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Using Topography Position Index for Landform classification in Zagros Mountain (case study: Shahoo Mountain)

M. Mokarram, and A. Seif

Abstract—Landform elements include land such as hills, mountains, plateaus, canyons, valleys, seascape and oceanic water body interface features such as bays, peninsulas, seas and so forth, including sub-aqueous terrain features such as mid-ocean ridges, volcanoes, and the great ocean basins. The main objective of this study is to landform classification in Shahoo Mountain where located in Zagros mountain, Iran. In order to landform classification used Digital Elevation Models (DEMs) with 30 m resolution. In this study used Topography Position Index (TPI) classes for landform classification for the case study. TPI values are between – 320 to 363. The result show that there are ten landform that consist of consist of canyons/deeply incised streams, midslope drainages/shallow valleys, upland drainages/headwaters, u-shaped valleys, plains small, open slopes, upper slopes/mesas, local ridges/hills in valleys, mid slope ridges/small hills in plains, mountain tops/high ridges. Low and high the areas are 1570.31, and 1.04 for canyons/deeply incised streams and plains small classes respectively.

Keywords—landform classification, topography position index, Shahoo Mountain.

I. Introduction

THE classification, like any other categorization attempt by human is intrinsic. It is more likely that we can understand what the categories of land reveal, than to perceiving and evaluating continuous representations. There is a long tradition of mapping, which can be attributed to the relative ease of representing discrete spatial units compared to understanding and evaluating continuous representations of surface (Strobl, 2007). “Landform classification is reducing terrain complexity into a limited number of easily discernible functional units (Burrough et al., 2000). Landform Landform classification emerged due to complexity of the earth surface which has necessitated seeking methods to quantify its form and subdivide it into more manageable components (Evans, 1990)” (Gerçek, 2010).

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Landform classification has been of great interest in earths ciences as it has a wide range of application domains, including mapping lithology (Kühni and Pfiffner, 2001) predicting soilproperties (Florinsky etal., 2002), vegetation mapping, precision agriculture (Verhagen etal.,1995). Landform classification indeed constitutes a central research topicin geomorphometry (Pike,2002; Rasemann et al., 2004). Geomorphometry is usually referred to asasub-discipline of geomorphology (Dehnetal., 2001; Bolongaro-Crevenna etal.,2005), as aninter disciplinary field from mathematics, and Earths ciences and computerscience (Pike etal.,2009).

The main objective of this study is to landform classification in Shahoo Mountain where located in Zagros mountain, Iran.

II. Material and Method

A. Topography Position Index (TPI)

Topographic Position Index (TPI) is an adaptation of this method which compares the elevation of each cell in a DEM to the mean elevation of a specified neighborhood around that cell. Local mean elevation is subtracted from the elevation value at centre of the local window. Algorithm is provided as an ESRI script by Jenness Enterprises (Jenness, 2006), and it has local window options of; rectangular, circular and annulus.

$$TPI_i = Z_0 - \frac{\sum_{1-n} Z_n}{n}$$

Where;

Z0 = elevation of the model point under evaluation

Zn = elevation of grid within the local window

n = the total number of surrounding points employed in the evaluation

Positive TPI values represent locations that are higher than the average of the local window e.g. ridges. Negative TPI values represent locations that are lower e.g. valleys. TPI values near zero are either flat areas (where the slope is near zero) or areas of constant slope (where the slope of the point is

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significantly greater than zero), high positive values relate to peaks and ridges.

B. Landform classification

TheTPI is the basis of the classification systemand is simply thedifference between a cell elevation valueand the average elevationof the neighborhoodaround that cell.Positive values mean the cell is higher than itssurroundings while negative values mean it is lower (Jenness 2006). Combining TPI at small and large scales allows a variety of nested landforms to be distinguished (Table 1).

Table 1: Landform classification based on TPI .
(Source: Weiss 2001)

Classes	Description
Canyons, deeply incised streams	Small Neighborhood: $z_o \leq$ -1 Large Neighborhood: $z_o \leq$ -1
Midslope drainages, shallow valleys	Small Neighborhood: $z_o \leq$ -1 Large Neighborhood: -1 <z_o< 1
upland drainages, headwaters	Small Neighborhood: $z_o \leq$ -1 Large Neighborhood: $z_o \geq$ 1
U-shaped valleys	Small Neighborhood: -1 <z_o< 1 Large Neighborhood: $z_o \leq$ -1
Plains small	Neighborhood: -1 <z_o< 1 Large Neighborhood: -1 <z_o< 1 Slope ≤ 5°
Open slopes	Small Neighborhood: -1 <z_o< 1 Large Neighborhood: -1 <z_o< 1 Slope > 5°
Upper slopes, mesas	Small Neighborhood: -1 <z_o< 1 Large Neighborhood: $z_o \geq$ 1
Local ridges/hills in valleys	Small Neighborhood: $z_o \geq$ 1 Large Neighborhood: $z_o \leq$ -1
Midslope ridges, small hills in plains	Small Neighborhood: $z_o \geq$ 1 Large Neighborhood: -1 <z_o< 1
Mountain tops, high ridges	Small Neighborhood: $z_o \geq$ 1 Large Neighborhood: $z_o \geq$ 1

TPI values can easily be classified into slopeposition classes based on how extreme they are and bythe slope at each point.TPIvalues abovea certain threshold might be classified as ridge tops or hilltops, while TPI values below a threshold might be classified as valley bottoms or depressions.TPI values near 0 could be classifiedas flat plains (if the slope is near 0) or asmid- slope areas(if the slope isabove a certain threshold).

C. Case study

The study area is Shahoo Mountains, Iran, which is located at 34° 32′ 59″ to 35° 23′ 07″ N and 46° 03′ 30″ to 46° 57′ 01″E, with area of 3,175.09 km^2 (Figure 1). The highest elevation in this area is 3345 m, which is located in the center of the basin, while the lowest elevation is 598 m, which is located in the north of basin. The dataset for the area originates from a DEM with resolution of 30 m (SRTM), which was downloaded from http://srtm.csi.cgiar.org.

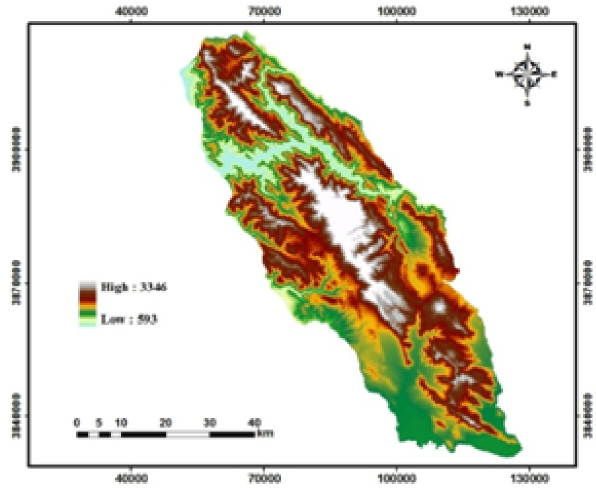

Fig. 1 Location of the study area

III. Result and Discussion

A. Topography Position Index (TPI)

TPI values are between – 320 to 363(Figure 2). TPI values near zero (close of -320) are either flat areas (where the slope is near zero) or areas of constant slope (where the slope of the point is significantly greater than zero), high positive (close of 363) values relate to peaks and ridges.

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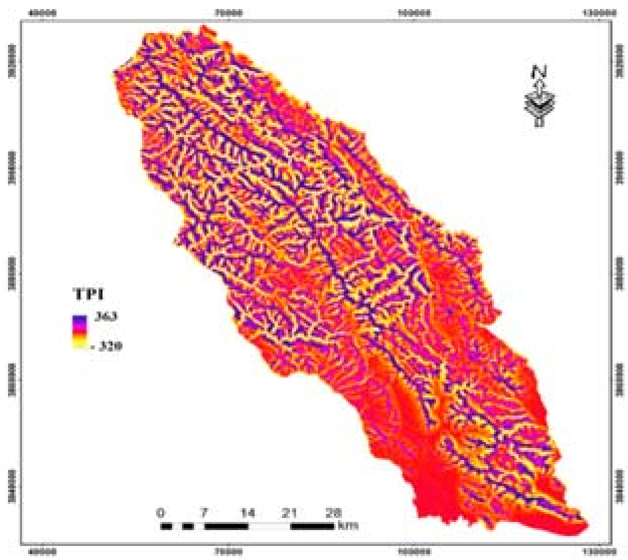

Fig. 2 Topography Position Index (TPI)

B. Landform classification

The result show that there are three landform that consist of canyons / deeply incised streams, open slopes, and mountain tops / high ridges and the areas are 1071.02, 293.92, and 1028.11 for each of the classes respectively (Figure 3 , Figure 4 and Table 1).

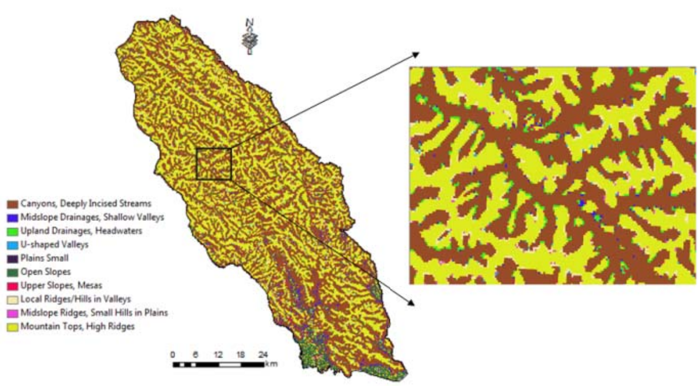

Fig. 3 Landform classification for the study area

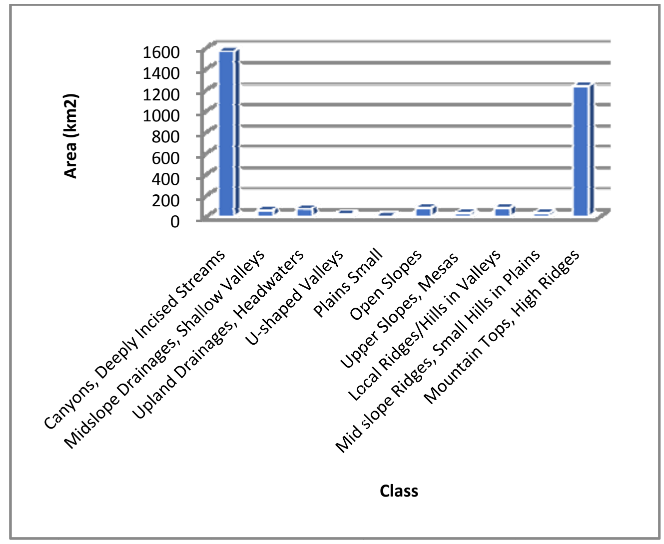

Fig. 4 Percentage of the each of landform classes in the case study

Table 1 Area of each of landform class in the study area

Landform classification	Area (%)	Area (km^2)
Canyons, Deeply Incised Streams	49.39	1570.31
Midslope Drainages, Shallow Valleys	1.87	59.51
Upland Drainages, Headwaters	2.28	72.41
U-shaped Valleys	0.66	20.85
Plains Small	0.03	1.04
Open Slopes	2.47	78.49
Upper Slopes, Mesas	0.89	28.29
Local Ridges/Hills in Valleys	2.45	78.03
Mid slope Ridges, Small Hills in Plains	0.92	29.24
Mountain Tops, High Ridges	39.03	1240.93
Sum	100.00	3179.1

IV. CONCLUSION

In this study, digital elevation models used as inputs data. TPI values are between – 320 to 363. By using TPI, the study area was classified into landform category. The result show that there are ten landform that consist of consist of canyons/deeply incised streams, midslope drainages/shallow valleys, upland drainages/headwaters, u-shaped valleys, plains small, open slopes, upper slopes/mesas, local ridges/hills in valleys, mid slope ridges/small hills in plains, mountain tops/high ridges. Low and high the areas are 1570.31, and 1.04 for canyons/deeply incised streams and plains small classes respectively.

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Landform classification using Topography Position Index for Zagros Mountain (case study: Lordegan Mountain)

M. Mokarram, and A. Seif

Abstract — A landform in the earth sciences comprises a geomorphological unit, and is largely defined by its surface form and location in the landscape. Landform elements include land such as hills, mountains, plateaus, canyons, valleys, seascape and oceanic water body interface features such as bays, peninsulas, seas and so forth, including sub-aqueous terrain features such as mid-ocean ridges, volcanoes, and the great ocean basins. The main objective of this study is to landform classification in Lordegan Mountain where located in Zagros mountain, Iran. In order to landform classification used Digital Elevation Models (DEMs) with 30 m resolution. In this study used Topography Position Index (TPI) classes for landform classification for the case study. TPI values are between – 169.24 to186.48. By using TPI, the study area was classified into landform category. The result show that there are three landform that consist of canyons / deeply incised streams, open slopes, and mountain tops / high ridges and the areas are 1071.02, 293.92, and 1028.11 for each of the classes respectively.

Keywords—landform classification, topography position index, Lordegan Mountain.

I. Introduction

THE Landform elements include land such as hills, mountains, plateaus, canyons, valleys, seascape and oceanic water body interface features such as bays, peninsulas, seas and so forth, including sub-aqueous terrain features such as mid-ocean ridges, volcanoes, and the great ocean basins.

"Landform classification is reducing terrain complexity into a limited number of easily discernible functional units (Burrough et al., 2000). Landform classification, like any other categorization attempt by human is intrinsic. It is more likely that we can understand what the categories of land reveal, than to perceiving and evaluating continuous representations. There is a long tradition of mapping, which can be attributed to the relative ease of representing discrete spatial units compared to understanding and evaluating continuous representations of surface (Strobl, 2007). Landform classification emerged due to complexity of the earth surface which has necessitated seeking methods to quantify its form and subdivide it into more manageable components (Evans, 1990)" (Gerçek, 2010).

Landform classification has been of great interest in earth sciences as it has a wide range of application domains, including mapping lithology (Kühni and Pfiffner, 2001) predicting soil properties (Florinsky et al., 2002), vegetation mapping, precision agriculture (Verhagen et al., 1995). Landform classification indeed constitutes a central research topic in geomorphometry (Pike, 2002; Rasemann et al., 2004). Geomorphometry is usually referred to as a sub-discipline of geomorphology (Dehn et al., 2001; Bolongaro-Crevenna et al., 2005), as an interdisciplinary field from mathematics, and Earth sciences and computer science (Pike et al., 2009).

The main objective of this study is to landform classification in Lordegan Mountain where located in Zagros mountain, Iran.

II. Material and Method

A. Topography Position Index (TPI)

Topographic Position Index (TPI) is an adaptation of this method which compares the elevation of each cell in a DEM to the mean elevation of a specified neighborhood around that cell. Local mean elevation is subtracted from the elevation value at centre of the local window. Algorithm is provided as an ESRI script by Jenness Enterprises (Jenness, 2006), and it has local window options of; rectangular, circular and annulus.

$$TPI_i = Z_0 - \frac{\sum_{1-n} Z_n}{n}$$

Where;

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Z0 = elevation of the model point under evaluation

Zn = elevation of grid within the local window

n = the total number of surrounding points employed in the evaluation

Positive TPI values represent locations that are higher than the average of the local window e.g. ridges. Negative TPI values represent locations that are lower e.g. valleys. TPI values near zero are either flat areas (where the slope is near zero) or areas of constant slope (where the slope of the point is significantly greater than zero), high positive values relate to peaks and ridges.

B. Landform classification

The TPI is the basis of the classification system and is simply the difference between a cell elevation value and the average elevation of the neighborhood around that cell. Positive values mean the cell is higher than its surroundings while negative values mean it is lower (Jenness 2006). Combining TPI at small and large scales allows a variety of nested landforms to be distinguished (Table 1).

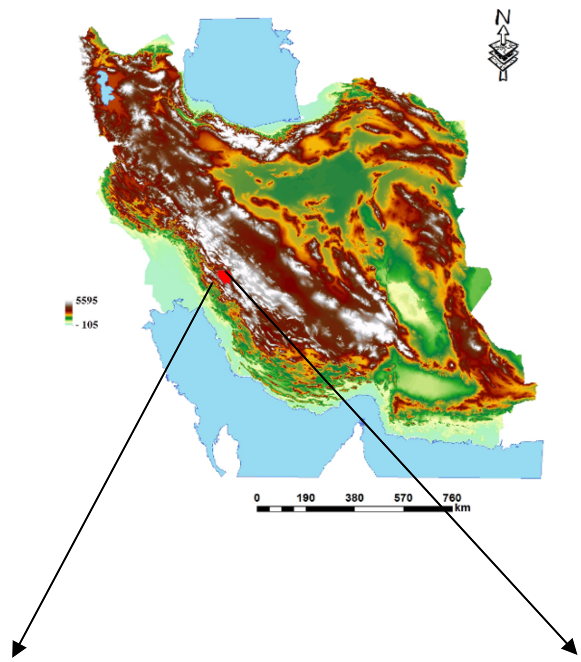
Table 1: Landform classification based on TPI .
(Source: Weiss 2001)

Classes	Description
Canyons, deeply incised streams	Small Neighborhood: $z_o \leq -1$ Large Neighborhood: $z_o \leq -1$
Midslope drainages, shallow valleys	Small Neighborhood: $z_o \leq -1$ Large Neighborhood: $-1 < z_o < 1$
upland drainages, headwaters	Small Neighborhood: $z_o \leq -1$ Large Neighborhood: $z_o \geq 1$
U-shaped valleys	Small Neighborhood: $-1 < z_o < 1$ Large Neighborhood: $z_o \leq -1$
Plains small	Neighborhood: $-1 < z_o < 1$ Large Neighborhood: $-1 < z_o < 1$ Slope ≤ 5°
Open slopes	Small Neighborhood: $-1 < z_o < 1$ Large Neighborhood: $-1 < z_o < 1$ Slope > 5°
Upper slopes, mesas	Small Neighborhood: $-1 < z_o < 1$ Large Neighborhood: $z_o \geq 1$
Local ridges/hills in valleys	Small Neighborhood: $z_o \geq 1$ Large Neighborhood: $z_o \leq -1$
Midslope ridges, small hills in plains	Small Neighborhood: $z_o \geq 1$ Large Neighborhood: $-1 < z_o < 1$
Mountain tops, high ridges	Small Neighborhood: $z_o \geq 1$ Large Neighborhood: $z_o \geq 1$

TPI values can easily be classified into slope position classes based on how extreme they are and by the slope at each point. TPI values above a certain threshold might be classified as ridge tops or hilltops, while TPI values below a threshold might be classified as valley bottoms or depressions. TPI values near 0 could be classified as flat plains (if the slope is near 0) or as mid- slope areas (if the slope is above a certain threshold) (Table 2).

C. Case study

The study area is Lordegan Mountains, Iran, which is located at 31° 01′ 03″ to 33° 31′ 09″ N and 50° 34′ 32″ to 51° 15′ 48″ E, with area of 2,393.06 km^2 (Figure 1). The highest elevation in this area is 3646 m, which is located in the south of the basin, while the lowest elevation is 994 m, which is located in the north of basin. The dataset for the area originates from a DEM with resolution of 30 m (SRTM), which was downloaded from http://srtm.csi.cgiar.org.



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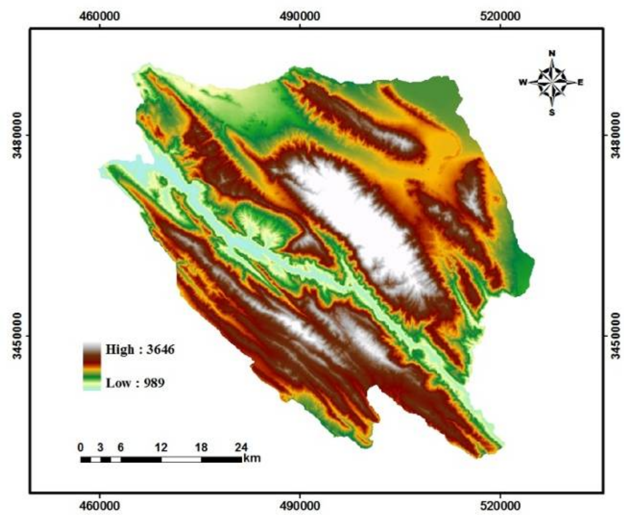

Fig. 1 Location of the study area

III. RESULT AND DISCUSSION

A. Topography Position Index (TPI)

TPI values are between – 169.24 to186.48 (Figure 2). TPI values near zero (close of -169.24) are either flat areas (where the slope is near zero) or areas of constant slope (where the slope of the point is significantly greater than zero), high positive (close of 186.48) values relate to peaks and ridges.

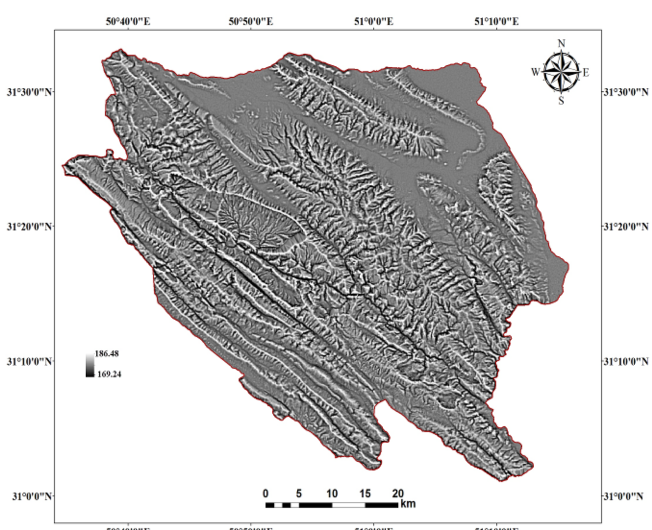

Fig. 2 Topography Position Index (TPI)

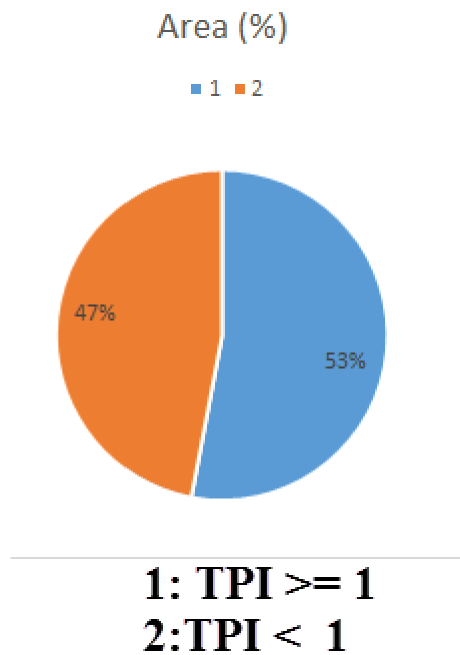

Fig. 3 Percentage of the TPI value in the case study

B. Landform classification

The result show that there are three landform that consist of canyons / deeply incised streams, open slopes, and mountain tops / high ridges and the areas are 1071.02, 293.92, and 1028.11 for each of the classes respectively (Figure 4 to Figure 8 and Table 1).

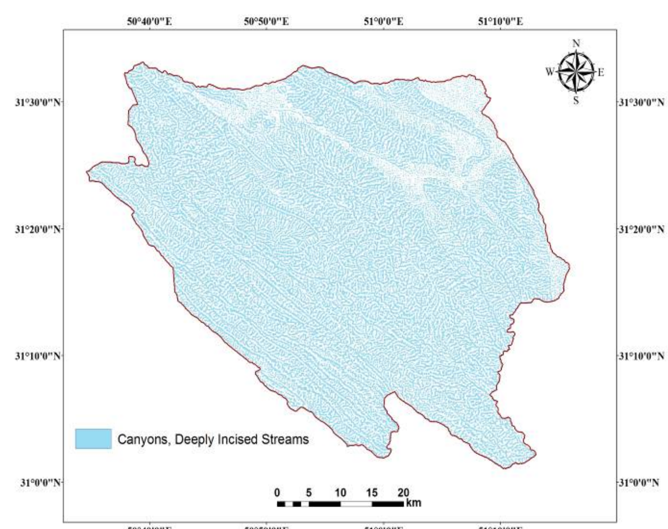

Fig. 4 Canyons, Deeply Incised Streams class for the study area

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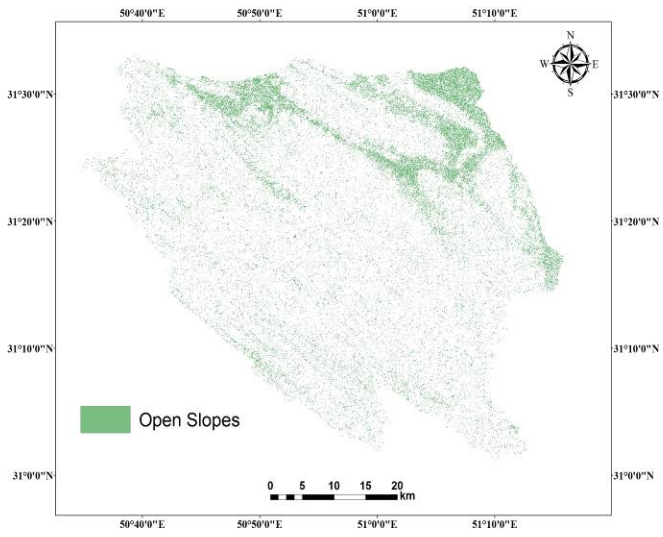

Fig. 5 Open slope for the study area

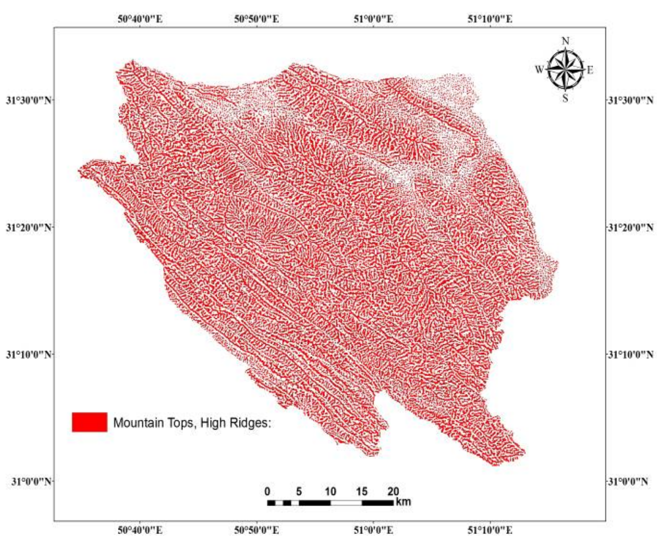

Fig. 6 Mountain Tops, High Ridges: class for the study area

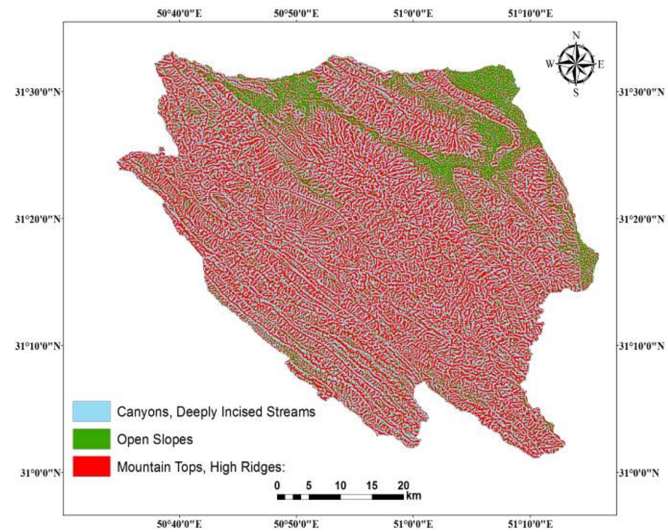

Fig. 7 Landform classification for the study area

Table 1 Area of each of landform class in the study area

Landform classification	Area (%)	Area (km^2)
Canyons, Deeply Incised Streams	0.45	1071.02
Open slpoe	0.12	293.92
Mountain Tops, High Ridges:	0.43	1028.11
Sum		2393.06

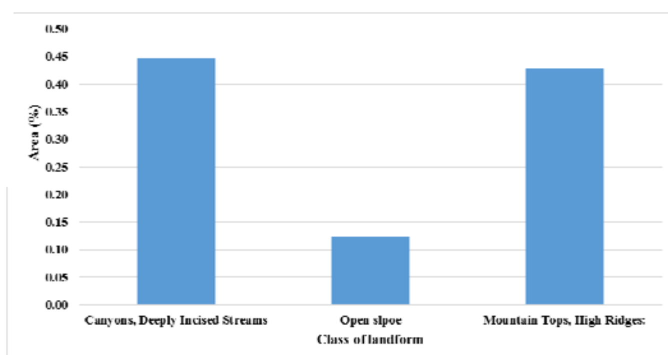

Fig. 8 Percentage of the each of landform classes in the case study

IV. CONCLUSION

In this study, digital elevation models used as inputs data. TPI values are between – 169.24 to186.48. By using TPI, the study area was classified into landform category. The result show that there are three landform that consist of canyons / deeply incised streams, open slopes, and mountain tops / high ridges. Using TPI and landform classification by Weiss in 2001 for category of different area can applied.

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Determination of some biophysical properties of Domsiyah Rice

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Abstract— Rice grain, which is a vital economical commodity, has many nutritional and medicinal properties. Therefore knowledge of its physical and engineering properties in the design of post – harvest mechanisms is essential. Information about dimensions, volume, coefficient of static friction, and repose angle in agricultural products on various surfacesis among mechanical properties, which are required in the design of silos, agricultural warehouse, transportation equipment including conveyer belts and spiral conveyers, and also in the design and determination of the efficiency of the post – harvest processing equipment. This study investigated the dimensional, frictional (the coefficient of static friction repose angle on a surface of galvanized iron), geometrical and gravitational (apparent and bulk densities) properties of domsiyah rice grain. The results determined the mean geometric and arithmetic diametersand the sphericity as 4.3, 3.074, and 33.37 respectively. The sample surface area, the large and small curvature radii were determined to be 29.67, 6.51, and 1.69 respectively. The coefficient of static friction and the release repose angle were evaluated as 0.45 and 26.87 respectively. The volume and the apparent and bulk densities were determined as $8.06 cm^3$, $1.46 gcm^{-3}$, and $750 kgm^{-3}$ respectively. All of these features can greatly influence the processing of food and agricultural produce. Therefore better recognition of these features and their influence on agricultural produce and food processing can aid the improvement of the quality and better processing of agricultural products.

Keywords— Domsiyah rice, dimensions, gravitational properties, geometrical properties

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I. Introduction

Rice scientifically called *oryza satival* is ranked second only to wheat in the global cereal chain. This food substance which, belongs to the grass family, is of the annual or perennial type. More than half of the world's population are dependent on rice as a food substance such that this product Forms 40% of the food required by 50% of the world population (Okhovat & Vakili, 1997).150m hectares of rice is grown globally forming 10% of the world's agricultural land. World rice production has to double by 2025 in order to safeguard the food supply of the growing world population (Yashittttola et al, 2002). The averageproduction of rice harvest in Iran has been 4200kg per hectare while the consumption per capita has been reported as 32kg (Agahi et al, 2012). Physical properties of agricultural products are employed in the optimal design of processing, planting and harvesting devices; and are essential in waste reduction and maintenance of products during harvesting. Some of these properties include: length, width, height, area, volume, grain weight, apparent and true densities, porosity, coefficient of static friction, and angle of repose (Asgari et al, 2010). Apparent density is used to determine thermal properties related to heat transfer while the Reynolds Number is employed in the pneumatic transfer of substances and the separation of impurities from the main product. The grain bulk resistance against air current is a function of porosity and dimensions (Reddy & Chakravetty, 2004).

Research conducted to determine the physical properties of agricultural products include: determination of bulk density, sphericity, porosity, coefficient of static friction, and moisture content in rice (Jouki & Khazaei, 2011). Various research has also been conducted on the physical properties of other products such as wheat (Bargale, 1995); Coefficient of friction in zea mays saccharata sturt (Bülent Coskul et al, 2006), millet (Baryeh et al, 2002), lentil (Carmen, 1996), and sunflower seed (Gupta 1997) all indicating the role and significant influence of physical properties of grains in agriculture and industry.

The research aimed to determine some of the essential physical properties of the Domsiyah rice variety such as dimensional, frictional, geometrical, and gravitational using prevalent laboratory methods because of the significance of these properties in agricultural products.

II. Materials and Methods

Sample Preparation

Approximately 1kg of rice was purchased from a shop in the city of Sabzevar in eastern Iran and transferred to a biophysics laboratory. All impurities such as husk, broken grains, and

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foreign particles were removed by sieving and placement in moderate wind currents. The initial grain sample was prepared by an oven (Jouki & Khazaei, 2011).

Determination of the Dimensions

30 rice grains were selected at random and the three main dimensions: small diameter (Thickness), medium diameter (width), and large diameter (length) were determined by callipers accurate to 0.01. Each grain was weight on a scale with an accuracy of 0.001. Arithmetic mean diameter (D_a), Geometric mean diameter (D_g), sphericity (φ), sample area (S) were evaluated by equations 1, 2, 3 and 4 respectively. The curvature radii (R_{min}, R_{max}) were determined by equations 5, 6, and 7. McCabe equations were used to evaluate the surface area of the samples (Sahin & Sumnu, 2006).

$$D_a = \frac{L+W+T}{3} \qquad (1)$$

$$D_g = (LWT)^{1/3} \qquad (2)$$

$$\varphi = \frac{(LWT)^{1/3}}{L} \times 100 \qquad (3)$$

$$S = \pi D^2 \qquad (4)$$

$$H = \frac{W+T}{2} \qquad (5)$$

$$R_{max} = \frac{H^2 + \frac{L^2}{4}}{2H} \qquad (6)$$

$$R_{min} = \frac{H}{2} \qquad (7)$$

Determination of the Release Repose Angle

The release repose angle θ_e is measured by using a $12 \times 12 \times 12$ cm wooden box which is first filled with grains and the sliding door is then quickly pulled up so that the grains are released outwards forming a natural pile. The repose angle was measured by evaluating the height of two sloping points on the pile and the horizontal line between these two points and subsequent substitution in equation 8 (Razavishirazi, 2012).

$$\theta_e = \tan^{-1}\left(\frac{h_2-h_1}{x_2-x_1}\right) \qquad (8)$$

Coefficient of Static friction

An adjustable galvanized iron sloping surface was used to determine the coefficient of static friction (μ_s). First an open-ended cylinder is placed on the above surface and then filled with grain. The box is at first lifted to avoid any contact with the surface. The sloping surface can be adjusted by a hinge connected to one end. The unhinged end can be lifted by a nut- bolt system and the angle of slide is the required angle and the coefficient of static friction is calculated by the equation 9 (Sahin & Sumnu, 2006).

$$\mu_S = \tan \alpha \qquad (9)$$

Volume and Apparent Density

The volume was evaluated by liquid displacement method using a pycnometer and toluene solvent. In this method sample and the solvent were weighted alongside the pycnometer. The volume is evaluated as follows: first the empty pycnometer is weight and then the solvent is added and weighed again. Approximately fifty grains are placed in the pycnometer and weighed. It is recommended that this amounts to 1/3 of the volume of the pycnometer. The remaining space in the pycnometer is filled with toluene and weight once more. The results are implemented in equation 10 in order to determine the apparent volume. The apparent density is subsequently determined from equation 11 by substituting the value from equation 9 (Sahin & Sumnu, 2006).

$$V_S = \frac{M_{td}}{\rho_f} = \frac{(M_{Pf} - M_P) - (M_{Pfs} - M_{Ps})}{\rho_f} \qquad (10)$$

$$\rho_S = \frac{M_{Ps} - M_P}{V_S} \qquad (11)$$

Bulk Density

In order to determine the bulk density part of the sample was selected at random. A container of known volume (V_a) and mass (M_1) was filled with selected sample and the surface levelled off using a flat object like a ruler so as to remove grains overfilling the container without external pressure. The container is weighed at this stage and the mass of container plus grains(M_2) calculated. Finally the density was evaluated from equation 11 (Agahi et al, 2012).

$$\rho_b = \frac{M_2 - M_1}{V_a} \qquad (12)$$

III. Results and Discussion

Dimensions

The mean data obtained by callipers from the 30 grains of

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rice is given in Table 1.

Table 1: Mean small, medium, and large diameters, arithmetic and geometric mean diameters, sphericity, sample surface area, and minimum and maximum curvature radii

Property	Unit	Mean	Standard deviation
Large Diameter (length)	mm	9.07	1.1
Medium Diameter (width)	mm	2.29	0.87
Small Diameter (thickness)	mm	1.4	0.79
Arithmetic Mean Diameter	mm	4.3	0.27
Geometric Mean Diameter	mm	3.074	0.77
Sphericity	mm	33.37	0.9
Sample Surface Area	mm	29.67	0.22
Minimum Curvature Radius	mm	1.69	0.087
Maximum Curvature Radius	mm	6.51	1.04

Release Repose Angle

When granules are released from the hatch at the bottom of a container or silo or when they are poured into a pan or on to a surface through a pipe they form a pile. The coefficient of friction influences the horizontal angle formed between the surface of the pile and the floor. This angle is called the repose angle. The results of the measurements on the samples for parameters h_1 and h_2 after 3 replications were 10.01 & 3.93 respectively which when substituted into the relevant equation the release repose angle is determined as 26.87. The difference in the parameter X was evaluated as 12. Type, moisture content, and physical properties of a food substance or agricultural produce such as form, density, coefficient of friction between particles etc. can influence the repose angle. The bigger this angel, the more grains remain inside the holding place (silo) which is not desirable (Razavishirazi et al, 2009).

Coefficient of Static Friction

This coefficient predicts the force at the moments of the commencement of motion. The result of the angular test $\alpha = 22^\circ$ was substituted in $\mu_s = \tan\alpha$ and μ_s was evaluated as 0.45. This coefficient is generally dependent upon moisture content, surface properties, sliding speed, and surface material. In identical situations surface properties of the grain prevail over moisture content, surface material and sliding speed and are responsible for variations between the coefficients of friction among various grains (Razavishirazi et al, 2009).

Bulk and Apparent Density and Volume

The apparent density and volume were evaluated as 8.06cm^3 and 1.46gcm^{-3} respectively. Bulk density is defined as the ratio of sample bulk mass to the total volume of the container which was determined as 750kgm^{-3} in this study. Separation of impurities, determination of Reynolds Number in pneumatic and hydraulic transfer, and knowledge of the density are essential when designing a silo (Razavishirazi et al, 2009).

IV. Conclusion

Rice is one of the essential global agricultural products and guarantees the food security of many people. Design of devices for harvest, transport, sorting, grading, and other agricultural process is reliant upon the knowledge about their biophysical properties. Physical and geometrical properties such as arithmetic mean diameter, geometric mean diameter, sphericity, sample surface area, minimum and maximum curvature radii, release repose angle, coefficient of static friction on a galvanized iron surface; and gravitational properties such as apparent and bulk density of Domsiyah rice were investigated in this research. Mean geometric diameter, mean arithmetic diameter and sphericity were evaluated as 4.3, 3.074, and 33.37 respectively while the values for sample surface area, and minimum and maximum curvature radii were determined as 29.67, 1.69, and 6.51 respectively. The release repose angle and coefficient of static friction were evaluated as 26.87, and 0.45 respectively. All physical properties effect the evaluation of the qualitative properties of rice, therefore more research is required in order to improve recognition and achieve better results.

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Distribution of nitrogen forms in calcareous soils province and their relationship with soil characteristics

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Abstract— Nitrogen is The most important element influencing plant growth , and the most important fertilizer element. Some forms of nitrogen distribution in soils examined with surface soil samples from different agricultural areas in the province. In The chemical test conducted on samples, Total nitrogen(STN) was measured from 490 to 2750 (mg / kg) of soil , And the greatest amount of nitrogen in the soil, With a mean corresponding to the BOX-NB 99/56 (mg / kg) of soil, and the lowest amount of nitrogen NPHEN, with an average of 43/10 (mg / kg) of soil, respectively. The overall abundance of nitrogen in the soil was determined as follows:

BOX-NB> NHOX-NH> NHSULN> NAOHNB> NKCL> NNH4> NPHEN

The highest correlation coefficient between the STN and forms of nitrogen in soils is the BOX-NB by a factor of 872/0, And the lowest a factor of 038/0 of NNH4, respectively. Equations obtained between total nitrogen and soil organic matter OM, and OM with BOX-NB was a high correlation coefficient.

Keywords—lorestan , nitrogen distribution , soil characteristics , plant .

INTRODUCTION

Nitrogen is one of The most important Fertilizing elements which effects on The plant growth and releaseds as a result of organic Fertilizer being decomposed in the soil(1). Nitrate is one of The absorbable Form of nitrogen in the soil. Nitrate which is very important For continuing The plants life as the prilimary source of nitrogen (2). is rinsed easily because of Its significant dynamism in the soil compared with other Form of nitrogen and caused to waste The soil nitrogen and pollutes The underground water. Cations and organic materials may be also transfered from The surface to The depth of the soil through washing process(1). Atmospheric nitrogen is one of the main resources of the soil nitrogen. The biological stability of nitrogen in the soil utillizing indepandant rhizobiomsand microorganisms of the soil such as blue-green algae and azote bacter bactria؛ or stablizing utillizing the thunderbolt in the forms of nitrogen oxides؛ are some of the main ways to transform the atmospheric nitrogen in to the forms appliable in the soil plants. One of the other significant resources of nitrogen in the soil is nitrogen fertillizers which have recently used noticeably.

Nitrogen existes in the soil in different forms. Although the plant is not able to apply all the forms equally. Some forms are: organic nitrogen، exchanging nitrogen (NH_4^+) and soluable in water (nitrate NO_3^- and nitrit No_2^-)،and the stablized nitrogen in the soil using some silicate clay which consist oLL nitrogen of the soil. Exchanging and soluable nitrogens are the inorganic forms of nitrogen(3).

The significant part of the soil nitrogen is usually saved organically in the soil which exists in the bactria stracture، Fungus. Plants roots in the soil، and plant remains؛ and as meationed above، It can be trans formed in to inorganic matrials. Based on the surveys، the potential of being inorganic in surface soil nitrogen is more than deep soils(1).

After passing afew decades of Environmental and health damage، applying the chemical fertilizers too much is revealed for every body، so It seems necessary to perform and develope the managering approaches to promote the organic fertilizers again to reduce the environmental pollution and improve the soil quality. Utillizing the animals، humans، and plants wastes(organic fertilizers) to improve the soil quality instead of applying the chemical fertilizers are some emergency actions.

In the studies related to plant-soil، having information about distributing the nitrogen element among the soil matrial takes a sigificant importance and help to understand the ferilizing aspects of the soil and plant nutrition.

Considering that a variety of methods have been presented to measure the nitrogen form in the soil، the recent research has used eight chemical methods for this purpose: measuring the all amount of the soil nitrogen by micro cajaldal method(STN)، Nitrate nitrogen of the soil using phenol di solphonic acid (NPHEN)، amonium nitrogen using potassium cloride(NNH_4) the prilimary nitrate nitrogen(NKCL)، the extracted amonium nitrogen because of the organic matrial oxidation using the acid solution of the permanganate (NHOX-NH)، the extracted amonium nitrogen utilizing the sodium hydroxide(NAOHNB),and the extracted amunium nitrogen because of the organic matrial oxidation using the alkalic solution permanganate (BOX-NB).(12،13، 14، 17).

The above eigh methods measure the being in organic nitrogen of the soil utillizing the chemical materials (5،10، 12،13)؛ the other measuring methods of nitrogen are either among the aerobic and inaerobic biological methods (۱۲،۱۳،۱۶،۲۰) or measure the in organic nitrogen of the soil directly(8).

Yasrebi etal.(4،3) have got to same results according to the existance of a significant relationship between the soil organic material and each form of nitrogen form of the soil، and soluable and exchanging form during doing two researches. The measured the amount of soil organic nitrogen as 12.1 percent in their first invstigation on 14 series of the soil samples. The result of their first research also shown the dominant form of nitrogen as the being in organic nitrogen utillizing acid permangenate. Antep(5) also measured the organic nitrogen of the soil using the alkalic pottasium permangenate and studied their relationship with the nitrogen with being in organic ability.

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Paramosium and britain back (18) reported the relative amount of organic nitrogen of the missisipi Regron soil as 84.9 percent. Jian Loo et al.(12)، like other investigaters، measuaed the organic nitrogen with oxidation potential applying the biological methods.

Considering this issue that the different forms of nitrogen distribution in Iran has been studied rarely، this measurment using & chemical methods in some planting soils of lorestan of province، along with assessing the corelation among all the forms with the soil chemical and physical features، and aquiring some equations to predict the forms utillizing the soil qualities, are the purposes of this investigation.

I. PROCEDURE FOR PAPER SUBMISSION

20 planting areas of lorestan were selected for sampling. The samples were prepared from to 30cm depth. After drying the samples exposuring the air and screening them using a 2mm sieve ,some of its chemical and physical charactristics such as the organic material rate, carbonate calsium rate, the ability for the electerical conductivity of the extract saturation, the ph of the saturated mud, and the amount of the clay were identified using the common methods: these chemical and physical, charactristics are presented in table.(1).

Table (1) some of the chemical and physical charactristics of the surveying soil

Soil series Number	name	PH (١:٢/٥)	EC (dsm-١)	caly (g kg-١)	carbonate Calsium (%)	organic material (%)
١	Alashtar	٧,٥٨	١,٣٢٤	١١١,٧	٢٣,٤٥	٣,١٠
٢	Mansourabad	٨,٣٢	٨,٣٢	٢٦٢,٠	١٨,٥٠	١,٨
٣	Alashtar	٨,٤٥	١,١٤٢	١٥٤,٦	٣٣,٤٥	٢,٥٠
٤	Abbarik	٧,٦٧	٠,٨٢١	٣١٣,٣	٢١,٠٠	١,٦٩
٥	kouhdasht	٧,٦٠	٠,٦٧٤	٢٢٤,٤	٥٠,١٢	١,٦٠
٦	Domsorkh	٨,٢٣	٠,٦٤١	٣١٩,٧	٢٩,٥٠	٢,٢٥
٧	kouhdasht	٧,٣٥	١,٢٨٧	٢٨٢,٣	٣٠,٠٠	١,٨٥
٨	Domsorkh	٧,٥٤	١,٨٢١	٣٦,٣	٤٢,٥٠	١,٣٨
٩	Chiasoureh	٨,١٢	٠,٦٧٩	٣٠٣,٥	٣٥,٥٠	١,٦٦
١٠	Chiasoureh	٧,٧٣	٠,٦٤٥	٣٦٢,٢	٤٤,٥٠	١,١٤
١١	Daeichi	٧,٥٣	٠,٧٩٨	٣٧,٤	٤٩,٠٠	١,٥١
١٢	Zahed shir	٧,٨٤	٠,٧٨٦	٣٥٣,٩	٣٤,٠٠	٢,١٢
١٣	Seifabad	٧,٧٦	٠,١٣٢	٣٩,٤	٢٠,٥٠	١,٨٩
١٤	Zagheh	٨,٢٤	٠,٧٦٤	٤٠٢,٨	٤٠,٠٠	١,٣٠
١٥	Sarapardeh	٨,١٠	١,٦٨٤	٥٣,٧	٢٨,٠٠	٢,١٤
١٦	Khorramabad	٧,٧٥	٠,٧٥٦	٢٩٢,٨	٤٠,٥٠	١,٧٤
١٧	Masour	٧,٩٠	٠,٦٧٥	٣٦,٩	٣٠,٠٠	٢,٢١
١٨	Tirbazar	٧,٨٧	٠,٦٧٦	٣١٢,٨	٣٤,٥٠	٢,٤٢
١٩	Mirabad	٨,٠٠	٠,٦٤٢	٣٠٢,٥	٣٠,٠٠	١,٧٠
٢٠	Dehpir	٧,٦٠	٠,٦٤٥	٢٣٣,٨	٣٠,٥٠	٢,٥٠
Average		٧,٧٨	٠,٨٢٦	٢١٨,١	٣٣,٢٧	١,٩٢٥

Eight chemical methods were applied to measure the different forms of the soil nitrogen:

Method1: Measuring the all nitrogen of the soil by micro Kajldal(STN) (6).

Method2: Measuring the nitrate nitrogen of the soil using the phenil, di solphounic acid(NPHEN) (9).

Method3 and 4: Measuring the anunium nitrogen utillizing potassium choloride(NNH4)- Measuring the primilary niterate nitrogen (NKCL), (17 . 7).

In this two –step method we need the choloride potussium solution to get the extract from the soil sample. At the first step؛ Mgo is used to evaporated dastillation in a part of extraction to measure the amunium nitrogen.

At the second step, amunium nitrogen is measured using again the Mgo and dovarda alloy, at another part of the extraction utillizing the evaporated distillation. The difference of these two steps, revealed the nitrate nitrogen.

Methods5 and 6: Measuring the extracted amunium nitrogen using the solphouric acid 1 normal (NHSULN) –the extracted amunium nitrogen as a result of the organic material oxidation using acid solution of permangenate (NHOX-NH) (12 , 13 , 15 , 19 ,21).

This method was done in two steps. In both steps this experiment, solphouric acid a one normal was applyied to extract the amunium nitrogen:

1-amunium nitrogen measurment was performed using the evaporated distillation with sodium hydroxide.2-At this step.Potussium permangenate solution was applied in addition to solphouric acid. The extracted amunium nitrogen was measured as a result of the organic matrial oxcidation by evaporated distillation.

Methods 7 and 8: Measuring the extracted amunium nitrogen using hydroxide sodium (NAOHNB) –the extracted amunium nitrogen as a result of the organic material oxidation using the alkalic solution of permangenate (BOX-NB) (12,19,21).

At the first step of this method, I gram of soil and 10ml normal sodium hydroxcide %25 and 0/1 gram potussium permangante gathered by the organic material oxidation were poured in to the distillation flask. The evaporated distillation was done using Mgo. At the second step, again using the evaporated distillation, but this time without applying the potussium Permangenate, amunium nitrogen was measured. The difference between the measured amounts in these two steps, is the extracted amunium measurment with the alkalic solution of permangenate.

The result of the performed chemical methods using the statistical programs spss and through the linear simple and multi variable equations with eachother and with the soil charactristics were analysed..

Conclusion and discussion:

THE MEASURED AMOUNTS OF NITROGEN USING THE EIGHT METHODS ALONG WITH THE RANGE AND THE MEAN AND THE RELATIVE AMOUNT (PERCENT OF THE AMOUNTS) ARE PRESENTED IN TABLE.(2). THE TABLE AMOUNTS SHOW THE VARIED DISTRIBUTION OF THE FORM OF THE SOIL NITROGEN.

Table 2 the nitrogen amount of the surveying soil ($mgkg^{-1}$), measured by different method: Soil STN NPHEN NNH4 NKCL NHSULN NHOX-NH NAOHNB BOX-NB

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As you see in table (2), the variation range of soil totall nitrogen (STN) varied between 490 to 270 with on average of 1097.2 .

Yasrebi et al reported the soil totall nitrogen under Doroudzan Band in fars province 910 and 1121 mg in every kilogram repectively during their two studies (3 , 4). The numbers adopt with Yasrebi etals research. Considering that lorestan has four arid month during a year and it can be said that it has a semi-arid climate , and hot and arid climate of Fars province , the result can be justified. The soil of zagros margin is often limy with a Ph between 7.5-8.5 , the soil organic materials are not a high amount, so the soil total nitrogen can not be high in these regions. The average of this kind of nitrogen in missisipis soil of the united stated is 1930mg in every kilogram soil, and in Iova, 2153mg in every kilogram of soil(6 , 13 , 18).

The high amount of nitrogen in all around the united state indicates the relatively high organic material of the wet soils of this region compared with the approximately semi-arid climat of zagrous margin in Iran.

NPHEN and NKCL are forms of nitrogen that are soluable in water (nitrate). As you can see, the amounts have gained respectively from 0.50 to 28.00 (with 10.43 average)and 2.53 to 42.10 (with 15.31 average)miligram in every kilogram soil, (table.2). At the first study about Farsós soils, yasrebi et al. The averag of these forms of nitrogen is reported respectively 7.6 and 16.3 mg in every kilogram soil, and at the second study, 11.67 and 15.4 mg in every kilogram soil(3 , 4), while in the areas of the united states, there is less amount of this kind of nitrogen, As the amount of NKCL in these regions is reported 3.2 mg in every kilogram soil (18).

The form of NNH_4 (Exchanging-native$^-$ amunium nitrogen) in the surveying water has a rage of 1.31-21.10 with an average of 11.78 mg in every kilogram(table.2). the averag of this form in the soils under the droudzan band in Fars province at the first study of yasrebi et al reported as 6.72 mg and in their second study. It was reported as 125mg in every kilogram of soil.(4). This amount has reported as 10mg in every kilogram soil in non-limy soils of turkey(5).

the rang of the form changing of NHSULN in the surveying soils is 6.5-57.45 with an average of 25.86 in every kilogram of soil. Yasrebi et al. (3 , 4)reported the average of this form, in their two studies, as 125 and 22.76 mg, respectively in every kilogram soil.

Another form of the soil nitrogen is NHOX-NH. As you see, Its amount is between 20.15-80.26 with an average of 50.07 mg in every kilogram of soil(table.2). yasrebi et al measured the amount of this kind of nitrogen during their two studies at respectively 42.50 and 105mg in every kilogram. Antep (5) has calculated Its average in the non-limy soils of turkey as 30.40 in every kilogram of soil.

The range variation of NAOHNB form, in the surveying soils was reported from 4.45-42.10 with an average of 18.75 mg in every kilogram of soil.

According to table(2), the range variation of BOX-NB varieds between 18.50-100.00 with an average of 56.99mg in every kilogram soil (table 2). Antep assessed this kind of nitrogen as 110.40, and Gianllo and Bremner measured that in acid and limy soils of the united state as 113mg in every kilogram of soil(5 , 6 , 13).

As you see, based on table (2), the highest amount of nitrogen in the surveying soil is BOX-NB with an average of 56.99 mg in every kilogram of soil; and the smallest amount is related to NPHEN form, wiht an average of 10.43 in every kilogram soil. So the nitrogen aboundance in the surveying soils can be reported as:

BOX-NB > NHOX-NH > NHSULN > NAOHNB > NKCL > NNH_4 > NPHEN

At their first study on Fars provinces soils. Yasrebi et al, reported the nitrogen aboundance as: NHOX > NHSULN > NNH_4 > NKCL > NPHEN

But in their next study, they gained these result, surveying a larger spectrum of the region soils (4):

BOX-NB>NHOX-NH>NHSULN>HOTKCLN>NKCL>NAOHNB>NPHEN >NNH_4

Considering the findings during the different studies and table(2) sums,

BOX-Nb and NHOX with 9.75 percent are the highest amount among the other form of nitrogen. Because these methods were able to extract the highes amount of in organic absorbable nitrogen in a definit to period. The other investigators also found BOX-NB as the highest amount in their surveying soils: Gianello and Bremner have reported, 5.25 , and Antep 9.21 percent for this kind of nitrogen in their studies(6 , 12).

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Inall, NKCL and NNH_4 as the wate soluable forms , with a sum of 2.46 percent, have low amount, and consist a smaller percent of total nitrogen compared with acid permanganate and alkalic permanganate (table 2). Yasrebi et al, also attained a lower sum of water soluable and exchanging than 5 percent (3). Antep also reported the sum of these two form less than 2 percent (5). The performed comparisions resulted in that NHOX-NH and BOX-NB the forms with a potential to oxidation using acidic and alkalic permanganate (an indice for capacity factor), have the highest amount among the other forms of nitrogen.and the lowest relative amount is for NNH_4 and NKCL , the water soluable and exchange in forms, (an indice for Intensity factor)(3).

The coefficient correlation(1) between diffrent form, of nitrogen are shown in table(3).

Table(3): the coefficient correlation between nitrogen forms

	FORMS						
	۱*	۲	۳	۴	۵	۶	۷
۲	-۰/۲۳۴						
۳	-۰/۰۳۸	**۰/۶۶۸					
۴	-۰/۰۵۳	**۰/۷۱۴	**۰/۸۹۰				
۵	**۰/۸۴۳	-۰/۲۴۸	-۰/۰۹۷	-۰/۰۹۲			
۶	**۰/۷۴۷	-۰/۴۲۷	-۰/۲۶۵	-۰/۲۶۸	**۰/۸۳۸		
۷	**۰/۸۱۴	-۰/۳۱۲	-۰/۱۶۰	-۰/۱۸۷	**۰/۸۳۴	**۰/۸۹۵	
۸	۰/۸۷۲**	*-۰/۴۶۵	-۰/۲۴۹	-۰/۲۵۷	**۰/۸۶۶	**۰/۹۱۵	**۰/۸۵۸

*: numbers description is presented in table(2).
and *: r is meaningful, respectivdy on the 1 and 5 level.

As you see in table (3), STN has the highest coefficient corelation using BOX-NB , NHSULN , and NAOHNB with respectivevly 0.877 , 0.843 , and 0.814 coefficient corelation. The reason for having a high coefficient corelation in these two froms is related to relative high amount of these forms compared with other forms: in a way that BOX-NB consists 5.19 percent: NHSULN ,2.35 percent. And NAOHNB 1.7 percent of total soil nitrogen (table2). Yasrebi et al attained the highest coefficient corelation between BOX-NB and NHOX-NH with total soil nitrogen (4).
The lowest STN correlation was attained with NKCL and NNH_4 with 0.038 and 0.053 coefficient , respectively (table 3).
NKCL and NPHEN are water soluable nitrogen which showed a meaningful correlafion at level 1 with 0.714 coefficient (table 3). This way, NKCL and NNH_4 with 0.890 coefficient have a meaningful corelation at level 1 percent.
The organic form of nitrogen with potacial for oxidation, BOX-NB and NHOX-NH, have a very meaningful correlation at level of one percent with 0.915 coefficient (table 3).
Inall, the highest coefficient corelation in the surveying soil is between STN and the forms of nitrogen related to BOX-NB with 0.872 coefficient , and the lowest one is related to NNH_4 with 0.038 coefficient (table 3). The water soluable forms of nitrogen , NNH_4 , NKCL , and NPHEN are more exposed to be rinsed because of dynamism and high dissolution(4).
The correation equations between nitrogen forms and soil qulities the simple linear regression and stepwise multi variable eqations are applyed to survey the relationship between nitrogen forms and physical and chemical qualities of the soil. The equations are preseated in table(3). The best equation among the simple equations waschose based on the high coefficient R^2 , and among the multi-variable equations waschose , based on the same coefficient and the meaning Fulness of indepandant variable of the equation.
Table 4. the simple and multi-variable Regression equation between nitrogen forms and some of the soil qualities.
The below meaningful relationship was attained between STN and the organic matter of soil (table 4):
STN=-966.00+1071.79(om)
R^2 =0.875, p
In equation [1],(OM) is the percent of organic matter of soil and STN is the Total nitrogen . the high expression coefficient of the equation and being meaningful indicate the good relationship between these two soil charactristics .yasrebi et al .also attained the same relationship with a high expression coefficient of0.957.(yasrebi 1382)(10).

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Table(4) Simple and multivariate regression equations between the nitrogen and other soil characteristics

There is meaningful relationship between NPHEN with PH and OM qualities but the below equation was attained utilizing both equation simultaneously(table4):

NPHEN=80.982-7.255(PH)-7.021(OM)

$$R^2 = 0.235(P < 0.001)$$

In this equation PH in suspension in 2 to1 for water soil ,OM indicates the percent of soil organic matter ,and NPHEN is one of the nitrogen forms defined in the tables . in the attained equation ,PH coefficient is negative which shows the reversed relation with the amount of soil organic matter;andthere is a direct relationship between the organic matter and nitrogen . it means that increasing the PH of the soil organic matter,the amount of soil nitrate decreases(3and4).

There is no meaningful relationship between NKCL of the soil with PH and OM charactristics(table4):

NKCL=75.536-6.763(PH)-3.646

$R^2 = 0.072(P < 0.001)$

In this equation , the expression coefficient of 0.072 was attained which was not a high one.

The next equation showed a good relationship with a high expression coefficient between NHSULN and organic matter and soil PH(table4).

NHSULN=1.942-4.232(PH)+29.703(OM)

$R^2 = 0.782(P < 0.0001)$

There is a meaningful relationship between just NHSULN and the soil organic matter ;but there is no meaningful relationship with PH. The expression coefficient in this equation was attained as 0.782.

NHOX-NH has a meaningful relationship whith soil OM(table4):

NHOX-NH=-30.473+41.232(OM)

$R^2 = 0.772(P < 0.001)$

As you see in equation [5],just NHOX-NH can have a meaningful relationshop with soil organic matter .a high expression coefficient of 0.772 was also attained.

But the below relation was acquired between BOX-NB and OM (table4):

BOX-NB=-39.480+50.118(OM)

$R^2 = 0.936(P < 0.001)$

You can see in equation [6]that three is agood and meaningful relationship between soil organic matter and BOX-NB which indicates that it has an oxidation potential as same as NHOX-NH.there is a meaningful relationship between nitrogen forms and soil organic matter in both equations[5]and[6].(4).

There is no meaningful relationship between $NNH_4$and organic matter and soil PH(table4):

$NNH_4 = 45.776 - 3.930(PH) - 1.615(OM)$

$R^2 = 0.749(P < 0.001)$

The last equation is between NAOHNB and the soil organic matter and ph (table4):

NAOHNB=-38.379+1.927(PH)+21.813(OM)

$R^2 = 0.749(P < 0.001)$

You can see that there is no meaningful relationship between this form of nitrogen and soil organic matter.

Surveying equations [1]to[8], it can concluded that equations[4],[6],and [8]are the best ones to sjow the relationship between nitrogen forms (except the total nitrogen)and soil qualities .among themequation [6]has a high expression coefficient and chooses as the best equation ,so using these equations, especially equation[6].you can measure the nitrogen forms from the features like om and ph ,with a high correctness.

Conclusion:

The result of this study can be expressed this way :

1.The nitrogen forms distribution in planting limy soils in Lorestan province is a below:

BOX-NB>NHOX-NH>NHSULN>NAOHNB>NKCL>NNH_4>NPHEN

2.Thehighest relative amount of nitrogen forms in the surveying soils is related to NHOX-NH and BOX-NB,forms with oxidation ability using alkalicand acidic permanganate and is respectively ,5.19and 4.56percent,and the lowest amount is related to dissolution forms like NPHEN, with 0.95percent.

3.The highest coefficient correlation in the studying soils is between STN and the soil nitrogen in the form of BOX-NB with a coefficient of 0.872,and the lowest one is related to $NNH_4$with a coefficient of 0.038.

4.The attained equations between soil total nitrogen and organic matter OMand BOX –Nband OM has a high expression coefficient:

STN=-966.00+1071.79(OM)

$R^2 = 0.875(P < 0.001)$

BOX-NB=-3948+50.118(OM)

$R^2 = 0.936(P < 0.001)$

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Finding the Best Location for Building a Dike: A Case Study of Bardsir Watershed

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***Abstract*—** The choice of a suitable place for building a dam in watersheds is a recurring subject in any dam-building project. The current study focuses on selecting the best possible place for building a dike in Bardsir watershed. Topography and the map of waterways were made ready and drainages, secondary drainages, waterways and other graphical data were shown in the map using Auto cad software. Two locations are considered for building the dike out of which one is chosen based on height-area and height-volume diagrams. In this project, features of watershed are identified and the choice of location is made based on whether or not behind-the-dike lake has the least area and the most volume. The height also mattered in this case.

***Keywords*—** dike, watershed, topography, level of waterway.

I. Introduction

DAM design and construction as a complex and age-old activity has long been practiced by societies. From an economic point of view, it is an important economic source in any country. Dam engineering can be defined as a set of basic and technical sciences working together to design and construct a dam. Dikes are made using earthen or riprapped materials often in trapezoidal forms with mild slopes. In other words, dikes are certain kind of dams that are constructed with natural materials such as soil, stone and gravel without having any kind of natural or non-natural cohesive materials, in a way that the power needed to tolerate water leakage is achieved solely through materials density. Watertight cores of such dikes or their bodies prevent the permeation and leakage. Although permeation control is impossible in the case of dikes constructed by gravels, upper slope or the degree of the tolerance can be minimized; i.e. the slope of earthen dikes can be minimized to 1:2-3.5 while this number for gravel dikes can be minimized to 5.1:1-2.

II. Choice of Location

Any dike has its own specific preparation site and building location that provide the necessary technical and practical needs. Therefore, suitability keeps a balance between physical and natural features of a dam and its main purposes. There are some factors that affect this balance, some of which are mentioned below:

a. Topographic details and reservoir level;
b. Foundation conditions and tectonic and geotechnical features;
c. Hydrology and sedimentation;
d. The place of spillage;
e. Available dike materials;
f. Detouring river;
g. Caulking reservoir and stability of the walls;
h. Suitable transportation; and
i. Environmental consequences.

III. Hydrological Data

The purpose of these calculations was to find the suitable place for dike construction for Bardsir watershed. Having determined watershed boundaries, levels of waterways were introduced and features like watershed area, pattern, form, bifurcation ratio, density, circularity ratio, elongation ratio, form factor ratio, equivalent rectangle, etc. were calculated. Based on topographic lines and achieved terms, some locations were finally selected as the available options for dike location. After calculating the amount of water which may gather behind the dikes, area-height and volume-surface diagrams were drawn so that the best location could be chosen.

IV. Watershed Specifications

Following information was obtained from the map:

Map scale: 1:25000

The length of the main river (here also considered as the length of the watershed): 10137.13 m

Area: 66239162.132 m^2

As to the area, watersheds are divided into three main types: small watershed having an area of less than 100 square kilometers, medium watersheds having an area of 100 to 1000 square kilometers and big watersheds having an area of 1000 square kilometers. The watershed studied in this research has an area of 66.24 which classes it in the category of small

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watersheds.

Perimeter: 43903.9372 m

Watershed perimeter refers to dividing line between neighboring watersheds and its unit is kilometer or mile. The perimeter of the studied watershed is 43.9030 kilometers. Longitudinal distance to the center of gravity (L_ca) is defined in this way: any watershed has a center of gravity which is placed either in the main river or out of the main river. As for the watershed studied in this research, the distance to the center of gravity is:

Lca =8815.5299 m

Calculations

In this watershed, in the upstream there is young river, in the midstream there is complete river and in the downstream there is old river. If the sum length of all the rivers and waterways is calculated and divided by watershed area, the result would be the river net density. Coefficient of density for this watershed is:

A=66.24 Km2

$$\mu = \frac{\sum_{1}^{n} l_i}{A} = \frac{676.9510892}{66.2391620132} = 10.22 \frac{Km}{km^2}$$

Bifurcation model of river network in this watershed was arboraceous. Each stream beginning from the heights is called order 1 river. When two order 1 rivers join together, they form an order 2 river, and so on. In this watershed, bifurcations are tree-like. Bifurcation ratio is used to determine the effect of river branching on flood hydrograph. Here, bifurcation ratio is:

$$BR = \left(\frac{n_1}{n_2} + \frac{n_2}{n_3} + \frac{n_3}{n_4} + \dots + \frac{n_{i-1}}{n_i}\right)\frac{1}{i-1} = 5.21$$

Density coefficient, also known as Gravilios coefficient, is the ratio of watershed perimeter to a hypothetical perimeter whose area is equal to watershed area. In this watershed, density coefficient is:

$$c = \frac{0.28P}{\sqrt{A}} = \frac{0.28 \times 43903/9372}{\sqrt{66239162/0132}} = 1.51$$

In any watershed, the product of main river length and distance to the center of gravity to the power of 0.3 will be form factor ratio. Form factor for this watershed is:

L_i=(L.L_ca)^0.3=(6.3 mile×5.48mile)^0.3=2/89

Circularity ratio is the ratio of watershed area to the area of circle having the same perimeter as the watershed. Here, circularity ratio is:

R_c=1/C^2 =1/〖1/51〗^2 =0/438

Enlongation ratio is the ratio of diameter of a circle of the same area as the watershed to the watershed length:

R_e=2/L_m

(A/π)^0.5=2/(10137/137)(((66239162/0132)/0132)/3.14)^0.5=0/906

As to the shape, watersheds are often compared with a rectangle which is referred to as equivalent rectangle. Equivalent rectangle shows a watershed whose shape can be molded to be like a rectangle without its area being changed. Here, equivalent rectangle is:

L= (C√A+√(C^2 A-1.2544A))/1.12=18332/29m

B= (C√A-√(C^2 A-1.2544A))/1.12=3613/25m

B=A/L=(66239162/0132)/(18332/29)=3613/25m

Showing graphical information on the maps using Auto cad

Topography and the map of regional waterways were made available by Kerman Regional Water Organization. These maps are presented in figures 2 and 3.

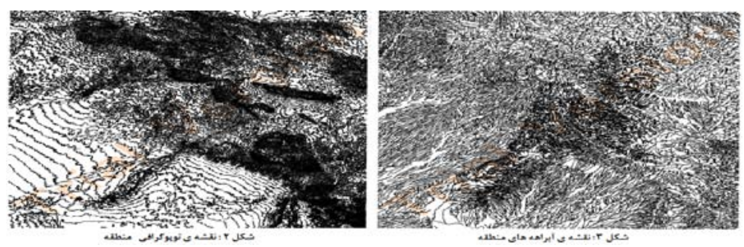

Fig.2 and 3

As illustrated in Fig. 2, waterways are tree-like, meaning that this watershed is the best location for building a dike. The main watershed is specified based on summits in the region and order 1 rivers. The order of other rivers will then be determined (Fig. 4, 5). In Fig. 5, different orders are shown with different colors.

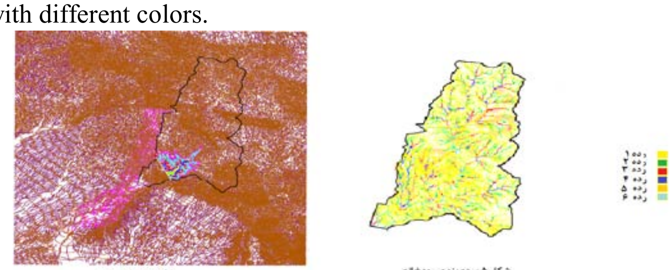

Fig.4 and 5

Software helps us to find the number and length of each waterway and provides hydrological information on the watershed. Figures 7 and 8 show reservoir level and spillways which are illustrated according to topography, neighboring rivers and the nearest watershed. The area of reservoir 1 is 631174.37 square meters and the area of reservoir 2 is

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863453.2605 square meters.

Topographic height	Height difference	(Aggregate) Area	Volume	Area
		0		0
2220	20	905.5024	9055.024	905.5024
2240	20	18758.1837	187581.837	17852.68
2260	20	154195.1317	1532896.293	135436.9
2280	20	378164.9293	3594067.456	223969.8
2300	20	863453.2605	7092581.288	485288.3
			12416181.9	

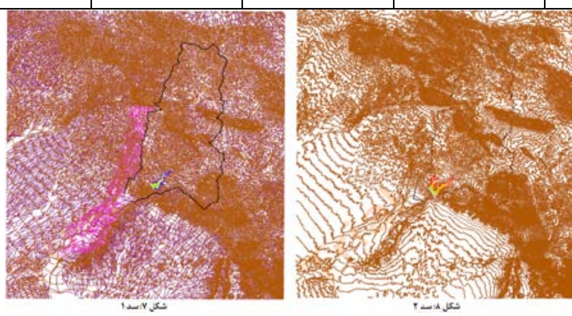

Fig.7 and 8

Information related to both dikes is given in the following two tables.

Table 1: Information about area and volume of dike 1

Table 2: Information about area and volume of dike 2

Topographic height	Height difference	(Aggregate) Area	Volume	Area
		0		0
2260	20	4222.0986	42220.986	4222.099
2280	20	50637.4099	506374.099	46415.31
2300	20	201269.4331	1970473.345	150632
2320	20	631174.3744	5805369.645	429904.9
			8324438.075	

Using above tables, surface-height and volume-height diagrams is drawn for each dike based on which we can select a suitable location for building a dike. Diagrams related to dike 1 are presented in figures 11, 12 and 13 and those related to dike 2 are shown in figures 14, 15 and 16.

Dike 1

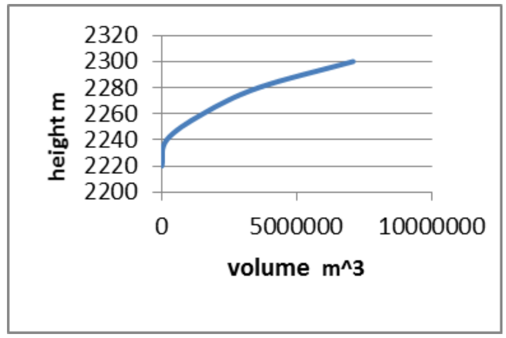

Fig. 11: Height-volume diagram for dike 1

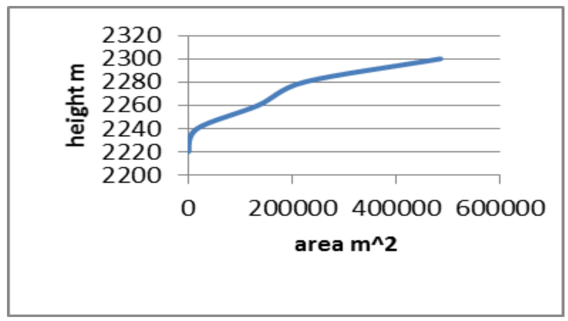

Fig. 12: Height-area diagram for dike 1

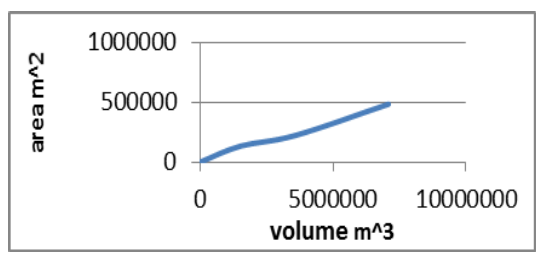

Fig. 13: Area-volume diagram for dike 1

Dike 2

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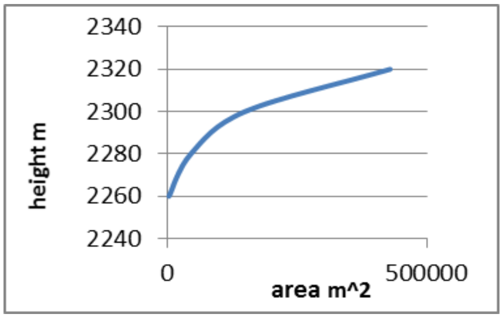

Fig. 14: Area-height diagram for dike 2

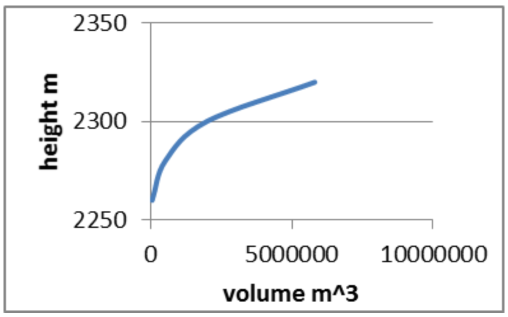

Fig 15: Volume-xheight diagram for dike 2

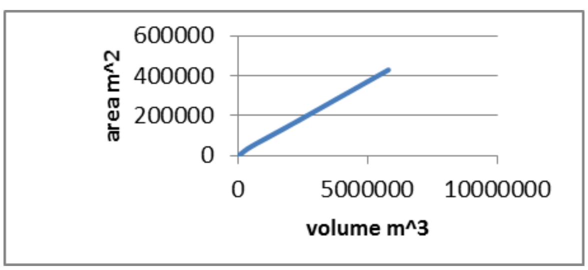

Fig. 16: Area-volume diagram for dike 2

Dike Dimensions

Crest width is achieved using equations of big dikes:

$$B = 1.65(H + 1.5)^\wedge(1/3)$$

	Length (m)	**Crest width (m)**	**Slope of upper hillside**	**Slope of down hillside**
Dike 1	704	7.153	01:03	01:03
Dike 2	870	7.153	01:03	01:03

V. Conclusion

Based on diagrams shown in previous section, it was concluded that location of dike 2 was a better one. However, both locations could be possible options because at the height of 80 meters, dike 2 had area of 450000 square meters and volume of about 6000000 cubic meters. At the same height, the area of dike 1 was approximately 250000 square meters and its volume was 4000000 cubic meters. Out of the options, a dike with less amount of area and more volume is opted for.

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Per Capita Consumption of Urban Water Using an Experimental Model (Case Study: Rooydar City)

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Abstract— One of the factors resulting in an increase in world population and a decrease in death rate is access to fresh and clean water. Besides human life, the lives of all living things and advances in agriculture and industry which results in a better life for people, is dependent on water. Therefore, it is necessary to consider ways for supplying water to the increasing population in cities. It is also recommended to choose places for new cities and towns, having in mind their need for fresh water. The need for water is an important factor in designing Water Utilities. In the current paper, using an experimental model, we try to calculate the per capita water consumption in Hormozgan, Iran.

Keywords— per capita consumption, water needs, experimental model, watering.

I. Introduction

WATER has been respected and adored by many nations around the world. Probably, the Persian chose the first two letters of their alphabet (/alef/ and /be/ which forms /āb/, the Persian equivalent for water) for water because of this respect. Humans have been depending water since the beginning of time. Supplying fresh and clean water is the first requirement for civilization. Water has had a special position in people's thoughts as the staff of life. Based on evidence, the first civilizations were formed besides water currents.

Basically, designs and studies concerning urban utilities (including water supply and sewer systems, …) are done based on some assumptions and criteria, called assumptions and criteria of the plan. Fundmentals of the plan include existing and effective factors and realities and their changing trends in plan's period, such as the population covered, determination of water consumption, and … . The assumptions include standards mostly chosen for hydraulic, and structural, etc. calculations. In the first stage of modification and development of urban water network in Rooydar, fundamentals of the plan have been chosen based on the existing information (current population, amount of water consumed) and future predictions; the criteria have been chosen considering the experiences gained in installations of other cities and globally credited references in this matter and making them compatible to the Rooydar's conditions (from economic, social, cultural viewpoints and efficient equipments and human resources).

II. Different Uses of Water

The amount of water being consumed by consumers from different locations is called water consumption.

Also, the water required by consumers which is determined based on factors like the type of activity, level of expectations, economic conditions, development, and people's education level, is called water demand.

The water consumption can be divided into five categories:

1. Domestic usage
2. Public usage
3. Industrial and mercantile usage
4. Public green places usage
5. Water loss

A. Domestic usage

This includes drinking, cooking, washing, hygienic use, conditioner equipment, domestic green space, etc. The daily average consumption for the above mentioned uses for each person is called the domestic per capita consumption.

B. Public and office use

This includes water consumption in offices and public organizations, medical and educational centers, religious places, bathrooms, arts and sports centers, fire departments, etc. Daily average consumption for the above mentioned for each person is called the average per capita of the public and office.

C. Industrial and commercial use

This includes water consumption in industrial and commercial units. The daily average consumption for the above mentioned for each person is called the industrial and commercial per capita.

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D. Public green space consumption

This includes water consumption in parks, green spaces and public areas.

E. Water loss

Difference between the input water for the network and the aggregate consumption of water, leaking through pumping stations, tanks (water storages), main pipes, secondary pipes, faucets, connections, which cannot be used anymore, and illegal consumptions, etc. is called water loss.

III. Prediction of Per capita Consumption of Water in Rooydar City

Estimating the required water for years to come in a city, considering the development and extension of the city, is done having the following factors in mind:

- Changes in peoples' habits
- Improvements in the level of peoples' lives and culture
- Improvements in hygienic equipment over time
- Having a water distribution system with chemical and bacteriological quality and enough water pressure
- Having an efficient sewer system
- Building new public places, industrial sites, and green places in the stages of construction
- The distributions having excusive counters
- All the facilities including production, transfer, refinement and distribution, being equipped with gauges
- Having a strong staff, along with integrated and organized formations

In most of developed countries, standards for water consumptions has been made available; adaptation of which in our country is not practical because of huge differences of social and cultural status between Iran and industrial countries. Because of this, the ministry of energy, has made efforts to standardize some branches of water industry in Iran in several fields, which is a big step towards making progress in civil plans in Iran.

Fundamental studies are of great importance in planning water supply systems, results of which play an important role in designing different parts of the system. There is no doubt that reaching the goal of the plan, which is providing fresh and clean water for consumers, and creating a natural and healthy environment from a social point of view, after the designing process is done, large investments are made for executing the plans. Therefore, it is necessary to do the preliminary studies in order for the investments to be based on accurate research and for the plan to pay back the expected benefits in time, and so that before the investments dry out, there would be no need for reinvestigations.

One of the basic principles in water supply system plans, is estimating the required water. Because of this, the interdependence of different parts of the plan requires this part to be considered from different viewpoints. Therefore, in order to discover the relationship between the per capita consumption from previous years using existing statistics and information, and the years to come, no sole approach is used, but different approaches have been examined and the most acceptable one is introduced as the base. There is a standard called the per capita usage of water which is used by most of water industry advisors in Iran.

Dependence of water consumption to different variable, has made it difficult to provide general instructions.

The location of each area is one of main variables determining the amount of water consumption. Weather conditions, existence of tourists' sites, good salaries and high level of culture, are among effective factors in increasing water consumption.

Another factor, which should be considered when estimating per capita consumption of water, is forming a per capita from the different water consumption sources such as domestic, public, green places, etc., the contribution of which changes based on geographical and economic conditions of cities. Based on the above mentioned, the numbers recommended by different books, each contain specific situations, and complete each other. In this section, we provide the use for each of the consumption categories mentioned above.

Table (1) Maximum per capita consumption recommended for cities in Iran

Type of city based on population	Population (x1000)	Per capita use (liters per person)		
		Cold regions	Temperate regions	Warm regions
Small cities	Less than 50	175	200	225
Medium cities	50 to 500	200	230	260
Large cities	More than 500	225	260	295

Based on Iran's regional divisions from the publication 3 – 117, Rooydar city has the characteristics of a desert. Therefore, it has a dry and desert-like weather. As a result, maximum per capita consumption recommended by the regulation, assuming that it is a warm region most of the year, would be 225 liters per each person in one day.

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The mentioned numbers in the table above, show the gross domestic consumption, and include domestic, mercantile, industrial, water loss, and consumptions related to urban green places. In the standard by Iran water industry no 3-117, for domestic consumption, 75 to 150 liters per person for one day is recommended.

IV.

V. Plan Period

Plan period, which is one of important basics of designing water distribution network in a city is, by definition, the period of time between operation of the facilities to the point when conditions and requirements of the plan are a base for the system plan, therefore, the capacity of the plan will be able to provide for its need in this period. The basics for this period, depends on the nature of the plan, conditions, variations and extension of needs. As of the urban water supply systems, determining the duration is not the same in different parts, therefore, providing a number in general and for all the water and sewer systems is not possible. However, considering the conditions in Iran, we can suppose 20 to 40 years as the base.

Of the factors influencing the determination of the plan, we can mention the below items:

Economic examination, lifetime of main components of the system along with considering quality of operation and the possibility of providing the necessary accessories, the trend of population growth, city extension plans and development approaches.

In order to determine the plan period, some rules and conditions can be utilized which are as follows:

Using the plan criteria, standards in water industry of Iran, utilizing accredited references, specificities of the plan, water distribution network of Rooydar city, in relation to plan period and city extension areas.

VI. The Experimantal Model

One of popular approaches for computing domestic per capita consumption, is the experimental model using Capone formula:

$$Q = Kp^{0.125}$$

In this formula:

Q = per capita consumption (liters per person)

P = population (x1000)

K = coefficient depending on per capita usage and population in previous years

K can be calculated inserting the per capita usage and population from previous years in the formula. Therefore, the amount of K related to Rooydar is estimated considering the experiences of water consumption in the past and its population and using these data, per capita consumption in the future will be estimated. Existence of enough experiences from previous years, makes the K coefficient more accurate. Table 2 shows the calculation of average K considering consumers statistics from 1383 to 1386, and Table 3 shows domestic consumption based on average K and Capone approach during the years of the plan period.

Table (2) the amount of K coefficient using Capone approach during past years

Kave	K	Domestic Per capita (Lpcd)	Population (persons)	Year
98	132.6	164	5471	1383
	81	100	5570	1384
	108	134	5672	1385
	88	110	5800	1386
	80.4	204	6085	1388

Table (3) domestic Per Capita consumption when average K = 98 using Capone approach in plan period

Domestic per capita (Lpcd)	Population (persons)	Year
124.28	6242	1389
124.56	6408	1390
125.96	7335	1395
127.36	8325	1400
128.76	9285	1405
130.16	10300	1410
135.87	11555	1415

VII. Per Capita Consumption of Rooydar City

Finally, the general consumption of Rooydar city is

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estimated using obtained values from the plan, and is provided in Table 4.

Table (4) per capita water consumption of Rooydar during the plan period

Type of use Year	Domestic (Lpcd)	Public and office (Lpcd)	Industrial and commercial (Lpcd)	Percent of loss	Loss (Lpcd)	Total (Lpcd)
۱۳۸۹	۲۸/۱۲۴	۱۰/۱۸	۵/۱۸	۳۰	۴۰	/۵۳ ۱۸۱
۱۳۹۰	۵۶/۱۲۴	۱۰/۳۶	۵/۳۶	۳۰	۲۶/۲	۱۶۸/۳
۱۳۹۵	۹۶/۱۲۵	۱۱/۳۶	۶/۲۶	۱۹/۶	۲۷/۲	۱۷۱/۶
۱۴۰۰	۳۶/۱۲۷	۱۲/۱۶	۷/۱۶	۱۹/۲	۲۷/۵	/۸۴ ۱۷۴
۱۴۰۵	۷۶/۱۲۸	۱۳/۰۶	۸/۰۶	۱۸/۸	/۷۵ ۲۷	/۰۶ ۱۷۸
۱۴۱۰	/۶ ۱۳۰	۱۳/۹۶	۸/۹۶	۱۸/۴	/۹۵ ۲۷	/۲۵ ۱۸۱
۱۴۱۵	۸۷/۱۳۵	۱۵	۱۰	۱۵	/۱۳ ۲۴	۱۸۵

Total per capita consumption of Rooydar between 1390 and 1395

Type of use Year	Domestic (Lpcd)	Public and office(Lpcd)	Industrial and commercial (Lpcd)	Percent of loss	Loss (Lpcd)	Total (Lpcd)
۱۳۹۰	۱۲٤.٥٦	۱۰.۳٦	٥.۳٦	۳۰.۰۰	۲٦.۲۰	۱٦۸.۳۰
۱۳۹۱	۱۲٤.۸٤	۱۰.٥٦	٥.٥٤	۲۷.۹۲	۳۹.۳٥	۱۸۰.۲۹
۱۳۹۲	۱۲٥.۱۲	۱۰.۷٦	٥.۷۲	۲٥.۸٤	۳٦.٥۹	۱۷۸.۱۹
۱۳۹۳	۱۲٥.٤۰	۱۰.۹٦	٥.۹۰	۲۳.۷٦	۳۳.۸۰	۱۷٦.۰٦
۱۳۹۴	۱۲٥.٦۸	۱۱.۱٦	٦.۰۸	۲۱.٦۸	۳۰.۹۹	۱۷۳.۹۱
۱۳۹۵	۱۲٥.۹٦	۱۱.۳٦	٦.۲٦	۱۹.٦۰	۲۷.۲۰	۱۷۱.٦۰

Table (5) a comparison between department of energy standard per capita and recommended values for Rooydar in 1415

Order	Per capita consumption Type of consumption	The standard of per capita usage from Iran water industry			Regu.ation	Capone approach
		Minimum	Average	Maximum		
۱	Domestic	۷۵	/۵ ۱۱۲	۱۵۰	–	۱۳۵/۸۷
۲	Public and office	۱۰	۱۵	۲۰	–	۱۵
۳	Industrial and commer	۱۵	۳۰	۴۵	–	۱۰

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	cial					
	Domestic green space	۴=۲۵ ۸× ۱/۶	۲۷/۵ ۴= ۱۱× ۱/۶	۴=۳۵ ۱۴× ۱/۶	–	–
۴	Sum of losses	۱۲۵	۱۸۵	۲۵۰	–	۱۶۰/۸۷
	Losses	۱۲/۵ %۱۰=	/۷۵ =۲۷ %۱۵	۲۰=۵۰ %	–	%۱۵
	Total	/۵ ۱۳۷	/۷۵ ۲۱۲	۳۰۰	۲۲۵	۱۸۵

VIII. Conclusions

Results shown in Tables 4 and 5 indicate that the water consumption of Rooydar city in the 1415 plan, considering the obtained statistics and department of energy standard average value is 185 liters per person which is more acceptable considering the other values in table 5 and weather condition in the area.

It is worth mentioning that if water consumption trend would continue as it is now, the consumption in future years would be far more than what is provided in Table 4, which asks for network management and monitoring, replacement of old pipes, modifications in distribution network, and continuous exploitation. Therefore, finally, the advisory engineers, considering aridity and the need for management of water consumption in the network, along with the negotiations with the respected employer, the amount of per capita consumption for each person was calculated as 185 liters in Rooydar city.

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