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Investigating the affecting factors on the fate of Polycyclic Aromatic Hydrocarbons (PAHs) in the Jajrood River of Southern Tehran

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Abstract— this study surveyed the critical factors in having an impact on the fate of the hydrocarbons in Jajrood River. The river originates from Alborz Mountains and after passing through Varamin city, flows into Salt Lake and is a major source of water in South of Tehran province. Aromatic hydrocarbons of natural and unnatural sources such as combustion of fossil fuel discharge to the river and cause negative impacts on the agricultural crops in the area. Five stations were selected along the river and four series of samples had been taken. The concentration of 16 polycyclic aromatic hydrocarbons (PAHs), all of the United States Environmental Protection Agency (US EPA) priority pollutant list, was analyzed by GC-FID. The results of modeling with AQUATOX model indicate increase concentrations of petroleum hydrocarbons in spring. It has been appeared that the fate of PAHs depends on factors like water flows out of segment, degradation of hydrocarbons into lighter compounds or adsorption to sediment particles. Also, the results show that Benzo[a]pyrene, which is a carcinogen and a hazardous compound has the highest concentration among PAHs.

***Keywords*—** Jajrood River, water pollution, polycyclic aromatic hydrocarbons, factor, AQUATOX model

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1 INTRODUCTION

Polycyclic aromatic hydrocarbons (PAHs) are a group of the lipophilic organic compounds which are formed from two or more fused aromatic rings; and these are usually introduced into the environment due to the activities of humans. From the hundreds of PAHs specified till date, the United States Environmental Protection Agency (EPA) has presented sixteen compounds, namely as priority toxic pollutants (Tolosa et al; 2004). These compounds have the probability of being carcinogenic and mutagenic and are indentified as being hazardous for the health of humanity and living creatures (Tam et al; 2001).

Vehicles, the leakage of gasoil, gasoline, improper burial of industrial sewage in refineries, the petrochemical industry, paint industry, occurrences taking place in pipelines transferring crude oil or tankers transporting petroleum and chemical materials, including the use of fossil fuels, can be accounted for capacitating the entrance of a main source of hydrocarbons into the living environment.

One of the critical challenges in conserving and or restoring water resources, is having an appropriate understanding, as to the connection between chemical compounds and the physical environment, as well as the creatures that live within it. Due to seasonal and annual changes in ecosystems, including numerous interactions between species, ecosystems are complicated systems (Park et al; 2009).

Awareness as to procedural changes and predictions in relative to the qualitative potentials of the waters of rivers in the future, with due attention to the plans and programming of urban, cropping and industrial water, scopes to visualize the probable problems in the future, including their central planning is attained. The objective of the current studies is to specify and determine the amount of PAHs in the water, sediment of the river bed and simulating the behavior of the PAHs pollutants in the water, in addition to investigating the

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fate of these pollutants in the environment, within a passage of time and in the various stations. Agricultural chemicals can contaminate surface water resources by runoff into streams and lakes or by the lateral movement of chemicals through unsaturated or saturated soil media to bodies of surface water (Shirmohammadi and Knisel, 1994).
According to Ahmadi (2011), the AQUATOX model indicated that the existing period of diazinon in the Tajan River could have severe undesired effects on the river fauna, Especially upon the benthic invertebrates and fish. McKnight et al. 2012 modelling results indicate that TCE contaminant does not pose a significant risk to either human or ecological receptors.

Rashleigh et al 2009 worked on polychlorinated biphenyls (PCBs) in the Twelvemile Creek Arm of Lake Hartwell, South Carolina, USA; and The model demonstrated that contaminated labile detritus loaded to the system was incorporated into the foodweb rather than deposited, thereby maintaining the PCB concentrations in fish while concentrations in the sediment declined. A dominant PCB pathway was from detritus to daphnia to shad to largemouth bass.

2 MATERIALS AND METHODS

Five stations were selected in the Jajrood River and drainage of southern Tehran (fig. 1).
Samplings were performed in the months of January, February, May and July 2012.The extraction of PAHs in the water samples was carried out by the Liquid-Liquid Extraction Method (LLE, EPA Method 3510). In order to measure the PAHs, the gas chromatography device of the GC-FID Model (Agilent 7890A) with split/split-less injection techniques, the Flame Ionization Detector (FID) and capillary columns where the EPA Method 8015C was utilized.
AQUATOX is a simulation model for aquatic systems. AQUATOX predicts the fate of various pollutants, such as nutrients and organic chemicals, and their effects on the ecosystem, including fish, invertebrates, and aquatic plants. AQUATOX is a valuable tool for ecologists, biologists, water quality modelers, and anyone involved in performing ecological risk assessments for aquatic ecosystems (Yang, 2012).

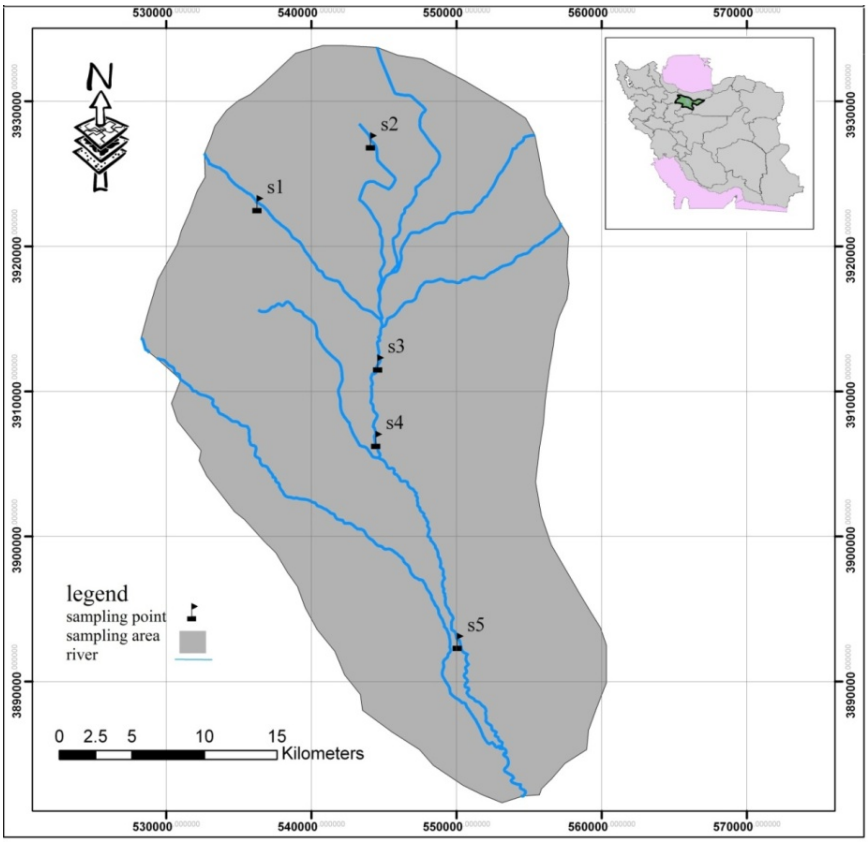

Figure 1- study area, south area of Tehran, Jajrood river

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III. RESULTS AND DISCUSSION

The levels of PAHs concentration and physicochemical Properties in the Jajrood River that were used as input to the AQUATOX model are shown in Table1. Hydrocarbons are organic pollutants with varied natural and anthropogenic resources. Due to the admission of a point and nonpoint source in the surroundings of the area of admission, throughout the five stations, a diverse procedure was observed in each of the stations. But the general procedure throughout the course of the river was a reduction in the concentration of hydrocarbons of petroleum in the water in Station No. 1 till Station No. 5.

Table 1- PAHs concentrations (microgram/liter)

July	May	February	January	
5.108858	4.096359	0.927906	0.686572	1
1.813824	1.938934	3.513685	0.686297	2
1.063445	1.112193	0.448753	0.360091	3
0.305587	0.189184	0.304146	0.252275	4
0.683871	0.217999	0.352145	0.139599	5

With due respect to the results of the simulation performed, the occurrence of the maximum polluting concentration of hydrocarbon has been predicted to be in the season of spring. In the months of February till May, which is the season for abundance in the Jajrood River water, it has the greatest percentage of PAHs present in the water. This increment can be due to the utilization of a larger number of heating appliances and fossil fuels in the cold months of the year and the immense traffic on the roads.

According to the AQUATOX model results, some of the parameters can be effective for the fate of PAHs. Some of them are discussed in the following:

2.1 Water retention time

The water flow and the retention time of pollutants in water is one of the factors affecting the fate of PAHs in the study area. Water flow causes contaminants to transfer, decomposition, aeration and increase the performance of microorganisms to break down the compounds. In Station No. 5, the flow rate is very low and remove the pollutant by water flow is impossible.

2.2 Degradation of polycyclic aromatic hydrocarbons

Analysis time to 50% (half-lives, DT50s) and time to 95% chemical loss (DT95s), independently in bottom sediment and in the water column, Can be measured by the AQUATOX model. Figure 2, is indicated the time required for Degradation of aromatic hydrocarbons. The Water retention time, DT50 and DT95 are showed in station no.4. It is observed that before the time required for degradation PAHs, Water comes out of the study segment. Because of the agricultural use in the study area, so the probability of Entering hydrocarbons before degradation, in soil and uptake by crops and livestock increases.

2.3 Sedimentation

One of the factors which reduce pollutants in water is sedimentation. Polycyclic aromatic hydrocarbons are a group of the lipophilic and hydrophobic organic compounds and Tend to stick to the surfaces and the particles. In the present study According to The measured and simulated results, sedimentation was recognized as one of the most important factors for reducing water pollution. Sedimentation depends on the flow rate of water at each segment.

With the high water velocity in the stations, the sedimentation has the least impact. But the Station No. 5, Water flow rate is reduced and the retention time on the water is increased, so Hydrocarbon concentrations in water, due to absorption by sediment, are reduced.

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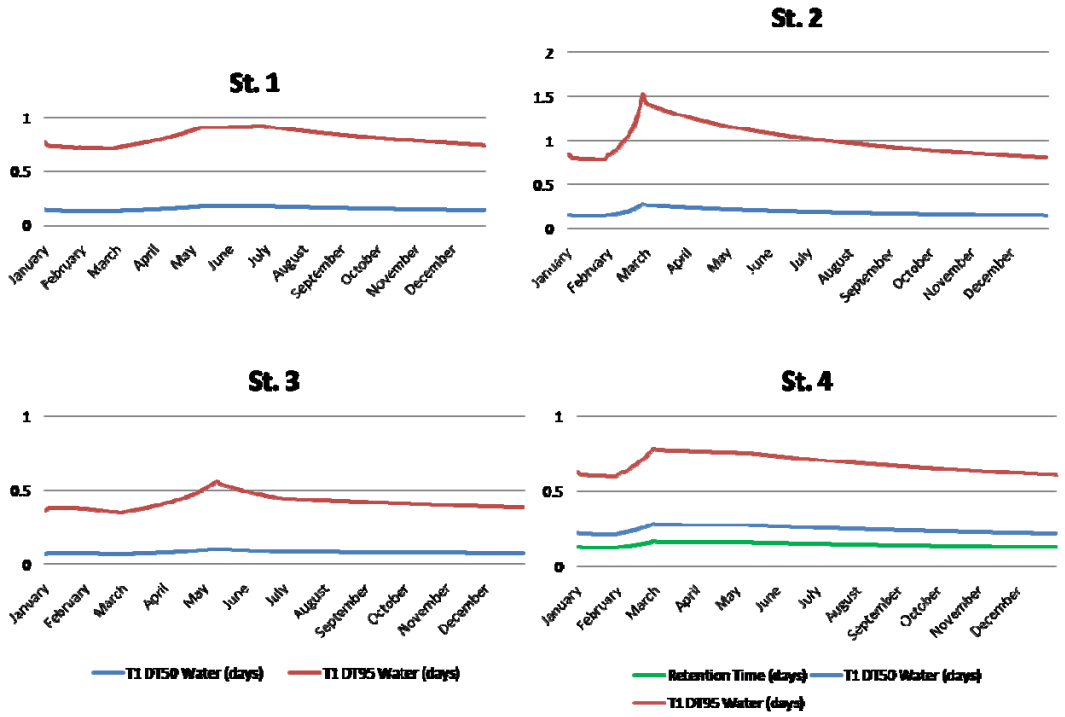

Figure2 - Comparison the results of 50 and 95 percent degradation and Retention time of the sampling stations

IV. CONCLUSIONS

The concentration of a number of 16 PAH compounds were measured by utilizing the GC-FID device for each station and simulation was performed with the Aquatox Model. In surveying the results which came to hand, the maximum mean concentration of the entire PAHs measured are relative to Station No. 1 in the fourth sampling *i.e.* 5.1 microgram per liter. The minimum concentration on an average is in relevance with Station No. 5 in the first sampling *i.e.*0.13 microgram per liter. The minimum amount of hydrocarbons measured were in the months of January, whereas, the maximum concentration of hydrocarbon pollution was measured in the months of July. The maximum concentration in the sampling stations was relevant to B[a]P Compounds, which are carcinogenic and mutagenic compositions for mankind and living creatures. The simulation of the fate of compounds displays the fact that, in the spring season, concentrations of PAHs increase.

Of the most critical factors in having an impact on the fate of the hydrocarbons is the discharge and its retention time in the region, the analysis of components and sedimentation. Though, in some of the stations, the most important factor is the intensity of discharge and in some, absorption due to sedimentation. Researches performed in the case of the impact of the intensity of the flow rate of runoffs on the concentration of hydrocarbons compounds, is indicated by the displacement of compounds due to the intensity of the rate of discharge (Hoffman, 1982).

The absorption by particles and sedimentation, are factors having impacts in the fate of petroleum hydrocarbons, which have been disclosed in the research performed by (Bathi et al; 2012). They came to this conclusion that the maximum PAH concentrations are in particles of minute circumference, which are displaced by the discharge and runoffs. In utilizing this water for cropping purposes, attention must be paid to the fact that, due to some of the components of polycyclic aromatic hydrocarbons, these are carcinogenic for mankind, such as B[a]P and their absorption by plants and soil. Therefore, a greater attention should be given to this aspect. The specification of the increment and decrement procedures of pollution concentrations, which have been simulated by the model, can determine the hazardous period and factors having an impact on this can prove beneficial, as to the management of the basin.

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