

Investigation of Polycyclic Aromatic Hydrocarbons (PAH) Pollution in Pazarsuyu Stream (Giresun, Turkey)

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Abstract: This study covers the investigation of Polycyclic Aromatic Hydrocarbons (PAHs) pollution in Pazarsuyu Stream which is located in East-Black Sea Basin. 14 PAHs analyzes were performed on water samples taken from a station on the Pazarsuyu Stream every month, covering the period of February 2017 - December 2017. The results of PAH analysis were evaluated according to annual average and maximum values of PAH parameters given in Water Quality Regulation. The results of the analysis showed that PAHs values change periodically, especially the amount of PAH increases in rainy periods. According to the results, it was seen that 5 PAH parameters (benzo (b) floranten, benzo (k) floranten, benzo (a) piren, benzo (g,h,i) perilen ve indeno piren) among 14 PAH parameters, exceeded the annual mean values given in Water Quality Regulation.

Keywords: Chromatography, PAH, Pazarsuyu Stream, Water Quality.

INTRODUCTION

Water is an essential part of all living things. The quality of water is important for human health and also for the environment. However, urbanization and technological developments adversely effects the water quality. Water can be easily contaminated with chemical and microbial contaminants through different ways. Among the pollutants, polycyclic aromatic hydrocarbons (PAHs) are a group of xenobiotic chemicals contains carbon and hydrogen in their structure. They have two or more fused benzene rings with different arrangements. The structural configurations of benzene ring diverse the physical, chemical and toxicological characteristics of PAHs. They have high boiling and melting points and low vapor pressure. The water solubility of PAHs is very low.

The main source of PAH pollution is anthropogenic activities. However, natural incomplete combustion can also cause the release of PAH into the environment. Besides water, PAHs can be found in soil, sediment, air, rain water, street dust, urban runoffs and even food. PAHs are generally carcinogenic, teratogenic and mutagenic. Exposure to high levels of PAHs can cause lung, bladder, skin cancers and also immunosuppressive effects^[1-4]. Thus, the investigation of water quality according to PAHs pollution is very important.

The main objective of this study is to investigate the distribution and seasonal variation of fifteen PAH parameters in Pazarsuyu Stream which has a potential to be used as a drinking water resource in Giresun.

MATERIAL&METHODS

Pazarsuyu Stream is located in the provincial district of Bulancak-Giresun in East-Black Sea Basin (Figure 1). A yearly average water potential of Pazarsuyu stream is 542 hm³ and the flow rate is 46 m³ s⁻¹. Pazarsuyu is formed by the merging of the waters of the Karagöl and Yürüz regions and ends up to the black sea from the west of Bulancak. It has a length of 80 km and 19 km of the stream is within the province of Giresun, and 4 km of the stream within the district of Bulancak. The stream is generally used for drinking water, agricultural and irrigation purposes. Pazarsuyu stream is open to pollution due to human activities (domestic waste waters and solid wastes), agricultural (pesticides and fertilizers) and industrial activities (mining activities)^[5].

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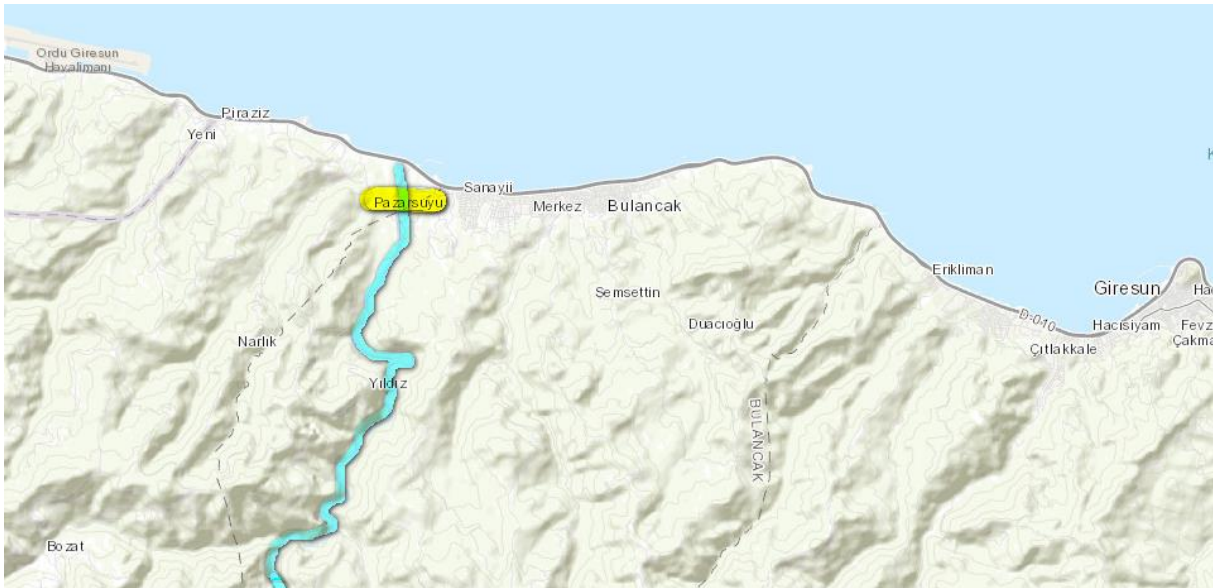


Figure 1. Pazarısu Stream, Giresun, Turkey (<https://www.arcgis.com/home/webmap/viewer.html>)

Water samples were collected from Pazarısu Stream at one station every month over the period from February 2017 to December 2017. The samples were collected in 1 L amber glass bottles. Bottles were sealed tightly, stored in a cooler at 4°C and transported to the DSI Water Analysis Laboratory in accordance with “Standard Methods 1060 Collection and Preservation of Samples”^[6]. Water samples were extracted using a solid phase extraction (SPE) system according to the established procedures in EPA 550.1^[7]. The chromatographic analysis of PAH was done by using high performance liquid chromatography (HPLC) (Agilent, USA) with Agilent Zorbax Eclipse PAH column (4.6x100 mm, 3.5 µm)^[8]. The operating conditions of HPLC were given in Table 1.

Table 1. The operation conditions of HPLC

Model	HPLC 1200	
Dedector	UV: ex:270nm – Em:330nm Floresans:254-360nm	
Column Temperature	30 °C	
Retention Time (RT)	Naphthalene	2,835
	Acenaphthylene	4,464
	Fluorene	4,738
	Phenanthrene	5,481
	Fluoranthene	7,234
	Pyrene	7,880
	Chrysene	11,067
	Benzo[b]fluoranthene	13,239
	Benzo[k]fluoranthene	14,306
	Benzo[a]pyrene	15,073
	Benzo[g,h,i]perylene	17,316
	Indeno pyrene	18,086
Flow Rate	2.000 mL/min	
Mobile phase	Pure water and acetonitrile	

RESULTS&DISCUSSIONS

Analysis of 14 PAH parameters has been conducted during experimental period and the minimum, maximum values and standard deviation of analysis results were listed in Table 2.

Table 2. The minimum and maximum PAH values, corresponding annual average values given in Turkish Surface Water Quality Regulation

PAH parameters	Annual Average Values (µg/L)	Pazarsuyu Stream			
		Min Value (µg/L)	Max Value (µg/L)	Average Value (µg/L)	Standard Deviation
Naphthalene	2	n.d.	0,1321	0,0415	0,0609
Acenaphthylene	6	n.d.	0,0068	0,0054	0,0021
Fluorene	3,4	n.d.	0,0038	0,0023	0,0016
Phenanthrene	1,4	n.d.	0,0076	0,0031	0,0035
Fluoranthene	0,0063	n.d.	0,0020	0,0014	0,0008
Pyrene	0,1	n.d.	0,0026	0,0016	0,0009
Benzo(a)luoranthene	0,1	n.d.	0,0008	0,0006	0,0002
Chrysene	1,9	n.d.	0,0012	0,0009	0,0003
Benzo(e)pyrene	0,6	n.d.	0,0028	0,0017	0,0016
Benzo(b)fluoranthene	0	n.d.	0,0016	0,0010	0,0005
Benzo(k)fluoranthene	0	n.d.	0,0007	0,0007	-
Benzo(a)pyrene	0,00017	n.d.	0,0010	0,0008	0,0003
Benzo(g,h,i)perylene	0	n.d.	0,0021	0,0014	0,0010
Indeno pyrene	0	n.d.	0,0013	0,0009	0,0004

n.d. not detected

The results were evaluated according to the annual average PAHs values given in Turkish Surface Water Quality Regulation^[9] (Table 1). The single PAHs concentrations ranged from not detected to 0,1321 µg L-1. It was determined that 5 PAH parameters were above the limit values given in the Turkish regulation. Especially, the annual average values for benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene and indeno pyrene, were set to zero concentration.

The seasonal change in PAH concentrations was also given in Figure 2. It was seen that PAH concentrations was high at mainly rainy seasons.

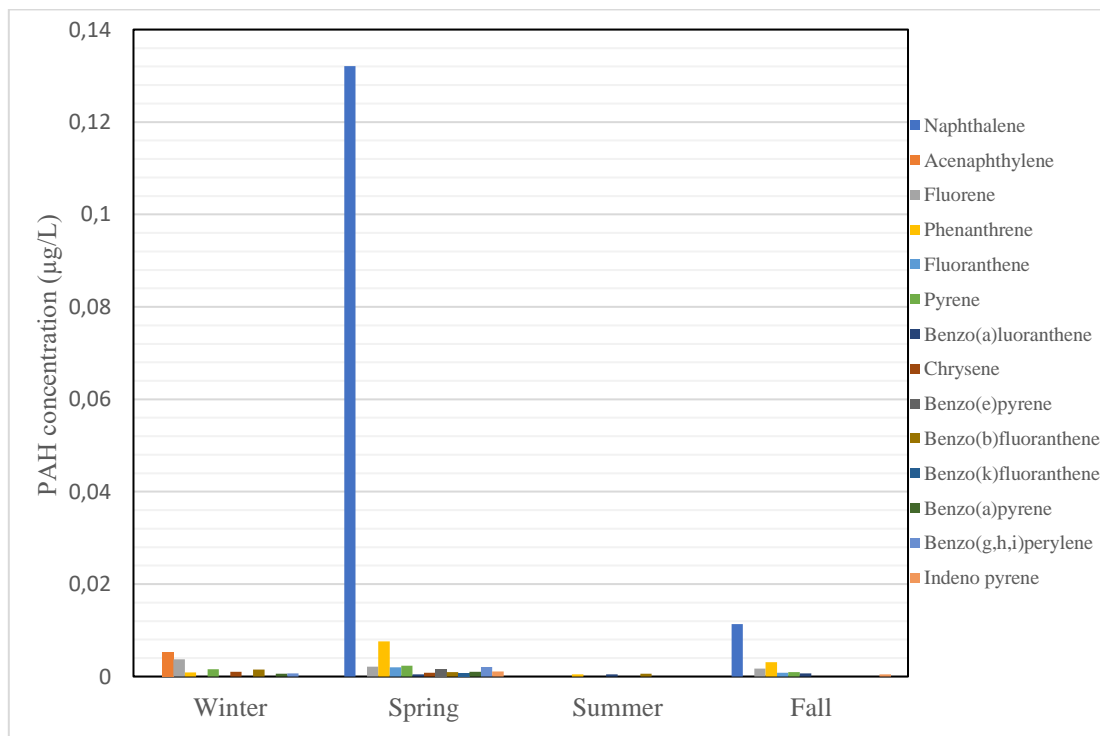


Figure 2. Seasonal change in PAH concentrations

CONCLUSION

Polycyclic aromatic hydrocarbons (PAHs) are large and multi-ring aromatic hydrocarbons that can accumulate in air and soil and mix to the surface water through rain water. The PAHs pollution in Pazarsuyu Stream was investigated in this study. Pazarsuyu stream is generally used for drinking water, agricultural and irrigation purposes. It is open to pollution due to human activities (domestic waste waters and solid wastes), agricultural (pesticides and fertilizers) and industrial activities (mining activities). The analyses of 14 PAH parameters were conducted during experimental studies. The results were evaluated according to Water Quality Regulation and it was detected that 5 parameters (benzo (b) floranten, benzo (k) floranten, benzo (a) piren, benzo (g,h,i) perilen ve indeno piren) exceeded the limit values given in the standards. The results showed that PAHs values increases in rainy period. The high PAHs concentrations in rainy seasons indicates the transportation of contaminants from soil/air environment into the surface water by rainfall.

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