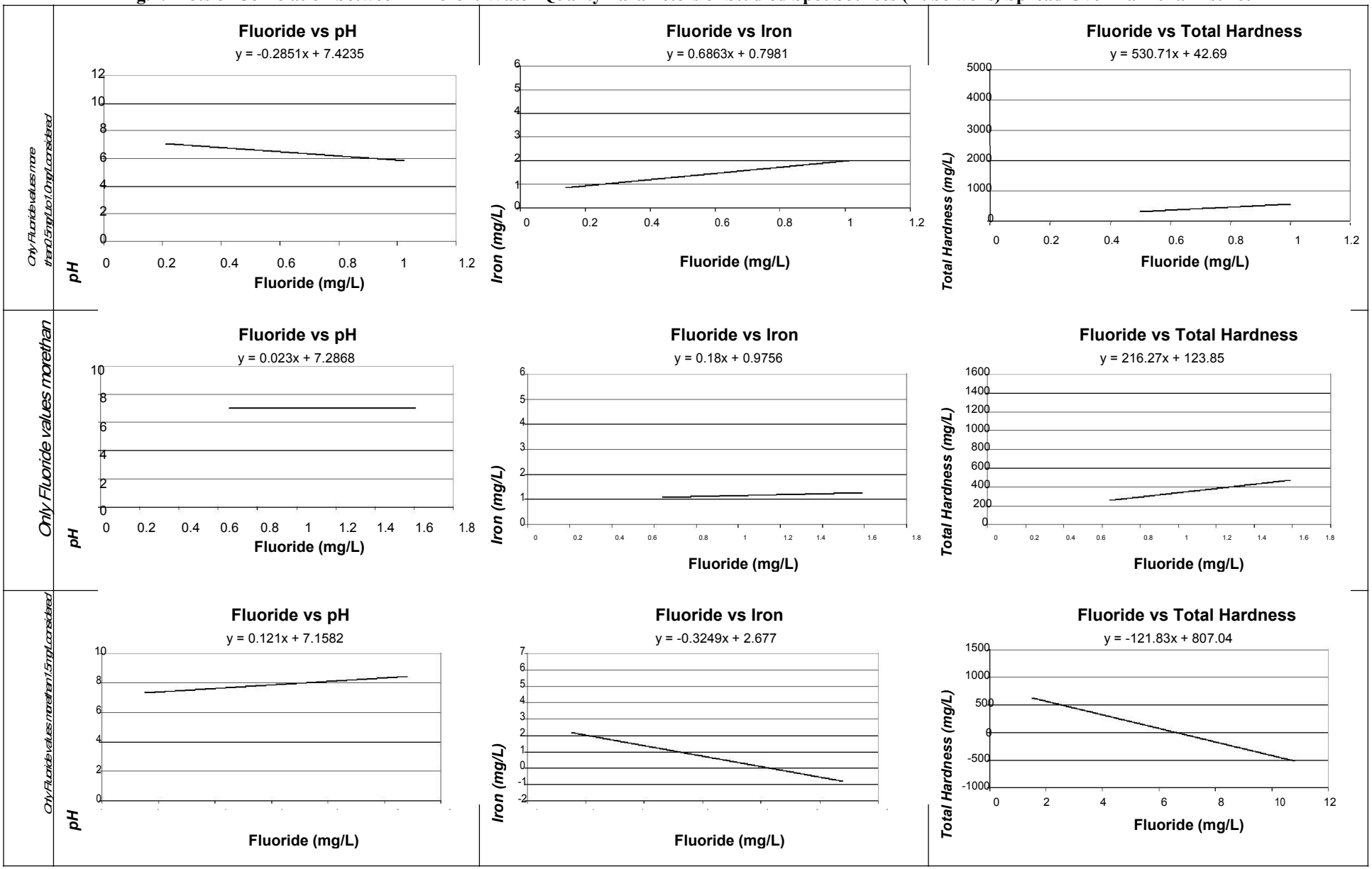


TABLE 6: INTERPRETATION OF CORRELATION GRAPHS OF DIFFERENT SELECTED WATER QUALITY PARAMETERS

	Range value of Fluoride		
Parameter Description	Fluoride Values More Than 0.5mg/L to 1.0mg/L	Fluoride Values More Than 1.0mg/L to 1.5mg/L	Fluoride Values More Than 1.5mg/L
Fluoride vs pH	- ve	+ ve	+ ve
Fluoride vs Iron	+ ve	+ ve	- ve
Fluoride vs Total Hardness	+ ve	+ ve	- ve

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ABSTRACTS

VHF Radio Network - An emergency Communication Solution: A case study from Sabarimala, Kerala, India

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The growth of pilgrimage tourism in India has been astonishingly impressive. India is blessed with plenty of well-known religious destinations, in which the south India's most popular one is Sabarimala in Pathanamthitta District, Kerala. The temple is situated on a hilltop at an altitude of 468 m above mean sea level, and is surrounded by mountains and dense forests. The temple opens for a short period of 5 days each month and for 41 days during the annual Mandalam festival season. The number of pilgrims visiting Sabarimala temple is approximately 30 million. The place has a history of disasters like Landslides, Stampede and Accidents every year. During such emergencies, communication is the most essential resource required to mitigate the effect of the disaster, for the victims as well as the emergency managers. The most common communication device of today, the mobile phone, often fails to meet such emergency requirements due to over communication resulting in network jamming. The availability of other communication options like the internet, landline and fax are very less due to the short period of the worship days. At this juncture the relevance of radio communication comes into the picture. VHF Radio Communication plays an important role in Emergency situations because of its efficiency in one-to-many communications, lower attenuation despite long distance covered, less prone to interferences by climatic conditions & geographical features, simplicity in installation and cost effectiveness. The case study presents the success story of Department of Revenue and Disaster Management, Govt of Kerala, India which succeeded in implementing a fool-proof communication system during the 2014 'Makaravilakku' festival season in Sabarimala.

Key words
VHF Radio Network, Radio Communication, Disaster, Sabarimala

Culturing Disaster Resilience in Rural Kerala: Potential programmes and advancement with Gender

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The advancement in alterative livelihood especially in Kerala fishermen community women is a phenomenal milestone in the history of DRR in Kerala. When the waves which mainstreaming the tributaries into DRR, the gender focus programmes and approaches could reset the customs as per the demand of the situation. The secondary income generation while ensuring the financial support in home management now turned to tunicate the total community at single step. The attracting factor to DRR was all about providing/searching a subsidiary income generation. And it destined almost at alternations of livelihood even enhancing their own conventional/ traditional practices. In the unfortunate situations of Kerala which tend t o being concentrated in vulnerable coastal communities only, the other communities who are vulnerable with their varied social- economic and location centricities are still ignored. Even the roots which can serve nutrition to the DRR into communities are sound in building up the capabilities of women culturing their resilience from their own surroundings. The PRI in identifying, discussing the issues and seeking for solutions which setting trends in implementing adequate infrastructural and non structural measures seen as the most supportive sign boards to DRR at local level with women and un skilled individuals. Current status of DRR in Kerala, raising demands for more suitable education and refreshments of DRR and traditional practices/knowledge are to be set at local level through PRI to fix rooting to support DRR. The experimental spaces of MNREGS providing to environmental protection activities and watershed management programmes despite of '100 days employment', the programmes can be established with its own local human resources. The challenges of Knowledge management mechanism in DRR at local level the issue which

put struggles over the complete reachability of the community was about the participation of men in the case of they do not have much better social gathering and activities. The Kudumbasree, and MNREGS helping women in their social gathering, a knowledge management system runs through it. While they are able to convey this to home a track to converse between community and service providers opens through women. The information's and information (EWS) systems are functional; the problem is how to get involved the middle class people into it as they do not participating in such social activities. The active participants were always women group, specified as from bottom level of the communities' skill building and technological revolution among women. It projects the economic crisis they facing throughout the year. To generalize the resilience building up in Kerala rural, the potentials are here; and it does not need to exaggerate and divert into DRR because there is a clear focus in how to reduce risks and vulnerabilities. The exact need is to cook inputs along with surroundings own resources to enhance both knowledge and finance with micro level projects to communities with most feasible approaches.

Review of Climate Change Adaptation Strategies for Disaster Risk Reduction (DRR)

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Climate changes are dynamic natural processes and now irregular natural phenomenon's (extreme rainfall, flood, landslide and drought) results disaster risk for human well being. The change in climate are also mostly triggered and contributed by the anthropogenic interferences like developmental activities that attributes risk and threaten human existences and sustenance. The unplanned developmental activities are hindering natural ecosystems and eventually losses occur in economic, property; livelihood that leads to migration, poverty ultimately deaths of mankind being resulted. The present work is a review study that finds out worldwide strategic methods existing and put forth to cope, adapt in accordance with the occurring climate change disasters like extreme rainfall, flood, landslide, water scarcity, drought and heat wave etc. The impacts of natural calamity to varying climates are differential now world widely. The tropical and subtropical regions are utmost victims to the climate change impacts. Climate changes are adverse and are detrimental without adaptation. The Climate Change Disaster Risks (CCDR) can be properly reduced and mitigated through adaptation to the changing climate. The adaptations are the only way to reduce the vulnerability of the climatic changes. The varied Disaster Adaptations (DA) or Climate Change Adaptations (CCA) strategies are emerging now and it is the technique and method for effective Climate Change Disaster Risk Reduction (CC-DRR) begun to be practiced worldwide.
Key words

Climate Change, Disaster Adaptation, Disaster Risk Reduction.

Urban Flood Vulnerability Zoning of Cochin City, Southwest Coast of India Using Remote Sensing and GIS

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Urban floods are a great disturbance of daily life in the city. Roads can be blocked; people cannot go to work and student can't go to schools. The economic damages are high but the number of casualties is usually very limited, because of the nature of the flood. The water slowly raises on the city streets. When the city is on flat terrain the flow speed is low and you can still see people driving through it. The water rises relatively slow and the water level usually does not reach life endangering heights. Urban flooding is specific in the fact that the cause is a lack of drainage in an urban area. High intensity rainfall can cause flooding when the city sewage system and draining canals do not have the necessary capacity to drain away the amounts of rain that are falling. Water may even enter the sewage system in one place and then get deposited somewhere else in the city on the streets.

The goal of this research is to identify the vulnerability towards urban flood in Cochin City Corporation as one component of flood risk. The analysis and assessment of vulnerability is based on the application of multi-criteria evaluation (MCE) approach. Flood vulnerability mapping is fundamental in flood risk management because it identifies areas vulnerable to flood. This study applies remote sensing and GIS techniques to produce flood vulnerability map of the study area. The vulnerability map of this study shows three vulnerability classes. The low vulnerability area is around 67.14 %, high vulnerable area is around 7.47 % and very high vulnerable area is 1.27% of the study area. The very high and high vulnerable zones together constitute 8.6 % of the total area of the Cochin City Corporation

Keywords

Urban flood, Flood vulnerability, Multi criteria evaluation, Vulnerability mapping

Youngster's Efficacy for Successful Disaster Risk reduction

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Children and youth make over half of the population of any community. Those come under age group of 0-18 years (according to constitution of India) regarded as children. India, the second populated country in the world has 41.1% children and youth as its wealth (2011 census). Even though children are considered among one of the most vulnerable groups affected by disasters, they have the potential to be agents of change in their community. Here the importance of Child (Young)-Centered Disaster Risk Management Programme. Several case studies highlight the importance of providing training to children and youth in disaster risk reduction, that can empower them to reduce both personal and community risks. The major role of children in DRR is in the stage of awareness generation. National organizations such as NSS, NCC, NYKS, Scouts and guides can play a major role in this regards. A trained student can easily teach ordinary personnel how to be aware from calamities or the precautions to be taken when an event occurs. The major roles which a trained student or youth can play in managing disasters includes spreading of awareness about disasters and tips to handle them, organize mock camps in their holidays in capacity building to cope up with disasters in their area, act as a first responder in emergency situations, running of school relief camps, awareness campaigns and rallies, street plays, basic first aid etc. All necessary training regarding the above aspects should start from schools because the schools play a very important role in dissemination of information among the masses. As we all know the children of today are the future of tomorrow, thus if children are taught disaster preparedness, they will bring a revolutionary change in the society as they are the future keepers of the villages and the country.

Key words
Children, Capacity building, DRR, Disaster preparedness

Firework: A disaster and an environment pollutant source

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A disaster can be defined as any tragic event stemming from events such as earthquakes, floods, catastrophic accidents, fires or explosion. It is a phenomenon that can cause damage to life and property and destroy the economic, social and cultural life of people. Fireworks is such a disaster which is usually not given due importance. In Kerala, firework is a part of religious faith. Large quantities of firework items are used in festivals of temples and churches. Even though firework is a part of festivals, it has many environmental impact and hazard. The present study assessed the firework disasters occurred in the past and sites of major fireworks as well as the quantity of materials used, in Kottayam district. The study revealed the use of large quantities of firework materials in the Kottayam district and is increasing year by year. Even though the agencies and churches/temples are taking conventional disaster preparedness and mitigation measures during the firework disaster, it is advisable to go for standard measures. Perchlorate is used as an oxidizing agent used in fireworks, which at concentrations above 24.5 ppb in drinking water can result in thyroid disorders. Perchlorate is highly persistent and from soil it can reach groundwater. Perchlorate was detected in high concentrations from soil samples collected after a fireworks display at festivals of Kottayam.

Key words

perchlorate, pollution, water

Management of Livestock and Wildlife During and After Disasters

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Disasters happen in plenty of ways and on different scales. Each and every area of this Earth is prone to them. The need for Pre disaster preparedness and proper coordination among different government agencies, departments, NGOs may not reduce the magnitude of forces of disaster but can ease rescues and management during and after disasters. The rescue and safety sequence should be human life, pets and livestock and then property but it is usually seen that pets and livestock priority shuffles place with property. The livestock owners, due to lack of awareness, tie their livestock during disasters in the fear of losing them and do not understand that all animals have natural instinct to save their lives, and huge loss of pets and livestock takes place. If the livestock can be saved during disasters, it can be a valuable asset for those who survive after disasters. It even reduces after-disaster burden on Government and rehabilitation agencies. These must be seen as an important resource and a valuable property to be saved. Animal safety during disasters must be taught to all the livestock owners. It must be a priority of animal husbandry department to make everyone, especially livestock keepers, aware how to deal with emergencies during disasters. This paper is an effort to study the effective techniques that must be adopted before any disaster happens and emergency steps to be taken for the safety of pets, livestock and wildlife during and after disasters.
Key words
Wildlife, Disaster, Domestic Animals, Management

Quality mapping of ground water in Chavara and its surroundings

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Abstract

Ground water is a major source of water for domestic, industrial and agricultural use. Unscientific tapping of ground water, exploitation and industrialisation collectively contributes to ground water pollution which seriously affects the environment. This paper aims to map the ground water vulnerability to contamination in the surrounding areas of an industrial unit at Chavara, Kollam, Kerala. This plant manufactures Rutile grade titanium dioxide by chloride process from raw ilmenite and produces iron oxide as a by product. The iron oxide is categorized under Hazardous Wastes Management & Handling (HWMH) rules and is stored separately in secured ponds constructed using bricks and impervious clay and have an interior lining of LDPE sheets. The sludge generated in the common effluent neutralization unit is also stored in these ponds. The total area of these ponds is around 15 acres and has a depth of 4ms from the ground level and about 2.0 lakh tonnes of sludge/iron oxide is stored. The study aims to map the ground water flow direction from the pond and possible leachate flow pattern to the adjacent areas which way possibly contaminate the nearby water resources. A hydro geological survey was conducted using GPS control points (16 nos) .The control points and reduced levels are transferred using total station instrument. Reduced levels of 100 wells at regular intervals were surveyed at closer intervals in downstream sides and longer intervals in upstream sides of the landfill pond. Mapping of the ground water flow is plotted. The water level reduced levels in the wells and the contour map interpolated indicates that the flow/ movement of ground water directions are positively towards NORTH WEST, SOUTH WEST and WEST side. Water samples are collected from all the test well considered for the hydrology survey. pH, iron distribution / variation is considered to identify the affected areas. The affected areas are marked using GIS technique. Vulnerable ground water contaminated area and possible management plans are discussed in the paper

Key words

Iron oxide pond, ground water contamination, hydrology survey, mapping, management plan

Rocket fuel contamination of ground water in Kerala: Issues and solutions

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Rocket fuel (Ammonium perchlorate) is an emerging environmental pollutant. The toxic oxy-anion perchlorate (ClO_4^-) in rocket fuel is known to interfere with the functioning of human thyroid gland causing Hypothyroidism (reduced thyroid gland hormones - T3 and T4). Hypothyroidism has many adverse effects on normal functioning of the body. Pregnant women, neonates and infants are the most vulnerable to perchlorate toxicity as hypothyroidism at this stage affect the normal brain and body developments of infants. Considering the high toxicity of perchlorate International agencies have fixed a permitted level of 15 ppb in drinking water. The major source of perchlorate in environment is from anthropogenic sources where this chemical is used mainly in rockets, missiles, explosives, match box and cracker industry, etc. Perchlorate is continued to report from many parts of the World in different human consumption products including fruits, vegetables, ground water, bottled drinking water and even mother's milk. A recent study conducted by CSIR-NIIST has revealed the presence of perchlorate at many places in Kerala and exceptionally high levels at few locations where this chemical is handled in bulk. The present paper discusses findings of the study including follow up actions carried out in the affected area to reduce human risk and also highlight probable actions that can be adopted to decontaminate the polluted ground water in the area to ensure public health.

Wild Fire Risk Analysis Using Geospatial Techniques: An approach in Thenmala Forest Division, Kollam District, Southern Kerala, India

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Wild fire occurrence in an area is influenced by both environmental conditions and human related factors. It can result in biodiversity loss and forest degradation. The present study aims to delineate forest fire risk zones in Thenmala forest division of Kollam district in Southern Kerala, India, using Geographic Information System (GIS) and Remote Sensing (RS) techniques. The factors selected for the analyses were land use/land cover type, slope, distance to settlement, distance from road, and elevation. All these factors have direct or indirect influence on fire occurrence. The thematic maps of these factors were prepared by using ArcGIS and ERDAS Imagine software tools. A numerical fire risk index model has been used to derive the fire risk zone map. The prepared Wild fire risk zone map of Thenmala forest division has classified the area into five categories, viz., very high risk, high risk, moderate risk, low risk and very low risk. Finally the risk zone map was validated with the fire inventory points. The present method can be used for entire Western Ghats region and will be helpful in forest management.
Keywords

Wild fire, Fire risk index model, Fire risk zone, Forest management

Forest Fire Risk Analysis Using Geo-Information Technology: A Study of Peppara Wildlife Sanctuary, Thiruvananthapuram, Kerala, India

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Forest fire is a common problem in the Western Ghats regions of Kerala. Therefore forest fire risk analysis is necessary for forest management. The present study area is also prone to forest fires. The present study deals with the identification of fire risk zones in Peppara Wildlife Sanctuary, Western Ghats mountain region, Kerala using GIS and Remote Sensing techniques. The forest fires are caused due to environmental and human related factors. This study considered 5 factors - land use/land cover, slope, elevation, distance from road, and distance from human settlements. Relevant thematic layer maps representing these factors that are related to forest fire occurrence have been prepared by using Geographic Information System (GIS) and Remote Sensing (RS) software tools. A multi parametric weighted index model was used to prepare the fire risk zone map using ArcGIS and ERDAS Imagine software tools. The forest fire risk zones were segmented into four zones, viz; low, moderate, high and very high risk zones. Finally the prepared map was validated by using the forest fire inventory points. Forest fire risk maps are useful tools for the efficient planning and management of forest in the Western Ghats mountain region.

Key words
Western Ghats, human related factors, multi parametric weighted index model, Forest fire risk zones

Comparative Effectiveness Study of Solar Power for Landslide Detection

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Landslide detection systems use distributed wireless remote sensing equipment to measure various physical phenomena that might indicate the occurrence of a landslide. Data from these electronic sensing equipment is processed and then transmitted, possibly using relays to a gateway and finally to a server, where the data is further processed to evaluate the possibility of the occurrence of a landslide. The first wireless landslide detection system in Asia was deployed successfully in the Anthoniar Colony Hill, Idukki, Kerala, where heavy rainfall causes frequent landslides [1]. Here, a wireless sensor network of 20 deep-earth probes (DEPs) has been deployed to monitor landslide detection. Each deep-earth probe consists of a variety of sensors such as piezometers, geo-phones, strain gauges, tiltmeters and rain gauges. Data collected by the sensor nodes is transmitted through a heterogeneous network to Amrita University campus – some 130 km away. Currently, the electronic components in the DEPs are powered by lead acid batteries, which are, in turn charged by an array of solar panels. However, over the years, it has been observed that power generation system, viz., solar panels and batteries, is sometimes inadequate, and at other times unreliable, leading to expensive maintenance. The goal of this work is to study alternative electricity generation systems for powering the electronic equipment in the DEPs. In this initial phase, we are still considering solar energy as the sole source of power because of the low infrastructure cost and independent nature of this resource [2]. However, over the course of this work, which will last over a year, we will also ascertain whether we need to augment solar power with other sources of power generation. In our current work, we will be studying different kinds of batteries, different kinds of solar panels with different power generation capacities and over a long period of time, viz., over a year and observe the variation in performance with respect to changing climatic and weather conditions. A comparative analysis of the system between a laboratory setup at Amritapuri, Kerala and the field deployment in Idukki, Kerala will also be done. Preliminary results show that there is significant day-to-day variation in power generation, viz., between sunny days and cloudy days, which would imply that we need to augment our power setup for DEPs at Idukki.

Traditional Knowledge In Disaster Risk Management: A Study From Flood Affected Area Of Vijayapuram Grama Panchayat, Kerala

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Traditional knowledge can be defined as a body of knowledge built up by a group of people through generations of living in close contact with nature. The main emphasis of it is on minimizing risks for the community rather than minimising

profits. This paper examined the traditional knowledge of local people in the field of disaster risk reduction. The study area for conducting the work was Meenadam, Kossamatom colony in Vijayapuram Panchayath in Kottayam District of Kerala. A random questionnaire survey conducted among the residents of the study area. The most commonly and widely used or known knowledge is the uplifting of house so as to reduce the impact of flood, also keeps belongings in a high and safer place, tree plantation or bamboo plantation near river banks and its protection, stocking of food materials prior to monsoon and sharing and helping are the common traditional practices of the people in the flood affected area. Through this study we can understand that the implementation of traditional knowledge have great importance in disaster risk reduction. This paper concludes that the local people applying there indigenous knowledge very effectively in all phases of disaster management and a comprehensive documentation of existing indigenous knowledge in emergency management is very essential.

Understanding the Causes of Uttarakhand Disaster - June 2013: A scientific Review

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India often faces natural calamities like earth quakes, landslides, floods, cyclones and drought occurring fairly frequently in different parts of the country. At times, the same area is subjected to one or more of these disasters situation in successive seasons or years. While not all natural calamities can be predicted and prevented, a state of preparedness and ability to respond quickly to a natural calamity can considerably mitigate loss of life and property and the human suffering and restore normalcy at the earliest. Hence it is important for a detailed study and analysis of each disaster. Against this background, this paper reviews the different possible causes behind the Uttarakhand Disaster of 14-17th June 2013 in detail. Uttarakhand district lies on the southern slope of the Himalayan range. The climate and vegetation vary greatly with elevation, from glaciers at the highest elevations to subtropical forests at the lower elevations. The district, in general, is prone to different disasters and the order of severity of damage are; earthquakes, excessive rains and cloud bursts, landslides, floods, forest fires and hailstorms. However, there have been numerous debates and controversies ever since the flash floods hit the state of Uttarakhand in June 2013. This has been one of the worst Himalayan tragedies in recent years in which the actual number of people buried or perished is not known as thousands are still missing. The entire Rambara, a large part of Gaurikund and many villages of Mandakini valley were also fully wiped out. Government sources have reported large number of deaths including missing of over ~5000 people in the wake of the devastating flooding. The death toll of 5,748 tops India's previous record worst monsoon flood death toll of 4892 set in July 1968 in Rajasthan and Gujarat provinces. The fact remains the same that the torrential rains triggered a massive landslide that hit Uttarakhand's Hindu shrine in Kedarnath, which lies just a short distance from the snout of two mountain glaciers. From 14 to 17 June 2013, the Indian state of Uttarakhand and adjoining area received heavy rainfall, which was about 375% more than the benchmark rainfall during a normal monsoon. This might have caused the melting of Chorabari Glacier at the height of 3800 metres, and eruption of the Mandakini River which led to heavy floods near Gobindghat, Kedar Dome, Rudraprayag district, Uttarakhand, Himachal Pradesh and Western Nepal, and acute rainfall in other nearby regions of Delhi, Haryana, Uttar Pradesh and some adjoining areas. It has been reported that the complete destruction of Mandakini River in Kedarnath on 16th and 17th June 2013 which resulted in large number of casualties especially among the floating population of pilgrims could have been avoided, if some regulations was in place to counter the mushrooming of different types of dwelling places in Kedarnath. In this context, it is important to understand torrential rain induced geodynamic processes of flash flood resulting rock falls and debris flow, Chorabari lake collapse and deposition of glacial material. This paper review the different scientific studies that have emerged during the last six months emphasizing Meteorological , Geological, Anthropogenic and other causes that lead to this catastrophic disaster
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A Mitigation, Rescue and Management Plan for the Neyyar Dam, Thiruvananthapuram in case of a Possible Breakage

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The work was done to unravel the situation that would arise on a possible collapse of the dam at Kallikad, Kattakada Taluk, Thiruvananthapuram district, Kerala state. This dam was built in the year 1958 and it is gravity, straight dam. The dam is constructed across the river Neyyar and is capable of holding 1060000000 M^3 of water. The main river Neyyar flows through Kallikkad, Ottasekharamangalam, Aryancode, Kezharoor, Marayamuttom, Neyyattinkara and Poovar and ends in the Arabian Sea. The reason for a potential failure is debatable. However an earthquake of catastrophic proportion or ageing and weakening of the structure could be the possible reasons. Reservoir Induced Seismicity (RIS) could be another reason, taking in account the large volume of water stored. Mitigation measures include the following. The energy of water gushing through the river channel can be effectively reduced by constructing transverse canals (transverse to the main river channel). Tree species with a wide canopy and that does not grow tall can effectively dissipate the energy and prevent overflowing water spurt. This phenomenon too was demonstrated by the mangroves by protecting the coastal habitations during the 2004 tsunami. It is desirable to have an automatic water level monitoring and alerting system. This system should be able to detect an alarmingly high or swift water flow within 50/100 meters away from the toe of the dam in the downstream direction in case of a water surge. The after effects of collapse are as follows: 1. Immediate and instantaneous washing away of natural as well as manmade structures and features including vegetation adjoining the toe of the dam. 2. Quick or gradual flooding of the low lying areas on either banks of the downstream part of the dam. 3. Another unique but possible effect may be the release of large number of crocodiles which are presently confined to the Crocodile Rehabilitation and Research Centre near the dam. Further, the wild animals including lions in the Neyyar lion safari park may also perish or may migrate to the habitations in the downstream part of the river, posing a threat to the people. 1. People and property, especially those on the flood plains of Neyyar River, in places like Kallikad, Ottashekharamangalam, Aryancod, Marayamuttom, Neyyattinkara and Poovar may be affected severely. The place likely to be affected most is Kallikad and its surroundings. 2. The resources/infrastructure adjoining the vulnerable areas is as follows: Police station, Fire station, Hospital. The man power available in the open prison near Kallikad is also a potential human resource that can be engaged during a casualty. These resources are located at elevations where flood water is not likely to reach. The management measures proposed after the dam collapse includes the following: Locating the stranded villages or houses, Evacuation of people from above localities, Provision for transport of the injured to the hospitals and to the relief camps, Providing first aid, shelter, food and medical treatment to the affected people, The second phase of the disaster management measures involves providing of counselling to the kith and kin of the perished as well as the injured, rehabilitation of the people who lost their houses, providing livelihood, land for agriculture and jobs to the survivors / victims of the catastrophe.

The Use of Unmanned Ariel Vehicles in Emergency Management: an International Policy Comparison

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As Unmanned Ariel Vehicles (UAV's) become less expensive and easier for a novice to operate, pioneers in the emergency management (EM) community have started testing and incorporating them into their regular repertoire of tools for use in all phases of EM. Operational activities incorporating UAV's include pre-impact mapping, hazard analysis, finding lost or missing people, and rapid damage assessments. Traditional aerial assets for survey and response require significant maintenance and money to operate, and large land allocations for takeoff and landing. Operational advantages to UAV use in emergency management include low operational costs, ease of equipment acquisition, and limited training or certifications. Additionally, UAV use in areas with populations living near little or no infrastructure can be deployed without large commitments from national or state jurisdictions. This paper will compare policies in regard to UAV technology use during disasters, specifically discussing their optimal use given low regulation, limited commercial air traffic, and deployability in rural areas of developing countries. Specifically this paper will profile UAV use in pre and post disaster environments for Haiti and the Philippines, discussing implications and applications in disaster management. A comparative policy analysis will explore differentials between the two countries, and with highly regulated UAV policies in the United States.

Key words

Unmanned Ariel Vehicles (UAV), Emergency Management, policies, Haiti, Philippines

Critical Role of Cross Sector Collaborations in Disaster Management

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Disasters are harbingers of human fatalities and crippling economic loss, the effects of which can be stymied, only by effective plans based on analyzing and evaluating risks, as well as planning and implementing risk reduction and mitigation action plans. Vulnerability is the susceptibility of being harmed, which can be due to natural or man-made factors. Hazard mitigation efforts for facing vulnerabilities are having effective disaster management plans, enacted mock drills, which become the core strength in a situation of chaos. A Plan-Do-Check-Act cycle, approach & emphasis can only meet the challenges in the Disaster Management knowledge domain improvement. Effectiveness of a disaster management plan has a straight correlation in ensuring coordination between various elements in the area of Infrastructure, Information availability, Logistics, Human resources for risk mitigation, field operations, finance mobilization, communication, governmental agencies etc. In disaster management, "successful response" term has no validity, but the aptness can be only attributed as, having an ability to enact, a more effective response with agility and quickness. Diversity in understanding the vulnerability and the gravity of risk issues by various agencies involved in mitigation processes, also pose a challenge to effectiveness of planned strategic approaches to hazards. The various systems in the society are independent in role play but in times of disasters they have a hybrid role to infuse robustness in lacking infrastructure systems, by sourcing from their core competencies, a helping hand for a common social cause. Utilization of technology of the various sectors, during chaos phases of a disaster, by coordinating and building up the disaster management grid, can help in boosting the core strengths of chain of dependencies of various links of disaster mitigation. Exposure of various agencies, to each other's strengths and capabilities to foster cross sector collaborations in the various sectors of society, industry, academia and government can only chalk out effective and tangible results in integrating effective disaster management plans. Estimating in advance the critical factors in play, quantitative estimates of urgently needed goods, prior agreements of support connectivity of various sectors would be handy in response situations of disaster management. Division of roles, work flow modules, command center clarity, information management and networks developments are needed in logistics flow during disaster mitigation plan implementation. The purpose of this paper is to explore the benefits, challenges & risks in cross-sector collaborations and opportunities in disaster management scenarios. It is also is an effort to analyze; the major critical success factors needed in the disaster plans based on an extensive literature review. Attempt is also made to find the possibility of establishing the Disaster Management partnerships within the framework of corporate social responsibility (CSR).

XSLT based proliferation of OpenStreetMap Data for Supporting Disaster Management

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In case of emergency information about the infrastructure of a region is indispensible for planning, support and rescue operations. OpenStreetMap, a project to create open geodata for the whole earth, already hosts geodata for many parts of the world digitized by volunteers. In special emergencies like the Guinea Ebola Outbrea collaborative mapping is used to refine and to extend the data available in the corresponding regions. The data model of OpenStreetMap is quite simple and flat and is basically offered in a specific XML-based format which is not (yet) an acknowledged standard and cannot be used directly all in Geographical Information Systems. In this article, the project itself, its infrastructure, and its data structures will be presented. As well the procedures to collect geodata in emergency cases are described. The Extensible Style Sheet Language (XSL) is used to transform OpenStreetMap formatted data into an encoding according to the international Geographic Markup Language (GML) standard trying to provide rich information for geographical features useful for transportation and logistics in the emergency case. The XSL techniques are presented and an outlook for the usability of the GML data will be given.
Key words

Rapid mapping,. OpenStreetMap, XSLT, Volunteered Geography, Disaster Mapping

Rapid Mapping to Support Disaster Management Based on Open Source Geospatial Technology

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In recent years, the Open Source Community has seen unexpected progress, especially in mapping technologies. Free, competing modules and a wide range of technical support have been emerging very fast and adopted by governments, GIS users and companies as well public agencies to build advanced GIS solutions. In parallel, open source Geodatabase Management Systems were developed and offer powerful options for data storage, management and analysis. In addition the trend to share publicly geospatial information covering the whole world emerged. OpenStreetMap, one of the most popular open source projects taking benefit from the democratization of mobile mapping and GPS technologies, provides such free geospatial data. The release of open geodatabase and the strong media coverage of the recent major crises have highlighted new practices in supporting crisis management. In this paper the design and implementation of a turn-key GIS platform based on open source technologies, in order to support crisis management by providing valuable geospatial data in very short delay.

Key words
Open Source, Rapid mapping, Disaster Mapping, OpenStreetMap, PostGIS

Arsenic Hazard in the Bengal Delta Plain & GIS Application for it management: A Case Study of Purbasthali I and II Block, Burdwan

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Arsenic is a natural constituent and deposited with sediments in the major flood plains of the world and the Bengal Delta Plain is no exception. The present study area is located within the active Bengal Delta plain where 19% of the total population are already affected and several thousand are at high risk of the same. Levels of As in the ground water is recorded as high as 0.20 mg/l. It is found that the average arsenic content of the shallow depth (<20m depth) tube wells is 0.09mg/l and it is as high as 0.08mg/l at the deepest tube well also (>100m depth) both of which are well above the Indian standard.. It has been calculated that the villages contain active geomorphic features and having arsenic contaminated tube wells having correlation co-efficient as high as 0.918. Several physical and social as well manifestations of arsenic poisoning are identified and they may be from skin pigmentation to cancer and social ostracism. But the common method of arsenic pollution management from the Government's end is to re-establish the tube wells at further down the surface. Using the multi temporal satellite imageries (LISS-III, LISS-IV, Google Earth, Landsat-ETM+) and Geographical Information System technology we identified and mapped the affected areas and vulnerable population groups. Using the same we identified and mapped land use land cover and flood plain features also. It has been found that the distribution of settlement, surface water bodies and other land use land cover are being determined by the geomorphic features in the region. Numerous surface water bodies are there as geomorphic features and hold more volume of water (5600000 Gallon) than the total requirement (1900000 Gallon). GIS study found that 62% of the total population are living at the water front. The arsenic in surface water is oxidized and not harmful to human health but may have some bacteria and pollutants. If proper care, treatment and policy are taken to purify and distribute the surface water for the domestic purpose, the problem of the arsenic pollution can successfully be managed.

Gender, Religion, and Disaster Survivors: A Narrative Inquiry

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Narratives are the simplest form of communication among people. Telling accounts of events and happenings comes so easily that narratives are ubiquitous in different societies and cultures. In a story the narrator situates action, people, and conflict in some particular time and space; and tries to make sense of them. Either fictional or real, a story always conveys a message. Central to this study is the idea that the "human life is a storied one." Story-telling is second nature for human beings. As a research methodology, narrative inquiry is non-threatening. It does not directly inquire into people's private lives; rather it simply invites them to share stories of events where they found themselves in. This study explores personal issues in the accounts of disaster survivors in the Philippines. It also attempts to forge pictures that would represent the meanings they bestowed upon their lived experiences during cataclysmic events. Findings show that some of the emergent issues are related to gender roles and religious beliefs; and have implications to survivors' ability to cope with their situations and rebuild their interrupted/shattered lives.

Keywords

Disaster survivors, personal issues, gender roles, religious beliefs, narrative inquiry

Nature and Properties of Soil Influencing Shallow Landslides: A Case Study from the South Western Ghats, India

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The Indian subcontinent, with diverse physiographic, seismotectonic and climatological conditions, is subjected to varying degree of landslide hazards; the Himalayas including Northeastern mountains ranges being the worst affected, followed by a section of Western Ghats and the Vindhyas. Torrential monsoon on the slopes with sparse vegetation cover was the main causative factor in the Peninsular India especially along the Western Ghats. Human intervention by way of slope modification has added grim to this effect. Apart from the rotational deep landslides, the south Western Ghats recorded a number of rotational/translational shallow landslides recently. Shallow landslides are those in which the sliding surface is located within the soil mantle or weathered bedrock, typically to a depth from few decimeters to some meters. The present study evaluated the influencing factors including geology, soil characteristics, land use changes and anthropogenic interventions in triggering the shallow landslides of south Western Ghats. The study also presented the variation in distribution of soil properties using Inverse Distance Weighted (IDW) method using the spatial analyst tool of Arc GIS. The results suggested that the nature and properties of soil characteristics along with significant changes in land use pattern, the occurrence of underlying weathered magnetite quartzite and incessant rainfall have significant role in triggering the shallow landslides at Kondalapally and Mullaringad of Idukki district in South Western Ghats.

Key words: Shallow landslides, Western Ghats, geochemistry, land use changes, IDW method

Drought Vulnerability Assessment in Bundelkhand Region of Central India

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The complex process of climate change affects vulnerable populations and livelihoods in drought prone regions through a rise in frequency and severity of such events. Vulnerability assessment is a new paradigm in disaster management and is one of the main aspects of any drought mitigation strategy. The paper focuses on understanding and quantifying the drought vulnerability, which is one of the prominent climate extremes in Bearma basin located in the Bundelkhand region of Central India. Regular drought conditions have been prevailing in the region in the last decade with continuous drought from 2004-2007. Even though the mean annual rainfall in the basin is 1187 mm, itshigh variability (28%) is one of the prominent reasons for the regular drought scenario. The maximum annual rainfall deficiency during drought years varied from -40.4% at Deori during 1992 to -62.8% at Damoh during 1979 with the drought frequency varying between once in 3 years and once in 4 years.

An integrated drought vulnerability assessment methodology has been developed to identify the drought vulnerable regions using a multiple indicator approach considering the the spatially and temporally varying factors. The spatial indicators include the water demands, topographical characteristics including the river basin reaches and basin slopes, land-use types, and soil type whereas the temporal indicators which vary during for every drought event included the meteorological drought and soil moisture drought characterised by Standardised Precipitation Index (SPI), surface water drought represented by Surface Water Drought Index (SDI) and ground water drought identified by the Groundwater Drought Index (GDI). The spatial information of the indicators was categorised in layers prepared in the spatial domain on a 50 x 50 m grid scale using a geographic information system (GIS) and the integrated values of weights of various classes of the indicators computed to arrive at the integrated drought vulnerability. Results show that the proposed methodology was highly effective in representing assessments of drought vulnerability in the basin and the methodology can be replicated for drought vulnerability assessments in other basins.

Disaster Management Education: Lessons learned from School Safety Campaign in Disaster Prone Areas of Bhachu Taluka of Kutch District, Gujarat

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The world is becoming increasingly vulnerable to natural disasters. Disaster education is aimed at developing a culture of preparedness and safety, besides implementing school DM plans. Education for Disaster Management is a trans-disciplinary exercise aimed at developing knowledge, skill, and values at all levels. The Government of India in its X and XI Five year plan document has emphasized the need to enhance knowledge skills and values to reduce the impact of disasters. Disaster management as a subject in Social Sciences has been introduced in the school curricula for Class VIII, IX, and X by the Ministry of Human Resources Development (HRD), through the Central Board of Secondary Education (CBSE) for empowering the younger generation to safeguard them and the society in the wake of a disaster. State Governments have also designed the curriculum for the inclusion of disaster management through State School Boards. Formal DM courses have been designed for meeting the growing demands of the experts in the fields of Disaster Mitigation, Risk reduction and preparedness (R K Sharma, 2012). The aim of this article is (1) to underline the scope of disaster management education at the academics as well as at the field practice level (2) to highlight the outcomes and the lessons learned from the school level campaign on disaster management carried out in the selected schools in Gujarat (3)suggestions and policy related arguments for the effective implementation of disaster management education at the country level starting from the grassroots level to the optimum level with the active participation of multi stakeholders. The author elaborately discusses the campaigning process and the findings derived from a field setting of Kutch district of Gujarat facilitated by the leading national NGO, Unnathi. There are exemplary stories of children who survived the deadly earthquake because of their knowledge of disasters and related skills to save their own lives as well as of others. Children play a major role in carrying information to the society (UNNATHI). Finally the author pointed out the benefits of integrating Disaster Management in the curriculum of schools, colleges and universities that would make available, an alert force of educated youth, who can combat the ravages caused by disasters with their knowledge, self confidence, and survival skills. The paper concludes with a section highlighting that effective collaboration and participation of appropriate institutions, community organisations and other major stakeholders is crucial for the successful planning, coordination and implementation of disaster management education in the country.

A Study Of Risk Perception About Various Disaster Situations Amongst Home Makers In Delhi, India

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Disaster risk reduction begins at home. The risk perception among the community can be a strong factor influencing their disaster preparedness. The women who are home makers represent a vulnerable group and thus a specific group of interest. This study was carried out with the objective to study risk perception about various disaster situations among home makers in a part of Delhi, India. Interviews were carried out with the women in representative residential colonies in a part of east Delhi, at their homes using a pre-tested questionnaire. A homemaker was defined as a woman in charge of the homemaking, who is not employed outside the home. The study participants were 754 homemakers aged 18 years and above. The respondents were first asked how concerned they were about various disasters possibly affecting their community. The disaster names were read out one by one, and the women were asked to indicate their response as 'not concerned', 'somewhat concerned' or 'very concerned'. Among the women, 171 (22.7%) were illiterate while 140 (19.7%) had done college graduation or higher studies. Majority (84.4%) were living in their own house while the remaining were tenants. The level of concern among the homemakers was highest for earthquake, fire and swine flu, among the disasters asked about. The perceived severity of concern was higher for earthquake, swine flu, and terrorist attack. It was disproportionately low for windstorm. The risk perception was significantly associated with type of locality, higher education status and higher socio-economic class. The current analysis revealed variations in the perception and concern about different disaster situations among the women, and these varied with their socio-demographic characteristics. Further in-depth studies of these differences can be useful in tailoring community interventions to increase disaster awareness and preparedness.

Key words
Disaster, women, home makers, risk perception, concern

Intelligent Traffic Management Technological step toward safer and bias free Management - A case study of Traffic Management Bengaluru

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Especially in developing and underdeveloped countries like China, India etc. due to population Explosion and immense pressure on private transport in the form of two wheelers and four wheelers. The cities are facing heavy threat to passenger's life and also leads to mismanagement of traffic, due to which long traffic jams, severe road accidents are major out products. Thus need is felt to use new technologies to get rid out these issues permanently. There was a time when Bangaluru city was as facing problems like: 1. City was having mixed traffic on the roads due to which the flow of the traffic was crawling. This situation was easily seen on all major junctions. 2. Excessive load on traffic police due to which traffic could not mange properly leading to long traffic jams. 3. The city was a place for often road accidents and in many of the cases the access of proper medical facility could not reach the needy. Resulting in cases of death. 4. Due to improper surveillance teams and they can also cater a smaller area resulting in breaking of traffic rules and laws. Moreover these were a major cause of road accidents. But this scenario change with a step towards a technological change which was going to set a excellent example for other cities. Thus this paper will highlight the case study of Bengaluru, how this Indian city has adopted technology for the management of traffic. For the proper detail this paper will be discussing Intelligent Traffic Management with the following Parameters: 1. Infrastructure, Load, Modes of transport and their composition. 2. Technology adoption (in the form of devices and the information Centers) 3. Beneficiaries (Public and the administration) 4. Indicators of success (through Fines, Lies Saved etc.). This paper gives emphases for use of Intelligent Traffic Management System, which changed the life of Bengaluru city's Traffic and which is waiting to change the life of your city.

Haphazard Industrialization and the Risk of Fire: A Study On Garments Industries In Dhaka

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Readymade garments are the most important export item from Bangladesh, yet the working conditions and fire safety records in the factories are often not up to the standard. In Bangladesh, fire accidents in export-oriented garment factories continue to kill workers, most of them women and children. Despite a number of initiatives to curb fire accidents in the garment industry, there are still a significant number of fire occurrences in this industry. The main focus of this paper is to find out garments workers vulnerability to fire risk due to haphazard industrialization in the different areas of Dhaka city. Beside this, some other issues also examined such as existence of fire warning system in the garments, workers knowledge about the fire equipments, their personal experience and opinion about fire hazard, any visit from fire service, people's knowledge about existing law on fire drill, condition of gas and electricity lines in the buildings, emergency exit condition etc. For the purpose of the study quantitative methodology was employed and interview and survey method were used as a technique of data collection. Five garments were selected randomly by which 180 garments workers were interviewed in a same manner. The study revealed that the safety scenario of the Bangladesh garment industry is one of the worst in the world. Since this is a highly labor intensive industry (hence Bangladesh's competitive advantage through its abundant supply of unskilled cheap labor) the sector is also the largest industrial employer in the country with around 3.6 million people directly working in these factories. Inclusion of backward and forward linkages would further increase the number of employees' dependant on this sector. Due to those reason industries haphazardly grow here and there without following any kind of construction law that enhance the risk of fire further. Fire is one of the most frequent and damage inducing accidents in these factories in Bangladesh. Fire is also purported to be the largest cause of on-the-job injuries and fatalities in this sector. Each new incident of fire and related damage adversely affects the reputation of the industry

abroad, especially since the working conditions in the manufacturing sectors in the developing countries is a general cause of concern in many developed countries. Despite the various measures, rules and regulations implemented in the past decades, there are still several instances of fire outbreak in the garment factories every year, resulting in significant losses of lives, livelihoods (through injuries), equipments and materials. These incidents raise questions about the effectiveness of existing fire prevention and fire fighting rules, regulations and practices. Based on this conceptions finally this study formulated a number of recommendations to bring a positive change in the garments industries.

Variation of Effective Hydraulic Conductivity with Variation In The Vertical Profile of Hydraulic Conductivity

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It is seen that macropores and mesopores though contributing only a small percentage (< 10%) of the total porosity, can contribute ∼90% of the water flux. Thus the effective porosity is primarily macro and meso porosity. A decrease in the percentage of macro and meso pores could thus - other factors remaining the same - lead to a significant decrease in the hydraulic conductivity. Hydraulic conductivity can vary both horizontally as well as vertically and in such cases an effective hydraulic conductivity is often considered. Changes in level of compaction can lead to changes in the effective porosity profiles and thus to changes in the effective hydraulic conductivity. We explore the variation in the effective hydraulic conductivity effected by changes in the structure as well as parameters of various assumed vertical profiles for the hydraulic conductivity.

Analysis of Extreme Weather Indices in a Rubber Growing Region of India Using R.ClimDex

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Variation in long term pattern of Indian climate is reported from many parts of the country, but regional climate changes in terms of extreme weather events has not been properly studied. The extreme weather events may have a greater ecological and socio-economic impact as compared to long term climatic changes. Extreme weather events in rubber growing regions need particular attention due to the influence of rubber cultivation on socio-economic sustainability of the nation. The present study analysed the occurrence of extreme temperature events using the weather data from the Rubber Research Institute of India (RRII) Kottayam, (9^0 34' 44.5" N and 74^0 36'16.7"E) during the past 40 years (1970-2010), with the help of R.ClimDex package developed by ETCCDMI (Expert Team on Climate Change Detection Monitoring and Indices) at the climate research branch of the Meteorological Service of Canada. The temporal variation in trends of occurrence of extreme weather events was tested with Mann-Kendall trend test. The results showed that the frequency of occurrence of extreme weather events significantly increasing in the case of daily temperature range (DTR), hottest day(TXx), cold spell duration index (CSDI), hot days (SU 32), Tmax mean, cool night frequency (TN10p), hot day frequency(TX 90P) etc during the past 40 years. A negative trend was observed for the occurrence of Tmin mean, coolest night (TNn), cool day frequency (TX10p) etc. The varying trend in extreme weather events at regional scale, as observed

over many regions of the world, may be attributed to the global climate change, urbanisation and changes in land use pattern. The study indicates the need of proper management strategies for sustainable rubber cultivation, since extreme weather events have significant impacts on growth and yield of rubber.

N2 Modeling and Geospatial Technologies for Tsunami Hazard Assessment - A Study from the Car Nicobar Islands, India

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This study deals with the tsunami hazard assessment along the coasts of Car-Nicobar Island in the Andaman Sea of India, which was affected by the 26 December 2004 tsunami generated due to the Sumatra earthquake (M 9.3).The tsunami has been simulated using the Tunami-N2 numerical modeling using the corresponding focal parameters. The simulated tsunami run-up heights at the coasts were extracted and the extent of the inundation has been derived using the Shuttle Radar Topographic Mission (SRTM) topographic data. Further, Remote Sensing and Geographic Information System (GIS) techniques were adopted to identify and assess the Tsunami hazard. The Enhanced Thematic Mapper (ETM+) onboard Landsat-7 and Linear Imaging Self-scanning Sensor (LISS)-III onboard Indian Remote Sensing (IRS)-P6 satellite data are used to assess the changes in the vegetation and shorelines during the pre and post tsunami. The analysis result reveals that the estimated tsunami run-up height along the coast was in the range of 5-10m and 65% of the total vegetation has been completely changed due to the tsunami.

Key words
Tsunami hazard assessment, Vegetation change, Shoreline changes, N2 modeling.

Knowledge and practice on School Safety among Bharath Scouts and Guides Instructors in Karnataka

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Schools are critical infrastructure entrusted with the responsibility of creating citizens of tomorrow. No task is as important as creating safe learning environment for our nation's children. Building a culture of Safety in schools is one of the priorities of Hyogo Framework for Action (HFA). If the current generations of students are sensitized about the culture of safety, next generation of citizens would be more empowered for the future. Teachers play a vital role in molding the students. Teachers are the role models for the students in the schools. Today's safe school environment helps in making safer world in future. Recent events of children deaths due to building collapse, fire accidents and stampede bring to light the need to be continually vigilant to ensure for safety of students and staff in schools. Considering all the factors the importance of working with school is emerging day by day. This prompted the researcher to conduct a study with the objective of assessing the existing knowledge and practice on school safety among scouts and guides instructors of Karnataka. Descriptive study was conducted. The study population included the Bharath Scouts and Guides instructors

who are primarily school teachers in Karnataka. Purposive sampling technique was used to select 200 Bharath Scouts and Guides instructors attended in state level scout conference. Data was collected by using structured interview schedule. The questionnaire comprised of three parts Part I: Demographic Profile, Part II: Knowledge Questionnaire on Disaster, Disaster Preparedness and First Aid and Part III: School Safety Practice questionnaire. In this study majority of the respondents were in age group of 31 – 41 years of age, professional experience of 11- 20 years, graduates and Males. 80 % of the participants did not have any formal training on disaster management or on school safety. 20 % of the participants either experienced disasters or participated in relief operation. 32 % and 68 % of the participants had moderate and inadequate knowledge respectively. The deficiencies with respect to training, practice and infrastructure on School Safety were documented. Majority of the scouts and guides instructors had inadequate knowledge. Practices on the school safety were deficient. Only 20 % of the scouts and guides instructors had formal training on disaster management, first aid, fire safety etc. None of the schools had school public address system, disaster management committee, school disaster management teams, school disaster management plan and identified hazards in school premises.

Key words
Knowledge, practice, School Safety, Bharath Scouts, Guides, Instructors

Heavy Metal Remediation in Water Treatment Systems: Revisiting Some Useful Applications and Processes

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The term "heavy metals" refer to a group of naturally occurring metals and metalloids that have atomic density over 6 gm/cm^3. Although many of these elements serve as useful links and essential micronutrients for life forms, the same may reflect toxic manifestations if their concentrations deviate from the optimum range. Discharge of wastewater laden with heavy metals without proper treatment is, therefore, a threat to public health. These heavy metals show biosorption, bioaccumulation, biomethylation and biomagnification phenomena under varying natural environments. Further, these heavy metals are known to be persistent pollutants, much stronger than their organic counterparts, such as pesticides, PAHs, or petroleum byproducts. Fate, transport, capture, remobilization and reworking of these metals in natural environment is still an enigma, and depends heavily on the interplay of physico-chemical conditions such as Eh-pH, chemical speciation, thermodynamic controls, reaction kinetics and biotic influences. Various technologies and processes are in vogue for heavy metal remediation. The present study gives a re-look to the understanding of these interactions between mineral surfaces and species in solution, and aqueous partitioning of toxins on oxide and silicate surfaces. The paper elucidates some of the salient processes that could be effective for heavy metal remediation in water treatment systems. If such attempts to decode the environmental flows of heavy metal assemblages achieve moderate success, it will hopefully be a foundation work of further research on heavy metal remediation in India.

Laipuitlang Rockslide Disaster of 11 May 2013: A Geotechnical Study

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Laipuitlang is one of the local council under Ward-III of Aizawl Municipal Council area under the Aizawl North-II Assembly Constituency, located at an altitude of about 1100 m (Fig.s 1 & 2). The location coordinate is N 23° 44" 46', E 92° 22" 09'. The area around here had been used as a quarry before and there are loose chunk of stones underneath it, and a few landslides have occurred way back in 1957 and 1969 as told by the resident. Though a small area, a good number of Government office and establishments are located within the Local Council jurisdiction. The most important could be water reservoir at the top of the hill-lock which serves as a main storage tank for northern part of the Aizawl city population. A cyclonic storm with heavy rain prevails over the Aizawl city on the night of May 10th 2013, which one may recalled some other day as one of the darkest night in a living memory which suddenly sweep away the whole block of

Laipuitlang down to hundreds of feet in the early hour of May 11th, 2013. The heavy downpour from the cyclonic storm causes a very high slope having little top soil and trees covers could not withstands the nature force and moves down with full force and fury. This sudden and tragic incidence causes a huge disaster in the entire slope housing 34 buildings. The huge rock-slide along with topsoil rampaged and destroyed all living and non-living features without any mercy causes huge loss of property and seventeen (17) valuable life and disrupted the life of the people.

The total covered area is 3,586.32m^2 where area falls between two roads is 3,398.61 m^2. The vertical slope height is 55.55 m whereas the total slope length is 96.3m. The geological setup of the area, the anthropogenic factors prevails in the entire settlement area and lack of proper development controls regulations enacted upon such area clearly shows that the situation and condition invites such type of disaster. In other words, disaster could be mitigated or at best could be avoid if and when development controls regulations are enacted base on geological/geotechnical report. The geotechnical studies strongly recommended five important agenda (*termed as Agenda for safer city for Aizawl*) for geological-related disaster preparedness plan and mitigation measure for safer city.

1. Landslide hazard is one of the most natural disasters repeatedly happen and causes very dearly to the state exchequer. In the backdrop of Laipuitlang disaster, Landslide hazard reduction and mitigation policy need to be evolves in a concerted manner.
2. Development activities need to be control and regulate with specific bye laws. Any site development and modification of land should be with proper planning and supervision under technical personnel.
3. Site-specific Geotechnical reports, maps and data.
4. Set-up of Geotechnical Engineering Office having an authority to formulate policy and administered Landslide hazard reduction and mitigation policy.
5. Setup monitoring and warning mechanism in a selected area.

Fig-2: Disaster Site

Key words
Rockslide, disaster, Geotechnical, Mitigation, Preparedness.

Progress and Challenges in Implementing Disaster Risk Reduction Initiatives in Kerala, India: An Assessment Based on the Hyogo Framework for Action

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The growing concern across the globe over unprecedented rise in the number of natural and manmade disasters appears to be resulting in corporate willingness for action in the arena of disaster risk reduction. The dimensions of the disaster impacts, especially in relation with the developmental activities and growth demands efficient disaster management strategies. Recognizing the significance of Disaster Risk Management, '*Hyogo Framework for Action (HFA)*' came into existence as an outcome of UN world conference on disaster risk reduction in 2005. The proposed frame work is currently considered as a global blueprint for implementing disaster risk reduction for the period of 2005 to 2015 by focusing on five priority areas (Institutional Strengthening, Scientific and technological applications, Disaster Management Education, Risk Reduction in Key sectors, and preparedness and response). An attempt has been made in this research to assess the progress of Disaster Risk Reduction initiatives in the State of Kerala in India in the context of multi-hazard proneness, Human Security and Ecological sensitivity using HFA. The progress and challenges in the set priorities of the state were assessed with the help of customized benchmark indicators, interviews and project reviews. Analysis of Disaster Risk Reduction Scoring Framework (DRRSF) indicates that the State has achieved just over 50% progress in the priority areas of Institutional strengthening, education and preparedness whereas in Science and Technology applications and Risk reduction in key sectors, the State needs to take immediate measures to achieve the required rate of progress.

Natural Disasters, Risk And Hazard Vulnerability In India and Their Mitigation And Management

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Natural hazards are not unusual phenomenon and India is among the most disaster prone areas in the world. This paper examines the need to take action for the disaster reduction, mitigation, preparedness and prevention and it focuses on the policies and programmes being adopted in India in this regard. It analyses the risk, hazard vulnerability in respect of earthquakes, tsunami, landslides and floods and discusses the usefulness of the Vulnerability Atlas, which is being developed by different organizations in India, for formulating proactive policies to face the threat due natural hazards. It discusses the different aspects of natural disasters and gives a brief account of the statistics on disasters. Natural disasters in Asia account for about 40% the world total, while the death toll ratio is about 50% and the number of people affected about 90%. In India 54% of land vulnerable to earthquakes, 8% of land vulnerable to cyclones, 5% of land vulnerable to floods. This paper overviews the natural disasters occurred in the Southeast Asia and hazard vulnerability in India. A strategy has been developed for the disaster prevention and mitigation and the importance of forecasting, satellite and remote sensing, computerized systems of vulnerability and risk assessment and other technologies for warning and monitoring has been discussed This paper concludes that increasing urbanization and degradation of the natural environment is having the effect of increasing the frequency and severity of disasters. A programme of public awareness of the potential hazard and warning system could save many lives in this region.

Keywords

Earthquakes, landslides, floods, tectonic, epicenter, tsunami, vulnerability

Nanotechnology and Sustainable Construction

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Nanotechnology is anticipated for its sustainability, lesser related to the construction sector. The key aspect in the early development and application of sustainable nanotech solutions in the construction sector is nanoconstruction. This paper provides a framework for addressing relevant issues of green nanoconstruction, considering current challenges. Sustainable nanoconstruction has the potential to simultaneously enhance the competitiveness and climate potential as a key strategic factor for the sector ahead. However, the considerable lack of knowledge on eco-opportunities and risks of nanoconstruction and the industrial dynamics involved forms a serious barrier in business and policy for pursuing nanoconstruction as a serious strategic target.

Dying Rivers due to human greed: An example from the Neyyar River of Thiruvananthapuram District, Southern Kerala, India

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Rivers are the lifelines of nature which provide the cradle to human civilizations. Rapid population growth, economic development and industrializations have lead to the unprecedented transformation of these fresh water ecosystems and consequent biodiversity loss. About 41% of world's population lives in river banks under water stress. The situation in Indian rivers is quiet alarming that rivers have been widely exploited for their biotic and abiotic resources and are

polluted indiscriminately. Kerala, the land of 44 rivers is now at the brim of unnatural death due to human greed for development and survival. The urbanization process which started in the state during 1970's exerted immense pressure on her river resources particularly sand which is an essential component that maintains her very existence. Conservation and restoration of rivers from anthropogenic disturbances is the need of the hour in the state. The present study is an attempt to reveal how human greed kills a river by considering river sand mining as an example from Neyyar River, the southernmost river of the state and its resultant impact on land, water, biotic and social components of the environment. The human greed on river is studied through field survey by observing the nature and complexity of mass sand extraction by violating existing laws and regulations. The environmental impacts have been examined by using historic maps and satellite imageries, published reports, PRA along with field survey. The study revealed that the river bed has lowered substantially due to sand mining and the flood plain sand mining has widened the river, created a lake like situation in Arakkunnu, Palakkadavu and Olathani areas. Salt water intrusion has observed from the Poovar estuary to a greater extent towards the lower reaches of the river and water quality has lowered drastically. Along with environmental problems, sand mining has affected the social well being of the people in the river basin.

Key Words
Human greed, rivers, sand mining and Neyyar

Humanitarian Aid and Logistics

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The basic task of humanitarian logistics comprises acquiring and delivering requested supplies and services, at the places and times they are needed, whilst ensuring best value for money. In the immediate aftermath of any disaster, these supplies include items that are vital for survival, such as food, water, temporary shelter and medicine, among others. Since disaster relief is about eighty per cent logistics it would follow then that the only way to achieve this is through slick, efficient and effective logistics operations and more precisely, supply chain management. This paper defines humanitarian logistics, underlines the crucial role of logistics and supply chain management in the humanitarian context, it identifies the main categories of disasters and describes disaster-relief operations. It delineates the phases that constitute the disaster management cycle; in particular, it identifies the specific phase of the humanitarian logistics stream that demands agile and lean principles. It also indicates the different key actors in the humanitarian system, and it describes their role in disaster relief, underlining the complexity of humanitarian supply chain relationships. The paper provides the reader with a brief introduction on the key concepts of humanitarian logistics and supply chain management, and underlines the complexity of an emergency relief operation.

Key words
Humanitarian logistics, Humanitarian supply chain, Types of disaster, Disaster relief operations, Disaster management cycle, Humanitarian logistics stream, Disaster preparation phase, Disaster response phase , Agility and leanness principles , Humanitarian players.

Assessing and Mapping the Spatial Dimensions of Drought Affected Areas Using SPI, Remote sensing and GIS, in Thiruvananthapuram District, Kerala

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Drought itself is not a disaster, it becomes a disaster when it affects human societies and economies. Kerala State is bestowed with a number of rivers and adequate amount of rainfall but in recent years the state as a whole is experiencing seasonal drought during the summer months. In the present study an attempt has been made to map and assess the

spatial dimensions of drought affected regions in Thiruvananthapuram district. To assess the meteorological drought situation, rainfall for the past 38 years for the entire district were collected and Standard Precipitation Index (SPI) analysis was carried out. As per the SPI analyses the year 2012, was obtained as the driest among the other years. The NDVI images from MODIS satellite having a resolution of 250m, for the year 2013 (summer months), were downloaded and the anomaly of NDVI from the mean for each image were classified to determine the spatial dimension of agricultural drought risk. Finally a resultant classified drought risk map with revenue villages was obtained using raster calculator in ArcGIS.

Keywords
Standard Precipitation Index, Normalised Difference Vegetation Index, Geographic Information System, MODIS.

Conflict Management

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In a present world with each country dependent upon each other for resources. The relations based on diplomacy mediation and the aptitude to accomplish agreement and reception from rivals the people across the globe the ability to negotiate and deal with conflicts is a main concern for any institution Conflict is a very wide-ranging term which has a relation with every field of Management. In an organization there is immense interaction between the employees Interaction in itself has a larger likelihood of conflict to happen. We in progress of communication cannot say that what outcome it will have in approaching moment in time over a meticulous problem. Conflict plays a very imperative role in the functioning of an organization. Without a conflict a proper decision making is not possible as seen in the past. The Managers in every organization should see whether the conflict is fertile or detrimental for the organization. Conflicts and decision making go side by side with each other. Many philosophers in the past has thrown light on the conflict management process but in comparison with today's changing and challenging environment these theories can't put a tangible picture in front of modern managers. It has also been seen that when there is no conflict there is always a lack in terms of decision making and output is also said to have been on its last legs and the that organization has an astonishing prospect. Corporate Institutions are day by day changing to improve on its competitive edge in the market place. In order to gain a better hold in the market. As we know that people are the key when it comes to dealing of conflict proper channelized approach should be used or it can turn against the benefit of the organization. Our paper focuses on how to channelize the conflict and analyze the role it plays in the organizational productivity.

Keywords
Corporate Institutions, Environment, Competitive edge, Meticulous, Prospect

Effect Of Life Skills Education Training On School Teachers From Tsunami Affected Villages

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Life skills education training programme was planned and implemented for school teachers from three tsunami affected villages in Kanniyakumari districts, namely Vaniakudy, Colachel and Kottilpadu. The training programme was the result of the inputs received at the handholding meetings with the teachers. Teachers reported that in the class the students were inattentive, lazy, playful, not punctual, unruly, indulging in substance abuse and so on around one year after the disaster. The aim of the programme was to orient teachers regarding the significance of life skill education and its application to children and adolescents. Twenty five teachers from St. James High School, Vaniakudy, Government Middle School, Colachel and St. Alex Middle School, Kottilpadu were trained based on a standardised module of life skills education. Assessment tools utilised for the research purpose were (1) Participant profile to collect the socio-demographic details of the participants and (2) Knowledge Assessment Scale (Sekar, 2007) a ten-point scale to record the changes in the level of

knowledge on life skills before and after the training programme and (3) Life Skills - Opinion Questionnaire (Bharat, Kishore Kumar and Vranda, 2005) to record the opinion of teachers on life skills education. The poster presentation shall include the outline of the programme and the effect that it had left on the participants.

Key Words
Life skills education, school teacher, disaster

Facing The Unexpected: Disaster Resilience Through Edification

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A disaster is a unexpected, catastrophic event that dangerously disrupts the functioning of a society and causes human, material, and economic or environmental losses that exceed the society's ability to cope using its own resources. The foremost people to take action to a disaster are those living in the local area. They are the first to initiate rescue and relief operations. Every nation has to focus on community-based disaster preparedness, which assists communities to reduce their vulnerability to disasters and strengthen their capacities to defend against them. The recovery from a disaster is the outcome of community's skill in managing the disaster. In India, people are not in a position to manage unforeseen disasters. The common people are not aware about the methodical management of disasters. Disasters have a major and long-lasting impact on community long after the immediate effect has been mitigated. Imperfectly planned relief activities can have a significant negative impact not only on the disaster victims but also on future generations. Public awareness on disaster management can save many lives during disaster. It is important that the content of awareness messages should be consistent, clear and context specific and it should be conducted at regular intervals so that the knowledge is kept alive in the community to pass on from generation to generation and ensure that the disaster risk reduction become an integral part of the culture and everyday life of the community. Some educational activities have been started by Indian Government in collaboration Ministry of Education has been working on integration of disaster management into school curriculums. However, there is a need to be conducted at regularly and a few additional activities have to be implemented to enhance the effectiveness. To deepen and inspire greater interest in disaster risk reduction, to encourage the design and implementation of creative and innovative interventions and to anchor the principles that strengthen the Disaster Risk Reduction commitment. Teachers are nation builders. They can play a crucial role in campaigning about disaster risk reduction techniques among the students. This paper highlights on the need for creating awareness among the secondary school teachers about disaster risk reduction techniques and suggests appropriate management options that can be implemented for the scientific disaster resilience through our present edification system. In the present study, investigators adopted Survey Method. The data collected from a sample of 90 secondary school teachers. The data collected through questionnaire. The collected data was analyzed by computing percentage. The major findings of the study reveal that there is an urgent need for creating awareness about disaster risk reduction. Education is a best means to create awareness about disaster risk reduction techniques, among the future generation through their guru.

Disasters And Accidents – What Shall Not Go Wrong?

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Disasters and accidents are stressful situations. After all, a disaster means something horrible has happened on a very large scale. Many of the people at the scene, especially victims, will be distraught. Disasters are seen as the consequence of inappropriately managed risk. In this paper, eight major disasters have been considered for analysis of its causes, consequences and the lessons learnt from it. From this study, it was found that many of the causes for the disasters could have been avoided if properly analyzed for the process safety and thoughts applied. This study suggests that the eradication of all risks and hazards is possible through safe working practices, behavioural and technical based training, hazard analysis such as HAZOP, FMEA, etc., Implementation of these suggestions will help to reduce the potential for accidents and improve the workforce morale and result in a safer environment.

Keywords

Risk Management Using Morphological Field Analysis: A Case Study from Nellore District, India

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In the event of any disaster, district administration of India is the focal point of coordination for relief and rehabilitation work. All districts in India are mandated to have disaster management plan indicating the actions on the basis of the presumptions derived from past experience. While templates for preparing the Disaster Management plans have been developed by National Institute of Disaster Management (NIDM) but after review of many District level Disaster Management (DM) plans available in the public domain, the authors felt that the understanding of the various elements of risks are not uniformly understood at district level, across India and there is no tool avialable to provide easy and effective decision during the time of crisis. Amarajeevi Potti Sri Ramulu Nellore district in Andhra Pradesh State is one such district which is prone to multiple hazards and the DM Plan is in place. In this paper, attempt has been made by authors to identify various "elements of risk" in the district from the DM plan and also through inputs from district officials in DM cell. Through MA/CARMA, an advanced computer program, morphology analysis has been done through Cross Compatibility Matrix between different elements of risk. A relationship has been established between various parameters of Hazard, Vulnerability and the Coping capacity prevalent in the district (resilience) based on the available data and correlation on the risk factors through "cross-consistency assessment" (CCA). It is based upon the insight that there may be numerous pairs of conditions in the morphological field which are mutually incompatible. Through the pair-wise comparison of the variables, the fitment process is completed based on the established procedure, then CCA Model of risk for Nellore was established. The model developed would allow to quickly identifying synergies or disparities in disaster reduction methods adopted by district administration by providing the right choice of the support functions during the time of crisis, as applicable to any particular disaster.

Keywords
District, Risk, Morphology, Cross-consistency assessment, Model

Corporate Sector in Disaster Management: India

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Abstract

Disasters due to natural hazards have increasingly devastating impacts on the development prospects of most countries. Unlike the bounty of nature, its fury is a great leveller. Natural disasters affect everyone alike although the nature of impact varies from region to region and sector to sector with the coping capacity of an individual sector being the differentiating factor. The catastrophic fallout of natural disasters on the community and the people is very well documented by now. At the same time, it is their impact on the existence, survival and viability of the economic muscle of a nation, community and region, i.e. the corporate sector, which also merits equally focused attention. India's geo-climatic conditions as well as its high degree of socio-economic vulnerability, makes it one of the most disaster-prone countries in the world. Traditionally, India had been 'reactive' in its approach towards disasters – with precious resources being spent on relief, rehabilitation and reconstruction efforts. Today, after considerable and meticulous planning and a concerted effort, a paradigm shift in the approach of the Government departments and agencies as well as of other stakeholders including the community, the corporate sector and others has been brought about for building holistic capabilities for disaster management. This article highlights the role of Corporate Sector in Disaster Management in India.

Key Words
Disaster management, Institutional and policy framework, Role of corporate sector, corporate disaster resource network.

Disaster Management of Livestock in Developing Countries

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Different disasters have similar consequence on the health and welfare of livestock. Numerous geophysical disasters can exacerbate epizootics, resulting in the deaths of many animals and the reduction of production efficiency. These disasters also present a considerable threat of spoilage of processed foods, endangering public health. Furthermore, large-scale disasters involving animals can modify the long-term stability of national economies, the environment and social structures. The authors discuss the vulnerability of the livestock industry to natural disasters and the impact of floods, droughts and transboundary diseases and pests on national economies. Examples are given on how some losses can be avoided, evaluated and compensated. The role of the veterinarian is presented in relation to work conducted by other relief organizations in cases of emergency. In developing countries, mitigation programmes should focus on strengthening global animal health services. Preparedness needs to be community based, with education provided in a timely manner. Effective recovery from disasters should be based on mitigation programmes, including international trade and mutual aid agreements between neighboring countries to supply appropriate goods and environmentally and culturally appropriate breeds of livestock. Disaster relief for the care of livestock should be recognized as a form of humanitarian assistance, given the benefits to be derived for public health and the socio-economic implications of successful intervention.

Helping Children after a Natural Disaster

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Natural disasters can be especially traumatic for children and youth. Experiencing a dangerous or violent flood, storm, or earthquake is frightening even for adults, and the devastation to the familiar environment (i.e., home and community) can be long lasting and distressing. Often an entire community is impacted, further undermining a child's sense of security and normalcy. These factors present a variety of unique issues and coping challenges, including issues associated with specific types of natural disasters, the need to relocate when home and/or community have been destroyed, the role of the family in lessening or exacerbating the trauma, emotional reactions, and coping techniques. Children look to the significant adults in their lives for guidance on how to manage their reactions after the immediate threat is over. Parents, teachers, and other caregivers can help children and youth cope in the aftermath of a natural disaster by remaining calm and reassuring children that they will be all right. Immediate response efforts should emphasize teaching effective coping strategies, fostering supportive relationships, and helping children understand their reactions. Schools can help play an important role is in this process by providing a stable and familiar environment. Through the support of caring adults school personnel can help children return to normal activities and routines (to the extent possible), and provide an opportunity to transform a frightening event into a learning experience.

Fluoride Toxicity in Groundwater of Bankura District, West Bengal, India: An Exemplar of Impending Disaster and Environmental Systems Collapse

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The United Nations had declared the 1980-1990 decade as the 'International Water Decade'. This was mooted with the vision of providing safe and continuous supply of water to people – rich or poor. As part of the above programme, bore wells were dug at random in different parts of West Bengal. Water from these wells was found to be relatively safe from pathogens and available throughout the year. But a severe fall-out of this mission was evidenced shortly. Reports of high incidences of fluoride in drinking water (>1.0 mg/L) and symptoms of fluorosis with skeletal and dental disorders became prevalent in many areas. Many patients got registered with symptoms of goiter and even incidences of cancer. Thus tube wells, that were once sunk to alleviate the public health of the poor rural people by way of providing pathogen free drinking water, inadvertently created another public health disaster. The groundwater contamination mainly occurred from natural dissolution of fluoride minerals from sub-terranean strata. The result of Water Decade became obvious. The Water Decade came to an end; but extensive fluoride contamination in groundwater started plaguing the water users in many parts of West Bengal. This has now become the prime matter of concern for the government at local, regional and national levels. In view of the recent reports of outbreak of fluorosis, hydro-geological monitoring was carried out in the different blocks of Bankura district, West Bengal (present study area) to find out the level and extent of affectation. The aim of this study is to assess the hydrogeochemical significance and relation between selected water parameters namely pH, iron and hardness that reportedly govern fluoride leaching in the groundwater of Bankura district, West Bengal. Groundwater samples were collected from public tube wells covering all the major hydrogeological units spread over 10 districts of Bankura in the pre-monsoon season of 2011. In the given area, groundwater is available in two major units: (i) the weathered zone and (ii) the hard rock fracture zone. Groundwater extraction is taking place dominantly through medium-to-large diameter open dug wells and limited low duty tube wells. The yield of these low duty tube wells (75 m to 100 m. depth) varies from 20 to 25 metre cube / hour. Analyses results of collected water samples show fluoride concentration ranging between 0.5 to 10.80mg/L, pH 5.1 to 9.4, iron 0.05 to 5 mg/L and total hardness 32 to 4700mg/L. If the pH of the water is slightly acidic, then iron and fluoride usually remain in dissolved state. Fluoride leaching is found most effective under slightly alkaline condition wherein it shows affinity towards iron in the form of unstable complexes (FeF_6^{+3}, FeF^{+2}, and FeF_2^{+}) and get precipitated out of the solution. Hence in presence of high fluoride in groundwater, some portion gets removed by way of adsorption to iron particles and thereby exhibiting negative correlation. On the other hand, total hardness also shows negative correlation with fluoride due to removal of calcium by way of fluorite and apatite from the system.

Key words
Bankura, contamination, fluoride, hard rock, iron, pH, hardness

Chemical & Industrial Disaster

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With globalization and industrial growth, there are emerged a quantum jump in chemical production, handling and transportation of hazardous chemicals across the globe, which is associated with a non speculative rises of fire, explosion, toxicity, environment pollution, etc. such disasters which occurred in past worldwide are eye openers. Chemicals disasters are always man-made. Unlike emergencies caused due to natural disasters which are difficult to prevent, industrial and chemical accidents can be prevented and their impacts minimized by better planning, preparedness and response. Advancement, transfer and sharing of knowledge are key foundation for disaster risk management. This paper reviews on the Bhopal gas disaster, also referred to as the Bhopal gas tragedy, was a gas leak incident in India, considered the world's worst industrial disaster & factors responsible & preventative measures to avoid such type of incidents.

Keywords
Definition, Indian industrial disasters scenario, Bhopal gas tragedy, Preventative Measures

Comparative Study on Post Traumatic Stress Disorder among Survivors of Disasters in Kerala

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Tsunami, one of the worst natural disasters occurred on the 26th of December 2004 across the world hitting the coastal land including the state of Kerala. The tsunami the first of its kind in the state took away hundreds of lives, destroyed houses and disrupted the entire fabric of the fisher folk. Although materialistic rehabilitation was carried out immediately with almost concern and empathy the psycho social problems were left out unattended. The present investigation was taken up to study the impact of tsunami on the psycho social status of survivors in Alappd Panchayat of Kollam District, which was the most adversely affected area. The psycho social variables selected for the study were Post Traumatic Stress Disorder (PTSD), Mental Disorders associated with Primary Health Condition, Disability Status, Maladjustment and Quality of Community Life. Five Hundred tsunami survivors were selected from various relief camps using the method of cluster smpling.500 subjects were selected from near by non affected panchayath for the sake of comparison. The study was conducted in three phase immediately after tsunami, after one year of occurrence and after two years of occurrence. Impact of Event Scale, Self Reporting Questionnaire, WHO Disability Assessment Scale, Mathews Maladjustment Inventory and Quality of Community Life Questionnaire were used for the study. Analysis was done using Statistical Package for Social Sciences (SPSS.20). Significant difference was observed in Post Traumatic Stress Disorders ($t= 106.28$, $p<.001$), Mental Disorders associated with Primary health condition ($t= 61.71$, $p<.001$), Disability level ($t= 76.55$, $p<.001$), Maladjustment ($t=116.43$, $p<.001$), Quality of Community Life ($t= -45.98$, $p<.001$) between Alappad and Chavara Grama Panchayaths. Study again shows significant difference in Post Traumatic Stress Disorders ($F=641.79$, $p<.001$), Mental Disorders associated with Primary Health condition ($F=454.23$, $p<.001$), Disability Level ($F=3253.55$, $p<.001$), Maladjustment Pattern($F=2441.39$, $p<.001$), Quality of Community Life ($F=1388.32$, $p<.001$) in survivors among Phase I, Phase II and Phase III in Alappad Panchayath.High significant difference was observed in Maladjustment Pattern($F=8.93$, $p<.001$), Quality of Community Life (QCL) ($F=13.77$,$p<.001$) with respect to the Income, Maladjustment Pattern($F=2.99$,$p<.05$) with respect to Type of Family, Mental Disorders Associated With Primary Health Condition ($t=-2.44$,$p<.05$) with respect to the Livelihood Loss, Disability Level ($F=5.45$,$p<.01$), Maladjustment Pattern ($F=4.02$,$p<.05$), Quality of Community Life (QCL) ($F=12.94$,$p<.005$) with respect to the Displacement Pattern of the survivors in Alappad Panchayath immediately after Tsunami.

Key Words
Impact, Psycho social Status, PTSD

Landslide Hazard Zonation Using Geospatial Technology in Parts of Kodaikanal Hill Region, Tamilnadu

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A methodology for landslide hazard zonation mapping using an integrated remote sensing and GIS approach is presented. Landslides often affect Kodaikanal, a well-known tourist hill resort in south India, The hills in Kodaikanal have a fairly thick weathered overburden that tend to slide during heavy rainfall. Therefore the frequency of landslides in these areas is higher. This study represents the causative factors of the Kodaikanal landslides. Here The landslide inventory map shows that, during the past 10 years, out of 66 landslide incidences, 35 incidences were fallen along the Vatlagundu-Kodaikanal-Palani Ghat roads. Secondly thematic maps were prepared on the various causative factors that is geosystem parameters like geology, lineaments/faults, geomorphology, land use/land cover, drainage system, slope, etc. High resolution Geo-eye satellite data, LANDSAT-TM and ASTER images have been used to generate a few of these thematic maps. To identify the vulnerable areas, the above-mentioned parameters were analyzed in a GIS by assigning appropriate ranks and weights. The result is a landslide hazard zonation map showing regions with varying degrees of vulnerability to landslides. Detailed landslide vulnerability analysis along road corridor. This prepared hazard zonation map will enable to propose and implement suitable mitigating measures, thus preventing loss of life and property in the Kodaikanal hills. An additional study made over landslide vulnerability analysis along road corridor region, using lineament and drainage maps. Though the heavy rainfall is triggering landslides in western Ghat region, the other causative factors in inducing landslides are anthropogenic activities, geosystem parameters like structure, geomorphology, land use practices, drainage system, etc.

Dealing with Stress in Disasters: Building Psychological Resilience

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Since the psychology of disasters was introduced in 1948, many have struggled with the concept of disasters and mental health. The last 30 years have seen a major shift of perspective from the treatment of "mental illness" to "mental health care." This has meant that mental health care providers have moved closer to the community in there interventions and have, thereby, become psychosocial in their approach, using community resources and personnel. People all over the world know the destruction produced by weather, the devastation of geological disaster, the havoc of industrial and transportation accidents. Many know, as well, the misery of terrorism, chronic political violence, and war. The physical effects of a disaster are usually obvious but the emotional effects are direct responses to the trauma of disaster. In every disaster, we focus on the intensity and magnitude of the disaster and without fail the medical assistance for the victim but, we generally forget the psychological phase of the victim. The psychological effects of any disaster may well prove to be more devastating than the physical effects, with survivors experiencing grief, guilt and fear. Empirical evidences suggest that, Disasters and emergencies are emotionally charged events that occur with little, if any, warning. They can involve severe, life threatening situations; cause widespread disruptions that deny shelter, food, water, and medical care to vast segments of the population; and interfere with communication and transportation. Affected residents often experience confusion, fear, hopelessness, sleeplessness, anxiety, grief, shock, guilt, and shame. Form this is can be very clear that the Psychological impact of the disaster will be immense for many survivors. It has to be strongly believed that that intervention of psychologist and mental health professional are very necessary before and after a traumatic event or a disaster .Emergency Management Australia (EMA) (Buckle, Marsh & Smale, 2001) suggest the magnitude and duration of any psychological effects experienced during and post of disaster should be prepared for by identifying potential disasters, examining their potential impact, and by identifying vulnerability and potential level of resilience among people and communities. "Resilience and vulnerability assessment is a necessary component of effective emergency management planning. This paper is an attempt to highlight the role of psychological resilience in coping with disaster by supporting the need of the study by analysing relevant case studies both from Indian as well as from other countries. The author would also like to discuss the relevant Emergency Response Plans exclusively dealing with Psychological first aid and resiliency.

Key words
Psychological Resilience, mental health care, psychosocial support

Real Time Seismic Analysis using G-Programming

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Vibration measurement is an important factor in predictive maintenance. Peizo actuated beam are used for this purpose. A flexible aluminum beam is considered in this paper. Piezo electric sensors are bonded to the surface of the beam. The bonded patches on the surface of the beam act as sensor which is connected to a DAQ board. The need of data acquisition is to measure physical phenomenon such as voltage, current, temperature etc... Computer based data acquisition utilizes a combination of application software, modular hardware, and a PC to take measurements. Data acquisition systems integrate signals, actuators, sensors, signal conditioning, data acquisition devices, and application software. Data Acquisition is the technique of acquiring signals from real-world, digitize the signals and analyze, presenting and saving the data. Bluetooth is a wireless protocol for exchanging data over short range of distances (using short-wavelength in the ISM band from 2400–2480 MHz radio transmissions) from fixed and portable devices, creating PANs with high security. Created in 1994 by telecom vendor Ericsson, it was replaced as a wireless alternative to RS-232 wired data cables. It can connect many devices and overcame the problem of synchronization. It is a packet-based protocol with a server-client structure. One server can communicate up to 7 clients in a piconet; all devices share the Server's clock. Packet sharing is based on the basic clock, defined by the server, which ticks to about 312.5 μs intervals. Two clock ticks constitute a slot of 625 μs; two slots constitute a slot pair of 250μs. LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a system based platform and development environment for a visual programming language from Instruments. The graphical language is named "G". It was originally released for the Apple Macintosh in 1986; LabVIEW is commonly used for instrument control, data acquisition and industrial automation on a variety of platforms including Microsoft Windows, various versions of UNIX, Linux, and Mac OS X. In this work we proposed the concept of introducing piezo sensor for the analysis of seismic measurement. Principle of piezoelectric materials has been utilized here i.e. Piezoelectric materials deform when a voltage is applied to them and inversely will produce a voltage when they are deformed. For this reason,

they can be used as both sensors and actuators. Here, Lab VIEW 2013 version, NI-DAQ, NI ELVIS (Educational Laboratory Virtual Instrumentation Suite) and Bluetooth device connected with PC has been utilized for acquiring and indicating vibration. The developed design is expected to be used universally for the measurement of seismic waves and also for measuring micro vibrations in machineries.

Disaster Management Education in India: Issues and Challenges

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India is one of the most disaster prone countries in the world. Over 55% of its land area is vulnerable to earthquakes. 70% of the land under cultivation is prone to draught, 12% to floods and 8% to cyclones. A huge amount is spent by our government as well as aid agencies in relief and rehabilitation measures every year. It has now become increasingly evident that an investment in disaster preparedness can save thousands of lives, vital economic assets, livelihoods and reduce the cost of overall relief assistance. Further, disaster mitigation is a step forward in attempting to conserve development gains before a disaster strikes. As we all know that Prevention is better than cure, the strategies of the agencies involved in disaster management activities should be to prevent the damages caused by disasters. Prevention starts with information. As schools are the best venue for sowing collective values, school students and teachers can serve as vehicles for building a culture of prevention. Students are an integral part of community, and have an important role to play in being prepared. Hence it is imperative that they should be prepared adequately to prevent, face and respond to disasters. History has shown that where communities have been prepared to face disasters, lesser lives have been lost, less significant damage to the environment has occurred, and property has been better conserved. According to the latest government survey there are 1,124,033 schools in India in which about one-third of the population study. With nearly 85% of the land area prone to disaster it is high time the 34% of the country's future generation has been prepared to combat future disasters. This number will be much higher if institutions of higher education, distance education etc. too is included in this population. Educational Institutions can contribute towards the generation of knowledge in the area of disasters, develop expertise in specific types of disaster and impart training in different fields. This paper attempts to provide a description of present status of disaster management education in India along with various issues and challenges. This paper focuses on the fact that though some of vital steps taken by Indian government are proving a lot helpful in disaster preparedness; there are still miles to go. Overall, it will highlight the importance of disaster management education in India and will focus on how disaster management education could help in disaster mitigation and could save a number of lives along with assets.

Key words
Disaster management, preparedness, mitigation, education, schools

The need for engendering institutionalities in post disaster reconstruction to address longterm vulnerabilities of women: A case study of Gujarat Earthquake 2001

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Gender issues need not necessarily be manifestations of disaster related crisis situation, but are inherent and intrinsic factors of the society, operational and visible in daily life. Disasters do not represent a clean slate. The process of recovery may either restore old patterns or institute new ones in its course of happening. Usually the emphasis of the concept of recovery is on the process and not on the end product. Incorporation of sensitivity of the gender aspect in the recovery process is important, primarily, because it affects the delegation of roles and responsibilities and in defining the access to resources and control over them. It is observed that in many emergencies and disasters women outnumber men in helping and arranging in the post disaster phases, yet in the proper official documentation, their work is often almost entirely neglected and women are mostly portrayed narrowly as mere victims and helpless. These gaps in turn reinforce the existing socially and economically imbalanced relationships and tend to increase the dependency ratio, which is further exacerbated by the intensification of women's responsibilities and duties post disaster. The effects of disaster, institutional

as well as individual differ for men and women. While providing just the minimum standards of relief and response the even the NDMA Act, 2005 does not clearly take into consideration the differential vulnerability of women and its manifestations in policy institutional mechanisms and the disadvantages that they are made a subject of, resulting from such internalized patriarchal processes and systems. Case studies from various disasters in India ranging from the Indian Ocean Tsunami, Latur earthquake, Orissa super cyclone and the Gujarat earthquake etc. reveal that in situations where women were actually not given better opportunities for participation and decision making in the rehabilitation processes, their interests seem to be marginalized and sidelined in the constitution of policies for aid delivery, no matter how much they claim to be pertaining to the needs of the specific groups. Women issues are also often neglected in few of the best practices which are encompassed to be a part of the 'Build Back Better' approach. Post disaster issues for women includes almost all aspects including high physical and livelihood insecurity, ignored compensation of items and tools required most by women, provisions of proper childcare facilities and call for formation of better collective actions for demanding or presenting their views. The most severe gaps in the women's access to aid and compensation are due to the 'head of the household' procedures of governance. The paper argues that it is during such institutional procedures that inclusion of a gender based perspective could provide for radical solutions as women's viewpoints, strategies and coping capacities could bring about far reaching positives and provide recovery that is sustainable and inclusive of voices that affect the masses. This paper argues that exclusion of women's specific needs from post-disaster reconstruction or development pushes them into long term disadvantages by reinstating their existing vulnerabilities and creating new ones, which are irreparable. The study tries to analyze the challenges and barriers faced by women in public and private sphere in accessing the few recovery initiatives taken for them by the government. This exploratory research tends to use qualitative methodology for analyzing data. The primary data collection was in Kutch district and the scheme chosen as case study is the "Widow Pension Scheme for Social Rehabilitation" by the Directorate of Social Defence. The secondary data includes the government documents (obtained through RTIs) and other academic works on Gujarat Earthquake apart from the literature review.

Natural Disaster Management: Application of Information and Communication Technology (ICT) in Earth Sciences

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Integrating Information and Communication Technology (ICT) with learning of natural processes is crucial in this knowledge era. Today, ICT are quite present in everyday's life. Considering this ICT has a great role to study the processes of natural disasters more effectively, making it accessible and affordable to all, using the latest technology available. An attempt is made is this study to assess the importance of ICT in natural disaster management. The e-Education policy was introduced into education with the intention of transforming information into education through knowledge. The policy places an obligation on natural disaster management techniques to include ICT to deliver on expectations of proper preparedness and mitigation. This study asserts the notion that for policy to be implemented, both the planners and responders should be instrumental partners in the formulation of policy. Experts from Earth Sciences should be encouraged to form ICT communities to support their teaching practice and foster policy implementation. This new resource may be used in order to improve public understanding of Earth Sciences processes and natural disasters. Taking this into account, a new multimedia document has to be developed which will be available both on-line and off-line (CD-ROM support). It is intended for those remote communities who are vulnerable to natural disasters. Its main aim is the presentation of educational materials that may contribute to enhance the teaching/learning of geological processes and the public awareness of the natural disasters of our country. Demonstration of earth-related Processes and their interactions with our lives is one of the main aims to be achieved using ICT which will create interest and render education among larger communities. Need of knowledge-development about earth's natural processes is essential for mitigation and judicial management of natural disasters by reducing the vulnerability using application of ICT in Earth Sciences. Instrumental use of web-portal of relevant government departments and identification of region-wise specific ICT thrust-area(s) both in terms of e-content and media depending upon the vulnerability to specific natural disaster(s) and the socio-economic condition of the region concerned are crucial for proper utility of ICT in natural disaster management.

Keywords
ICT, Earth Sciences, web-portal, knowledge development, natural processes, disaster management.

A public health situation manifesting into a socio-economic disaster in the land of 'Lahe Lahe': A case study of Arsenic contamination in Assam

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The concept of sustainable development (Brundtland, 1987) came into being because of the various environmental, social and economic challenges manifesting in contemporary life. Many of these challenges were consequences of historical decisions which were not necessarily considered to have an adverse impact on the society at that moment in time. The current problem of Arsenic in Indian states can be traced to the foreign aid which in the 1980s played a major role in mitigating the problem of malnutrition and hygiene related issues; the problem manifesting in another form, a decade later thereby completing a vicious cycle. Arsenic has been discovered in the Ganga basin on a fairly large scale. But the presence of arsenic in groundwater is a fairly new phenomenon in the Brahmaputra Valley. Besides seeping into the food chain and affecting livestock, groundwater arsenic contamination creates widespread social and economic problems for its victims and their families in Assam. The paper attempts to capture the understanding of the communities in the blocks affected by Arsenicosis, a disease caused due to the prolonged consumption of Arsenic laced water. It also tries to record the perceptions of how people survive and cope with the socioeconomic consequences of the disease. The paper tries to capture the Five capitals of Sustainable development in the context of the communities namely natural, human, social, manufactured and financial with a sixth cultural added to the mix. This paper employed mainly participatory rapid appraisal (PRA) techniques to interpret people's understandings about the toxic impact of groundwater arsenic poisoning on their social lives. Arsenic-affected patients in Central Assam were asked to determine their 'own priorities' in measuring arsenic toxicity on their social activities and to explore their perceptions about their own survival strategies. The results revealed severe negative social impacts and a sharp difference of perceptions and priorities about arsenic and social issues between Arsenicosis patients and unaffected people. The case study revealed a differential impact of Arsenicosis on men and women within the affected communities. The study also revealed a huge differential know how of the mitigation methods employed by the government among the people. With the idea of a sustainable development wherein a balance needs to be achieved between environmental, social and economic activities the paper tries to analyze the prevailing public health situation through the Sustainability framework of vulnerability in order to succinctly capture the facets of exposure, sensitivity and resilience.

Key words
Arsenic contamination, Sustainable development, mitigation methods, Five capitals of Sustainable development, Participatory rapid appraisal, Sustainability framework, vulnerability, exposure, sensitivity, resilience

How to Sustain Agricultural Production in Drought

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Disasters are the events of environmental extremes which are inevitable entities of this living world. The impact and frequency of the disasters is augmenting. During last decade, there has been greater focus on the interface between environment, livelihoods and disasters with environment and Disaster Risk Reduction for agriculture especially. Because Indian agriculture is a field which is fully depends on rainfall, temperature fluctuation, climate and other natural factors. The irrigation water is limiting factor of agriculture production. In natural disaster Drought is most serious disaster. 43% of total area and 60% of Agricultural area are under Drought forever. 27% of total population of Gujarat state facing Drought Problems permanently. During the 1960 to 1990 (30 yrs) were 18 droughts in Gujarat. This ignored aspect need scientific study. With the help of various references this study was carried out with objectives to know proportion of farmers who adopts High Tech Agriculture systems like Micro Irrigation, Green / Glass Houses, Mulching etc in five Talukas of Junagadh District of Gujarat State. The short questioner giving farmers and data collected was analyzed by simple percentage/ proportion method.
The results are: 1. 70 to 80 percent farmers are adopting Drip Irrigation systems and 25 to 40 percent farmers adopting sprinkle irrigation which saves 35 to 70 percent and 25 to 35 percent of water respectively. 2. 50 to 60 percent farmers are adopting mulching to maintain soil temperature and soil moisture in horticultural crops. It reduces 25 to 35 percent water requirement of crops during drought condition. 3. 30 to 35 percent farmers are adopting low cost Greenhouses which reduce 20% of water requirement in controlled condition and increase 18 - 24 % agricultural production. So the suggestions are: 1. Every farmer of arid region should adopt any Micro irrigation system to minimize water requirement of crops during drought condition. 2. Every farmer should adopt mulching practices to maintain soil moisture and soil temperature in water deficiency. 3. Green House may be used as and when require to create controlled atmospheric condition to sustain crop yield in any disaster. 4. This way with the help of various Advanced Agricultural systems, we can reduce effects of any drought on agricultural productivity.

Coastal Cliffs and Their Stability of South West Coast of India

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In earth system science, a cliff is a significant vertical, or near vertical, rock exposure. Cliffs are formed as erosion landforms due to the processes of erosion and weathering that produce them. Cliffs are common on coasts, in mountainous areas, escarpments along rivers and around closed water bodies. They are usually formed by rock that is resistant to erosion and weathering. Their steepness causes them to be so narrow in plan that they make up only a very small area compared with the areas of the plateaus, hills, or mountains that they separate from the ocean. Nevertheless, sea cliffs are ubiquitous, occurring along nearly 80% of the ocean coasts of the earth and at all latitudes. Rock formations of varying age, from Pre-Cambrian to Holocene, outcrop on the world's coastlines, but most cliffs have been shaped during Pleistocene and Holocene times, mainly the past 9,000 years, when the sea has stood at or close to its present level. Some cliffs have been produced by uplift of the land margin as the result of faulting; others follow fault lines, but are partly or wholly the outcome of differential erosion, where faulting has placed weak rock formations (ex: laterite) alongside resistant rocks. . A steep or cliff coast produced by faulting, where the seaward slope coincides with the plane of the fault, along which the land has been raised, is termed a fault coast: a tectonic feature known as a fault scarp. Some coasts were initiated as fault coasts, but have been cut back by marine erosion and now stand landward of the fault. Now these cliff under goes erosion, slumping and sliding; and are common phenomenon seen on permeable cliff shorelines of the world and Indian coasts of this are of no exception. These cliff shorelines and their adjoining beaches are one such area, which needs attention. However, very little studies are available on the proper documentation of these permeable cliffs and their vulnerability for appropriately utilizing them for coastal protection and developmental activities. The present study documents the cliff shorelines and their vulnerability between Kanniyakumari and Mangalore in the south west coast of India with the effective utilization of Remote Sensing Data in conjunction with GPS and GIS. The geomorphological mapping revealed that 82.25 km cliff shoreline is available between Kanniyakumari and Mangalore. These cliffs has been further classified into very stable, moderately stable, stable, unstable & very unstable depending on their vulnerability (tectonic activities, geotechnical properties, weathering processes, climatic factors and human interference). "Cliff Shoreline Map" for the Vettur – Varkala – Edava region has been prepared in detail for its effective use in the Geological Park which is being envisaged at Varkala. The results derived for the entire 700 km coastline from this study may be of help for CZMA, SDMA as well as other agencies, both Governmental and Non-Governmental, interested in the coastal protection and other different developmental activities in the coastal zone of Kannyakumari-Mangalore sector in the south-west coast of India.

River Bank Erosion and Floods: Implication on the Psychosocial Well-Being of the Misings of Majuli

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It is not an unknown fact that India's North-eastern region is one of the most disaster-prone areas of the country. One of the main causes of impoverishment of the rural areas of Assam has been the recurrent floods and riverbank erosion. Beyond the more obvious and immediate outcomes of loss of life, property and infrastructure, any natural or human-induced disaster has more long-term and difficult outcomes of vulnerability to various elements: increased poverty, lifelong psycho-social effects, malnutrition, leading to out-migration from villages, enhanced social disparities and strife (Niazi, 2009). Disasters, and more so, natural disasters like floods and bank erosion have prolonged effects on the lives of the survivors; of varied dimensions like emotional, psychological, social, economical and political as well. Assam's Majuli is a place recurrently hit by floods and erosions, the worst affected-being the Mising Community. Getting displaced results in change of roles and hence, in family dynamics as well. Striking amounts of the population go through nervousness and tension at all times. Two of the most distressing factors are the loss of agricultural land and the lack of quality education to their children. The element of surprise being floods is still perceived as "natural phenomenon" by such communities; bank erosion being the primary issue of concern. However, due to the consequential displacement due to these disasters, not only families but also communities at large are being displaced. This compels them to find an alternative, temporary shelter to begin life from scratch. The response of the government is nothing beyond petty assurances. The brighter side

here being the invincible spirit demonstrated by this community to survive these human-induced natural disasters till date through strong support-system, optimistic nature, living in stilted houses called chang-ghar etc. Yet it is essential to understand that psychosocial well-being of an individual is not only been affected by disasters in isolation; subjective world experiences such as events within the family, one's personal life, structural response to the floods are few of the crucial aspects too.

Key Words
Psycho-social well-being, Natural disasters, Mising community, Displacement, Structural Response

Making a Case for Private Oil Spill Response Organisations

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For decades, policy planners, regulators and disaster contingency planners in India have engaged with the industry stakeholders to arrive at an equitable model for establishment of a national stockpile of oil spill response resources. The need is exacerbated by burgeoning crude oil import at several ports, rapidly increasing offshore oil production, passing tanker traffic, et al and the corresponding increase in risk of oil spills. Major oil spills such as from the *Deep Water Horizon* in the Gulf of Mexico, United States and *m.v. MSC Chitra* in Mumbai port served to rekindle the focus of the media, civil society, and the Government of India on the maintenance of adequate preparedness for oil spills. Establishing inventories is a very expensive proposition and, therefore, complex governance issue. In a tiered approach, as envisaged by the International Maritime Organisation, first response capability is expected to be maintained by the facility operator, on premises, and pooling of local, regional, and national resources provides for scaling-up operations. The local, regional and national inventories could be either established by private parties, typically by the oil majors or OSRO, or the State, or both. India's national plan adopts the three tier concept, with tier-1 inventory for 700 ton spill expected to be maintained by the individual facility and the Coast Guard, tier-2 inventory to handle a spill of up to 10,000 tonnes. While on the one hand, responsibility for clean-up vests with the polluter and expending taxpayers' money for establishing inventories could lead to un-internalized externalities, on the other hand, even the tier-1 stipulation in the national plan has perpetually been contested by the industry, possibly guided by a view that oil spill response inventories are public goods. This paper examines the State vis-à-vis stakeholder debate for establishing inventories of response equipment, reviews policy elements and facilitating provisions under national law fostering private oil spill response organisations (OSRO) in select countries, and argues on the unsuitability of direct response action by government agencies such as Coast Guards. In thus making a case for private OSRO, the paper attempts to fill a significant gap in addressing externalities that arise out of the maritime transportation, and offshore exploration and production of crude oil.

Key words
Disaster preparedness, environmental governance, externalities, tiered approach, OSRO

Emergency Response Planning & Mitigation Strategies for Terrorism Events Involving Radioactive Sources

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The radioactive isotopes play a key role in the public domain including medical and health care sectors, research and academic application and industrial sources. Though these sources are regulated; chances of the use of such sources as a terrorism vector will cause unprecedented consequences in public domain. The abandoned sources and waste generated by virtue of radioactive applications can be used for widespread contamination. The terrorism events involving Radiation Sources are based on the concept of 'Collective Dose', i.e. Exposing a large number of people to low levels of radiation leading to stochastic effects and widespread panic. The severity of the attack is based on the radioactive material used and the dispersion method followed. The objective of this study is to develop an early warning system (EWS) and evolve a response procedure to protect the Counter-value targets from the detrimental effects of terrorist events involving

radioactive materials. The environmental radiological survey has been conducted to develop a database of background radiation levels of a metro city. This database forms the basis of the EWS for the identification of such events. The emergency response procedures are developed through a case study conducted for particular accident reported at Mayapuri scrap market, New Delhi in April 2010, where a radioactive source from academic institution triggered contamination in public domain. Handling of such events has been analyzed by assessing threat perception, simulating radiological event and consequence modeling (PM models). The contamination of radio-nuclides, even in minute scale in an open environment can cause serious impact on human health. Study result demonstrates a Consolidated Emergency Management plan for terrorism events involving radiological sources. A graded method is evolved in accordance with national and international protocols on radiological protection and emergency management, viz., Threat perception, Monitoring and reporting network, Response Measures, Capacity Building measures. This study concludes with the recommendation for developing a national level Mobile/Standalone Environmental Radiation Monitoring Network at Metro Cities, and to implement the emergency response plan on public domain.

Disaster Risk Reduction and Climate Change Adaptation

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Natural hazards and climate change present considerable challenges for poverty reduction and sustainable development because they affect a wide range of social and ecological systems. In many of the world's developing and least developed countries extreme events occur so frequently that they tend to overwhelm their coping capacity and hamper long-term progress because attention and resources desperately needed for poverty reduction and economic development are diverted to disaster relief and reconstruction. Many societies today are still ill-prepared to cope with extreme events and climate change threatens to undermine many decades of effort in the spheres of development assistance, poverty reduction and disaster risk management. However, disaster risk can be significantly reduced through strategies that seek to decrease vulnerability and exposure to hazards within wider efforts to address poverty and inequality. Humanitarian responses to disasters and other crises can be designed and implemented in ways that protect the affected people's right to life and other basic rights in the short and longer term. The purpose of this review paper is to highlight the benefits of a more integrated approach to these issues, and, ultimately, to increase the level of strategic co-ordination between the climate change and disaster risk reduction. Current global climate change is understood to be the result of human activities since the Industrial Revolution, such as the burning of fossil fuels and land-use change (for example, deforestation), resulting in a significant increase in greenhouse gases such as carbon dioxide. Projected changes in the climate include temperature increases on land and at sea, sea-level rise, melting of glaciers and ice caps, and changing and irregular rainfall patterns. Climate change will result in increases in the frequency and intensity of extreme weather events. State's recognition of environment-disaster relations is manifested in their National Progress Reports on the implementation of the Hyogo Framework for Action: HFA Priority 4, core indicator 4.1 "Disaster Risk Reduction is an integral objective of environment related policies and plans, including for land use, natural resource management and adaptation to climate change." Climate change adaptation is a dynamic process and not an end state, given the uncertainty in climate change impacts and the need to support at-risk populations to: address current hazards, increased variability and emerging trends; manage risk and uncertainty; and build their capacity to adapt. The main driver of the increase in disaster risk is not any more the growing intensity and frequency of extreme events. Risk is increasing due to development processes that expose more people and assets to climate related hazards faster than countries are able to reduce their vulnerability and develop their resilience. Specific measures are being undertaken for mainstreaming DRR into flagship Central Sector and centrally sponsored schemes of GoI in Agriculture, Rural Development, Urban Development, Infrastructure, Power, Education, Environment, coal & Mines etc. This integration of DRR with Climate Change adaptation and mitigation strategy needs to be further emphasized.

Key words: Disaster Risk Reduction, Climate Change, Adaptation, Mainstreaming, Resilience

Storm Surge Simulations for the Tamil Nadu Coast Using Delft3d - A Open Source Numerical Model

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Cyclone induced storm surges have claimed an extraordinary high number of lives in the low lying areas bordering the Bay of Bengal. The Super cyclone which hit the coast of West Bengal on October, 1737 caused a storm surge of 12m and killed over 300,000 people. Orissa witnessed a 7m storm surge during the 1885 and 1999 super cyclones that killed over 5000 and 10,000 people respectively. The severe cyclones of 1864 and 1996 that hit the Andhra Pradesh coast generated a surge of 4m and killed over 35,000 people. The Rameswaram cyclone ruined the Dhanuskodi Town with a storm surge of 5m in 1964. The loss of life could be reduced; if these storm surges could be forecasted well in advance, effective preparedness and evacuation procedures can be done. Much effort has been put in the development of tools and methodologies to model storm surges generated by cyclonic storms in the Bay of Bengal. Several research and new methodologies were attempted to forecast storm surges. Keeping this in view, DELFT3D, an open source high resolution numerical model is used for the prediction of storm surges for the Tamil Nadu coast with a grid resolution of 900m. Using the model, numerical experiments are performed to simulate the storm surge associated with, the 1992 Tuticorin cyclone, the 1993 Karaikal cyclone, 1994 Madras cyclone and the 2011 Thane cyclone. It is found that the computed storm surge elevations are in close agreement with the available observations/estimates.

Keywords: Storm surge DELFT3D, open source, numerical model, tropical cyclone, Tamil Nadu coast

Climate Change Vulnerability and Agrarian Communities: Insights from the Composite Vulnerability Index of Andhra Pradesh and Karnataka

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Climate change is a main challenge for agriculture, food security and rural livelihoods for billions of people in India. Agriculture is the sector most vulnerable to climate change due to its high dependence on climate and weather conditions. Among India's population of more than one billion people, about 68% are directly or indirectly involved in the agricultural sector. This sector is particularly vulnerable to present-day climate variability. In this contest this paper examines the Socio-economic and climate analytical study of the vulnerability index in Andhra Pradesh and Karnataka states using secondary data; it examines the vulnerability through five different Sub-indicator of socio-demographic, agriculture, occupational, CPR, and climate in respective states among different districts. Data was used in this paper has taken from different sources, like census in India 2011, Directorate of Economics and Statistics of respective states governments. Rainfall data was collected from the India Meteorological Department (IMD). In order to capture the vulnerability from two different states the composite vulnerability index (CVI) was developed and used. This indicates the vulnerability situation of different districts under two states. The study finds that Adilabed district in Andhra Pradesh and Chamarajanagar in Karnataka had highest level of vulnerability while Hyderabad and Bangalore in respective states have least level of vulnerability. Further, it also notices that the index was mapped using GIS maps and it has been observed that almost same districts from two states are found to be facing highest vulnerability.

SPOC: A Secure and Privacy-preserving Opportunistic Computing Framework for Mobile-Healthcare Emergency

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With the pervasiveness of smart phones and the advance of wireless body sensor networks (BSNs), mobile Healthcare (m-Healthcare), which extends the operation of Healthcare provider into a pervasive environment for better health monitoring, has attracted considerable interest recently. However, the flourish of m-Healthcare still faces many challenges including information security and privacy preservation. In this paper, we propose a secure and privacy-preserving opportunistic computing framework, called SPOC, for m-Healthcare emergency. With SPOC, smart phone resources including computing power and energy can be opportunistically gathered to process the computing intensive personal health information (PHI) during m-Healthcare emergency with minimal privacy disclosure. In specific, to leverage the PHI privacy disclosure and the high reliability of PHI process and transmission in m-Healthcare emergency, we introduce an

efficient user-centric privacy access control in SPOC framework, which is based on an attribute-based access control and a new privacy-preserving scalar product computation (PPSPC) technique, and allows a medical user to decide who can participate in the opportunistic computing to assist in processing his overwhelming PHI data. Detailed security analysis shows that the proposed SPOC framework can efficiently achieve user-centric privacy access control in m-Healthcare emergency. In addition, performance evaluations via extensive simulations demonstrate the SPOC's effectiveness in term of providing high reliable PHI process and transmission while minimizing the privacy disclosure during m-Healthcare emergency.

Natural Disasters and Uttarakhand: An overview

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Main Central Thrust (MCT), Main Boundary Thrust (MBT), Himalayan Fontal Thrust (HFT), Trans Himalayan Fault, pressure of Indo-Australian plate, Delhi-Haridwar ridge, huge ranges of river, glacier etc have been well recognized as the main characteristics that has made the Uttarakhand unstable, fragile and prone to different natural hazards and disasters. The paper attempts to present the extent and nature of different forms of disasters which occurred in the region in the past. In addition, the focus of the present paper is to critically present the concept of Community Based Disaster Management Planning and to highlight the extent of community participation echelon in natural disasters of Uttarakhand. To examine these issues the authors in this paper uses primary data with the help of PRA (Participatory Rural Appraisal) tools and secondary information from various past studies, articles, material available in web sites of different institutes & organizations, also uses GPS for geo reference and GIS (Geographic Information System) technique.

Keywords
Natural disasters, community participation, GPS, GIS, PRA tools, CBDMP, Uttarakhand

Safety practices in educational Institutions in India: Policy, Practice and Need

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In 2006-2007 World Disaster Reduction Campaign was devoted to the theme "Disaster Reduction Begins at School". This theme was chosen by UN/ISDR because (a) it is in line with the Priority 3 of the Hyogo Framework for Action 2005-2015: "Use knowledge, innovation and education to build a culture of safety and resilience at all levels, and (b) schools are the best venues for forging durable collective values; and therefore suitable for building a culture of prevention and disaster resilience. UNESCO and UNEP (2004) emphasize on the importance of school safety by stating that, "the upgrading and construction of schools that will be relatively safe during the occurrence of disasters should be part of a nation's long-term planning." It even went beyond to identify the specific reasons for which a school should be made safe; for safety as school buildings can save lives, for shelter as schools be utilized as shelters in emergency period, for continuation of education as education is disrupted in times of emergencies and finally for resource preservation as schools are valuable local investment of a nation. For India in the National Building Code the educational buildings and hospitals are considered as a national life line buildings. It means at the time of emergency these buildings will serve the purpose of shelter and treatment. As per the national policy on disaster management national life line buildings must be built with all the safety measures. In India we come across many reports regarding accidents of school children. Like collapse of building or its part, accidents in play ground, fire in schools, school bus accidents of the vehicle carrying school children etc. Schools also face difficulties in saving the lives of their children in disaster situation like flood, earthquake, tsunami or cyclone etc. Thousands of our children died in these disasters and accidents could be easily saved, if we could have been paid attention towards preparedness. Growing figures of avoidable deaths indicate our negligence and failure in inculcating the culture of prevention. Inculcating the culture of prevention was one of the agenda mention in the policy document of our country. It is now high time to pay attention towards building a resilience community which can cope with the disasters by their own. One of the Teacher who was teaching disaster management in the school shared her experience of being non reactive to the alarm which was given by the hotel in Bangkok, in the next morning they could realize the fact that it was a fire alarm and they just ignored it, because of not having practice to respond to the situation and just familiar with

the theory. It indicates the importance of mock drills is very high. In this paper author wish to discuss the need and priority areas for improving the Policy on Disaster Management on the basis of her research experience in the CBSE schools.

Land resources disaster management - Rwanda experience

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According to the Rwanda Ministry for Disaster Management and Refugee Affairs 2014 report, Rwanda spends about Rwf 1billion in meeting the cost of natural disasters annually and disasters claim at least 100 people, 200 get handicapped, 3,000 houses are destroyed, while 3000 hectares of crops are damaged annually. Infrastructure like roads, schools, electricity is damaged, costing Rwanda about Rwf1 billion on reconstructions annually (Ntigurirwa, 2014). According to UNEP, climate change projections in Rwanda indicate that most parts of the country will experience increased but irregular rainfall, raising the risk of flooding events. Flooding and landslides pose a major disaster risk in the northern and western regions of Rwanda. Flash floods trigger landslides which damage land resources. Torrential rains in 2007 caused extensive flooding, destroying crops in Gishwati. The frequency of flash floods often accompanied by landslides has significantly increased in the ten years since 1998. Hence a need for optimum land policy arises (UNEP, 2011). Persistent deforestation, landslides and flooding in all the provinces of Rwanda need urgent attention and a clear optimal land utilisation orientation. For instance by July 2013, Ministry of Local Government in Rwanda reports that out of 47680 of households settled in high risk zones, 30,822 households (35%) are still in high risk zone and need to be relocated. Developing special rehabilitation plans for the poulation in the high risk zones are an urgent priority (Minaloc, 2013). Rwanda being located geologically in a rift valley is prone to disasters due to the area being inherently endowed with uneven altitude characterised by steep slopes prone to landsliding and other natural and man-made disasters. Optimum land utilisation policy is needed to design strategies to protect citizens against the risks and identification and mapping of the high-risk zones have to be done urgently. These strategies may include awareness creation, collective participation and effort to facilitate the process of disaster management by all institutions, all citizens and all the countries in the region by establishing a comprehensive early warning system to try to minimise the damages. Incorporating disaster management studies in the school curricula can widen awareness and focus can be placed on preventive and preparedness strategies and methods because disaster management is a crosscutting issue. For example, in 2013, 43,000 households were identified as living in risky zones. Another area of concern is the Nyabarongo River in Nyarugenge district of Kigali City, which has previously caused loss of life due to flooding. Rwanda also needs to step up the ban on artisanal mining activities to prevent people dying in mining caves (Ntigurirwa, 2014).

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Recent landslide incidences and its implications in Idukki district, Kerala

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Landslides are very frequent in Kerala, the third densely populated state of India. Out of the 14 districts of Kerala, 13 are prone to landslides. Among them, Idukki is the worst affected district wherein very recently in 2013 about 15 human lives were lost due to landslides. Idukki lies mostly in the highland area and is covered with dense forest, steep hills and deep valleys. In fact, the landslide inventory data reveals that more than 80% of landslides are cut slope failures confined along road corridors. In 2013, an incessant rainfall measuring 220 mm on 5th August 2013 triggered more than 100 landslides in the district. The landslides along the National and State Highways resulted in the blockage of the roads thereby resulting in great hardship to the local population and tourists. An inventory of 129 landslides generated during the last year reveals that 99% of the landslide incidences in the district falls under three landslide types and are earth slide (61%), debris slide (23%) and debris flow (15%). The debris/earth slides are usually observed on cut slopes whereas debris flows along the courses of 1st and 2nd order streams. Rock slide and rock fall are rarely observed. The main causative factors observed are the following:

1. Steep cutting made for road/building construction resulting in day lighting of rock/overburden interface. The unsupported cut slope resulted in debris/earth slide due to increase in pore water pressure during very heavy rainfall.
2. Presence of dense tress along the edge or crown of the cut slopes resulted in increase of load at the marginally stable cut faces. The roots penetrating through the loose and exposed overburden shattered the soil mass; thus facilitating the faster ingress of rain water. The process in turn resulted in loosening of the overburden, which failed at many locations during rains. This is evident from the presence of trees in the debris.
3. Unscientific land use practices such as terracing and contour bunding on steep hill slope for plantation activity have altered the micro drainage existed along the slope. This along with preparation of rain water pits and pits for rubber saplings has increased the storm water infiltration rate.
4. Blockage of natural drainage courses for the purpose of settlements. This has led to damages due to bank failures during torrent stream conditions.
5. Absence/ insufficient number of surface water drainage lines to drain out the storm water as many first order streams were obliterated for plantation and human settlement.
6. Unscientifically constructed culverts for excess storm water discharge. Water diverted through these culverts erodes away the loose material on the hill slope resulting in filled slope failure.

From field observations, certain locations have been identified as "highly vulnerable" for landslides. Among them the most important are Kallarkutty, Cheruthoni and Erachilpara. At Kallarkutty town, a large ground crack has been formed at the crown of the earth slide triggered in August 2013. The crack has dimension of 50m (length) x 0.3 m (width). The uphill slope of Kallarkutty town is highly vulnerable to failure. The exposed cut slope initially resulted in small landslides (cut slope failures), but with passage of time these landslides have retrograded and attained large dimension. The overburden consisting of loose earth material (mainly sandy soil) gets easily detached during rainfall as the pore water pressure in the overburden material can quickly exceed the shear strength of the material. The presence of distressed zone (ground cracks) indicates the retrogression limit of the probable mass movement. However, further retrogression and formation of new cracks upslope cannot be ruled out. If a landslide of considerable magnitude takes place in this area, it can devastate Kallarkutty town and it may also have a bearing on the safety of the Kallarkutty dam. Cheruthoni Town area has witnessed two major earth slides affecting Cheruthoni bus stand and part of the SH-33 during the first week of August 2013. The landslides are basically failure of the cut slopes made for road and shops for the bus stand. The slopes, overlain by thick overburden mass, were steeply cut and left unattended and exposed. During high rainfall in August 2013, two major failures were initiated from the cut face. The 10-15m thick overburden over the weathered bedrock is prone to further failure if immediate remedial measures are not undertaken. Erachilpara Colony, located near Devikulam witnessed two earth slides during the early hours of 5th of August 2013. The first slide scar has an average dimension of 12m (L) ×18m (W) ×1.5m (T). The second scar has an average dimension of 13m (L) ×10m (W) ×2m (T). Parts of two houses were damaged due to the slide. The toe of the hillock located towards the northeast of the Erachilpara colony is unscientifically modified for human settlement and this appears to be the causative factor for the above-mentioned slope failures. Around 30 houses of Erachilpara colony, located in the vicinity of this unscientifically modified hillock is at risk if a major slope failure takes place in the area.

From the study, it can be concluded that the majority of the slope failures in Idukki district are the result of unscientific human interferences leading to modification of slopes from stable to unstable condition.

Important remedial measures suggested to avoid the slope failures are listed below:

1. Landslide susceptibility study along the major road corridors of Idukki district is being carried out to identify the vulnerable zones.
2. Future hill slope modifications must be carried out scientifically after considering the slope stability and engineering aspects.
3. Vulnerability of the cut slopes can be reduced by using appropriate mitigation options, such as reinforcement of the cut slope with properly engineered retaining structures.
4. Proper land use practice must be followed especially along the vulnerable slopes. Terracing and contour bunding should be avoided along the steep slopes. People living in highland areas must be educated about the importance of proper land use practices to minimise the risks.
5. All the natural drainage channels must be meticulously preserved and during peak monsoon season more drainage channels may be developed especially along the terraced slope to drain out the storm water.
6. Benching of crown slope can be done in some of the areas to reduce the risk.

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Kerala State Council for Science, Technology and Environment (KSCSTE) is an organization committed towards the promotion of Science, Education, Research and Scientific temper.

Sharing Kerala's constant endeavourers in supporting developmental Schemes the Science & Technology Programme of KSCSTE is in the process of various creative Schemes in the Science sector. KSCSTE is now looking at the future by providing world class research and implementing globally accepted quality parameters pertaining to the State's overall development.

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