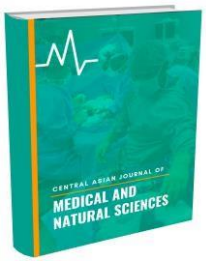

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Article

Investigation of Possible Pollution by Some Trace Elements and Some Environmental Factors in Water of the Euphrates River in Suq Al Shioukh Southern Iraq

Hasanain Ali Al-Kinani[1]

1. Department of Pathological Analytics Science, College of Applied Medical Science, Shatrah University, Thi-Qar, 64001, Iraq

* Correspondence: hasanainali@shu.edu.iq

Abstract: The present study was conducted in the Suq Al Shioukh district, southeast of Thi Qar Province, Iraq. The study area is located within an agricultural area whose population greatly depends on the river water for their various uses, so it is expected that the river water will be polluted by agricultural activities and domestic waste water nearby. Therefore, the study aimed to investigate the levels of possible mineral pollution with some trace elements and some physicochemical factors in the water quality of the Euphrates River in the study area and to obtain useful recommendations that help improve the water quality of the river and its use for agricultural and domestic purposes. The levels of mineral pollution trace elements using the Flame Atomic Absorption Spectrophotometer in the river's water were investigated. The study recorded an increase in the values of cadmium, lead, and zinc during the summer and copper during the spring in the waters of the Euphrates River, exceeding the permissible limits when compared with international and Iraqi standards and for all study stations. The concentrations of the Cd element ranged from 0.64 to 4.64 mg/L, while Pb recorded concentrations between 0.15 and 3.98 mg/L, Cu ranged from 0.82 to 4.14 mg/L, and Zn reached values ranging from 3.67 to 30.82 mg/L. Other factors, such as sewage, Al-Masab Alamm water, and climatic factors, also contribute to the pollution of the river's water through some physical and chemical factors. The study also showed turbidity values high above the permissible limits, ranging from 10.6 to 22.45 NTU. As for the pH, they tended to have a light alkalinity; their values ranged from 7.12 to 8.73, EC values ranged from 7421 to 16520 µS/cm, and TDS recorded values of 3920 to 10320 mg/L. It was also found that the water is salty in the stations studied, as the salinity values ranged from 11.62 to 31.75 ppt. The CL values ranged between 210 and 370 mg/L, while SO_4 recorded values between 260 and 581 mg/L, and PO_4 values ranged between 0.08 and 1.31 mg/L.

Keywords: Al-Masab Alamm, Euphrates River, Suq Al Shioukh, Trace Elements

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1. Introduction

Environmentalists defined water pollution as the increase in the values of chemical, physical, or biological pollutants at a concentration or in a way that makes water harmful to humans, living organisms, or property [1]. Many studies in different places on the rivers of Iraq have shown a difference in the hydrological factors of those rivers, including the Euphrates River [2, 3, 4].

It is one of the main rivers in Iraq, and due to the lack of environmental and health awareness and the lack of water drainage networks in these areas, waste from agricultural and domestic activities is thrown directly into the river, causing its pollution through high

concentrations of trace elements found in pesticides, fertilizers, plant waste and concentrations of salts that contain organic materials and chemical nutrients. It plays a role in increasing the degree of river pollution through the eutrophication process carried out by some aquatic plants and the negative effects resulting from it. Pathological microorganisms are also a source of infection for the inhabitants of these areas as a result of their use of polluted river water.

Water pollution is evidence of pollution of the aquatic environment, and water sources available for drinking and domestic purposes should have a high degree of purity and the absence of chemical pollutants and microorganisms [5]. Water pollution by trace elements is one of the most important problems all over the world because most of them have toxic effects on living organisms [6], and some of them are harmful and dangerous even in their low concentrations because they are not biodegradable, so they remain stuck or partially dissolved in the water column and enter the body through food, air, or polluted water and accumulate in it over time, causing various damage to the organism [7].

The increase in the concentrations of some trace elements or environmental factors resulting from chemical and environmentally hazardous toxins, the significant expansion of the use of agricultural pesticides and insecticides, as well as plant fertilizers, disinfectants, sterilization materials and the waste of untreated domestic and industrial, to pollute water sources, especially rivers, streams, canals, and inland lakes, and the occurrence of a change in water quality that is less suitable for specific uses, whether drinking or domestic use, irrigation of crops, or others [1] and [8].

[9] showed the extent of the influence of industrial activities represented by the waste of the wool textile factory on the water quality of the Euphrates River at the center of the city of Nasiriyah.

[10] explained the attention to the water quality of the Euphrates River and the investigation of pollution levels by conducting continuous monitoring of the discharge of sewage and agricultural waste because of their impact on human life and other living organisms. The nature and quantity of pollutants resulting from agricultural activities and poor wastewater treatment released to the river are the reason for increasing the degree of pollution of river water to be unsuitable for various uses. So, the present study investigates the potential mineral pollution caused by trace elements in the Suq Al Shioukh district, influenced by agricultural and domestic activities, and aimed to identify physical and chemical environmental factors that contribute to river water pollution. The Novelty of this study stated an increase in the values of cadmium, lead, and zinc during the summer and copper during the spring in the water of the Euphrates. The results for those elements exhibited high level when compared with international and Iraqi standards for all study stations in related studies.

The recommendations for improving water quality and enhancing the use of the river for agricultural and domestic purposes in the region.

2. Materials and Methods

Sample Collection

The samples were collected from three stations (Station1: 30°58'04.2"N 46°20'33.3"E, Station 2: 30°56'17.9"N 46°24'40.0"E, Station 3: 30°54'45.1"N 46°28'20.6"E) in the study region at Suq Al Shioukh district, southeast of Thi Qar Province, Iraq (Fig. 1). Using clean 5 liter polyethylene bottles, from summer 2023 to spring 2024, with three repeaters for each station and at a depth of about 20 cm below the surface of the water to collect water samples for physical and chemical tests, and the necessary information was recorded on each bottle. Clean 1-liter polyethylene bottles were also used in the same way to collect water samples for measuring trace elements.

Digestion and Estimation of Trace Elements

The water samples were completely digested according to the method described in [11] by taking 100 ml per sample in a 250 ml volumetric flask, evaporating the solution at a temperature of 70 °C on a hot plate to pre-dry, and then adding 0.5 N of HCl of ion-free water and leaving the solution to complete dissolution. The final volume was completed to 25 ml with ion-free distilled water. The trace element ions in the digested water samples were estimated using the flame atomic absorption spectrophotometer, and the output was expressed in mg/L units.

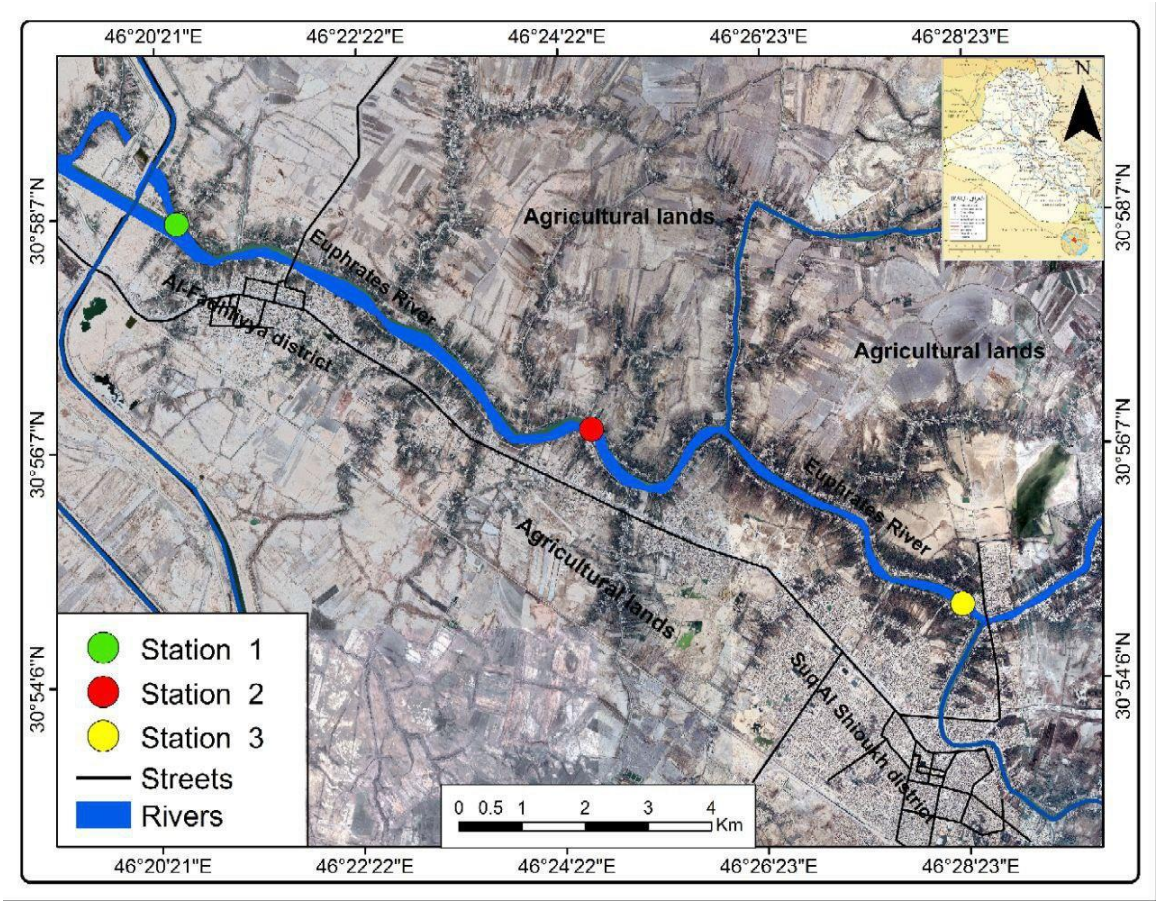

Figure 1. The three study stations on the Euphrates River within Suq Al Shioukh district, southeast of Thi-Qar Province, Iraq. green circle: station 1; red circle: station 2; yellow circle: station 3

Physical and chemical properties

Air and water temperature: The air and water temperatures at the station were measured using a mercury thermometer at 0-100 degrees.

Turbidity: The turbidity was estimated using the turbidity meter and with nephlometric turbidity unit (NTU).

Electrical Conductivity, Total Dissolved Salt, and Salinity: Water samples were measured after being transported directly from the study stations to the laboratory using a Hanna-type device and expressed by measuring Electrical Conductivity (E.C) by μS/cm unit, Total Dissolved Salt (TDS) by mg/L unit, and salinity by ppt unit.

pH: The pH values at the station were estimated using a pH meter according to the method described by [12].

Chloride Cl: The chlorine concentrations in the water samples of the study stations were estimated at mg/L, according to [11].

Sulfates SO_4: Sulfates were measured in mg/L units according to [11] and using a spectrophotometer with a wavelength of 420 nm.

Phosphate PO_4: The phosphate concentration was estimated in mg/L units according to [11] and using a spectrophotometer with a wavelength of 885 nm.

3. Results and Discussion

Trace Elements in Water

Trace elements are one of the most important pollutants harmful to the aquatic environment, as they have harmful effects on human health and living organisms present in aquatic and terrestrial ecosystems, in addition to affecting the characteristics of the ecosystem itself [13].These harmful effects of trace elements are due to their extreme toxicity, being non-biodegradable, possessing a long biological half-life, and having the ability to bioaccumulate in different parts of the organism's body [14]. The ingress of trace element concentrations above the acceptable limits into the body of the organism causes intoxication to combine these elements with biomolecules in the body, such as proteins and enzymes, and the production of toxic compounds, whose destruction disrupts their functioning [6].Human and agricultural activities constantly increase the amount of trace elements in the aquatic environment, which are able to circulate and move between water layers, reach all levels of the food chain of environmental products, bioaccumulate in them, and transfer their danger to all consumers, including humans [15].

The study recorded an increase in the values of cadmium, lead, and zinc during the summer and copper during the spring in the waters of the Euphrates River. (Table 1). When comparing the results with international and Iraqi standards, they exceeded the acceptable limits, and for all study stations, see (Table 2). This increase can be attributed to the impact of agricultural activities and the excessive use of agricultural pesticides and fertilizers, which play an important role in water pollution as they contain concentrations of trace elements that are released directly into the river water [16], or because factory waste and wastewater are thrown into the river from its source to reach the study area and the pollutants it contains are rich in some trace elements to reach the surface water [17]. This is explained by the results of the study by [18] on the water of the Tigris River in the city of Mosul.

[9] explained that the factors of erosion and weathering of adjacent agricultural soils, in addition to the decomposition of dead aquatic plants and organic matter due to the activity of microorganisms, play an important role in increasing the concentration of elements in the aquatic environment.

Table 1. Seasonal values of trace elements in the water of the Euphrates River with highest, lowest, and total values by mg/L units from summer 2023 to spring 2024

Seasons	Sta.	Cd	Pb	Cu	Zn
Summer					
	1	1.75	2.41	2.81	17.72
	2	3.85	3.98	2.75	25.91
	3	4.64	3.73	3.11	30.82
Autumn					
	1	0.84	0.92	3.14	3.67
	2	1.06	0.94	2.05	6.48
	3	1.29	1.32	2.22	6.73
Winter					

	1	0.88	0.15	2.07	4.21
	2	0.64	0.28	1.93	8.17
	3	1.21	1.84	1.82	10.53
Spring					
	1	2.25	1.31	3.14	10.22
	2	3.52	2.44	3.61	18.32
	3	3.93	2.76	2.87	17.85
Values					
Highest value		4.64	3.98	3.61	30.82
Lowest value		0.64	0.15	1.82	3.67
Total value		2.15	1.84	2.62	13.38

As [19] showed, the high temperature during the summer and the resulting evaporation of water and increased concentrations of salts may cause an increase in the concentration of trace elements. As for the decrease in the values of the trace elements cadmium, lead, and copper during the winter and the element zinc during the autumn, it may be due to the role of important physical and chemical properties in changing the concentrations of trace elements in water [20].

Table 2. Comparison of the concentrations of trace elements in the water of the Euphrates River at the study stations with international and Iraqi standards according to [21] by mg/L unit

This study (total metals) by (mg/L) unit		**Drinking Water Standards [22] (mg/L) unit**	**Iraqi standard specifications for drinking water [23] (mg/L) unit**	**Drinking Water Standards, [21] (mg/L) unit**
Cd	2.15	0.005	0.003	0.003
Pb	1.84	0.015	0.01	0.01
Cu	2.62	1.3	1.0	2.0
Zn	13.38	5.0	3.0	5.0

The decrease in water temperature, pH value, increased salinity, lack of depth, changes in viscosity values, electrical conductivity, and other factors, as well as the high-water levels, which increase the dilution factor of water and reduce the concentrations of these elements in the aquatic environment, this explains the decline during the winter and autumn [24] and [25]. This agreed with [19] and [26] and did not agree with the results of [1] and [27]. The decrease in the concentration of some trace elements due to their removal by adsorption on suspended substances, sedimentation, or consumption by aquatic organisms [28].

The results of this study in the water of the Euphrates River were also compared with the results of other studies conducted on different water bodies, as shown in (Table 3).

Table 3. Comparison of the concentrations of trace elements in the water of the Euphrates River with other studies and rivers

River	Cd	Pb	Cu	Zn	Reference
Al-Gharraf	0.34	10.27	-	36.6	[29]
Abu-Zariq Marsh	0.21	1.60	0.52	5.41	[30]
Al-Masab Alamm	0.05	0.35	0.03	12.12	[31]
Euphrates	2.10	0.142	-	12.75	[32]
Bani-Hassan stream	0.06	2.45	0.51	-	[1]
Euphrates	2.60	13.15	1.88	13.87	[9]
Irrigation project of Tuz Khurmatu	0.047-0.001	0.21 -0.026	0.27-0.008	0.098-0.022	[20]
Euphrates	1.23	1.75	0.81	1.71	[33]
Tigris	-	3.77 -0.22	-	1.163 -0.443	[18]
Euphrates	2.15	1.84	2.62	13.38	Present study

Physical and Chemical Factors

The present study recorded, over the seasons of the year, significant changes in some physical and chemical factors of the water of the Euphrates River. Due to agricultural and domestic activities, sewage, as well as Al-Masab Alamm water, which affect the quality of river water and aquatic organisms, seasonal values of physical factors in the water of the Euphrates (Table 4 and Table 5) show seasonal values of chemical factors in river water. This was proved by comparing the results with international and Iraqi standard specifications (Table 6).

Air and Water Temperature

The air temperature recorded its lowest values at the first station during the winter and its highest values in the summer at the third station, while the water temperature recorded its lowest values at the first station in the winter and its highest values at the third station during the summer.It is noted that the water temperature follows the air temperature; the reason may be due to the time of sample collection or it may be due to the climate difference during the study seasons, and this is what characterizes the climate of Iraq as being hot and dry in summer and cold and rainy in winter, and this is consistent with [34] and [27].

Turbidity

There is an increase in turbidity values above the acceptable limits in all study stations and for all seasons. It may be due to rains that wash the soil and release industrial and agricultural waste and discharge it to the river, or because of the temperature that increases evaporation and increases the turbidity of water, or due to the speed of the Euphrates river flow in the season of water releases [9], and this is consistent with [27], when

he showed that the values of turbidity in summer are higher than in autumn and did not agree with [10].

Electrical Conductivity

The highest values of electrical conductivity were recorded above the acceptable limits at all stations and for all seasons, as the highest values were recorded at the first station during the summer and the lowest values during the winter at the second station. Its increase may be due to the pollution of the river with up to water and soil residues from agricultural activities containing large amounts of pesticides, fertilizers, and salts [24], or it may be due to the influence of the discharges of adjacent Al-Masab Alamm water containing high salt concentrations [27].The decrease in values during winter may be due to precipitation, which increases the water level and is influenced by the dilution factor [19].This agreed with [10] and did not agree with [35] and [26].

Table 4. The seasonal values of physical factors in the water of the Euphrates River, with the highest, lowest, and total values from summer 2023 to spring 2024

Seasons	Sta.	Air Tem.	Water Tem.	Turbidity	E.C
		C^0	C^0	NTU	µS /cm
Summer					
	1	43.5	29.6	18.14	16520
	2	47.0	32.3	16.67	14610
	3	48.5	33.1	22.45	15170
Autumn					
	1	32.7	19.5	11.2	13110
	2	32.0	21.0	10.6	9935
	3	34.2	23.6	11.1	10373
Winter					
	1	11.0	9.4	16.41	8930
	2	13.5	11.5	10.62	7421
	3	16.7	15.1	11.85	8813
Spring					
	1	32.0	25.0	19.43	14113
	2	37.0	26.7	13.77	13130
	3	37.2	28.2	18.85	14700
Values					
Highest value		48.5	33.1	22.45	16520
Lowest value		11.0	9.4	10.6	7421
Total value		32.13	21.99	15.09	12235.4

pH

The pH values were towards alkalinity at all stations, which is a characteristic feature of Iraqi water [19]. PH values are a reflection of life activities and events in the water, as well as the impact of other environmental pollutants. The highest values were recorded during the spring and the lowest during the summer. The reason for the rise in large amounts of pesticides, fertilizers, and agricultural residues reaching the river after washing the soil by rain or the water of the agricultural land at the study stations may be due to the activity and flowering of aquatic plants during the spring [36]. As for the decrease

in summer, it may be due to higher temperatures that increase the activity of microorganisms and, consequently, an increase in the decomposition of organic substances and the production of HCO3 acid, causing a decrease in pH values [37], this was agreed with [27] and did not agree with the study [19].

Total Dissolved Salt and Salinity

The salinity recorded the highest salinity values at the first station during the spring and its lowest values at the second station during the winter, while the total dissolved substances recorded the highest values during the summer at the first station and the lowest value in the winter at the second station. It may increase due to the subtraction of agricultural and industrial activities [9]. or due to the waters of the adjacent Al-Masab Alamm, which have high salt concentrations [27], or may be due to the high temperature directly proportional to the concentration of salts [38]. As for the decrease during the winter season, it may be due to precipitation, which increases the water level and is influenced by the mitigation factor, or to a lack of evaporation [19]. These results are consistent with [1] and does not agree with the results of [26].

Chloride

Chloride values increased in most stations, reaching the highest value in the third station during the winter and the lowest value in the second station during the summer. Pollution by chloride comes from multiple sources, including the dissolution of organic and inorganic salts, or from the water of trocars and irrigation of agricultural soils in the agricultural season and increasing the water levels of the Al-Masab Alamm, which contains large concentrations of fertilizers and agricultural pesticides, most of which are in the form of salts of chlorides and sulfates, or from excretions resulting from industrial activities and wastewater [9]. These results agreed with Mohammed (2018) and did not agree with [39] and [10].

Table 5. The seasonal values of chemical factors in the water of the Euphrates River, with the highest, lowest, and total values from summer 2023 to spring 2024

Seasons	Sta.	pH	Salinity	TDS	Cl	SO_4	PO_4
			ppt	mg/L	mg/L	mg/L	mg/L
Summer							
	1	7.13	31.24	10320	246	423	0,26
	2	7.23	29.18	9375	210	538	0.87
	3	7.12	27.44	9403	227	581	1.31
Autumn							
	1	8.43	27.22	5173	260	380	0.3
	2	8.15	25.51	4483	260	401	0.08
	3	7.92	23.76	5120	292	460	0.72
Winter							
	1	8.41	14.78	4131	270	260	0.11
	2	7.92	11.62	3920	310	318	0.26
	3	8.33	16.01	5182	370	311	0.67
Spring							
	1	7.62	31.75	8110	230	460	0.66
	2	8.21	30.82	8050	255	481	0.82
	3	8.73	27.92	9100	280	477	1.02

Highest value	8.73	31.75	10320	370	581	**1.31**
Lowest value	7.12	11.62	3920	210	260	**0.08**
Total value	7.93	24.77	6863.92	267.5	424.16	**0.59**

Sulfate

The highest value was recorded at the third station during the summer and the lowest value at the first station during the winter, and the reason for the increase may be due to the impact of large flows of water from the Masab Alamm, which are loaded with agricultural pollutants from pesticides and fertilizers containing sulfur compounds. While the decrease may be due to the dilution factor that reduces the concentration of sulfates in the river water. These results agreed with [34] and did not agree with the results of [27].

Phosphate

High phosphate values are observed in most of the study stations, as the highest value was recorded at the third station during the summer and the lowest value at the second station in the autumn. A significant increase in effective phosphate values was recorded throughout the year. This may be due to the impact of trocars containing phosphate fertilizer residues that are thrown into the river, or it may be due to sewage containing phosphates. Microorganisms work on the analysis of organic substances and the liberation of nutrients, including phosphate compounds. Also, the increase in water temperature leads to an increase in the evaporation processes of water and then an increase in the concentrations of many salts, including phosphate compounds. As for the low values of phosphates in water, this may be due to their consumption by aquatic plants as well as their absorption from the soil and the lack of release of these substances from sediments. These results agreed with [34] and [19] and did not agree with [24].

Table 6. Comparison of physical and chemical factors in the water of the Euphrates River at the study stations with international and Iraqi standards according to (WOH, 2006)

This study (total values)		**Drinking Water Standards [22]**	**Iraqi standard specifications for drinking water [23]**	**WOH Drinking Water Standards, [21]**
Air Tem. C^0	32.13	-	-	-
Water em.C^0	21.99	-	-	-
Turbidity NTU	15.09	<5	5	<5
EC µS /cm	12235	-	-	-
pH	7.93	6.5-8.5	6.5-8.5	6.5-8.5
Salinity ppt	24.77	-	-	-
TDS mg/L	6864	500	1000	1000
Cl mg/L	267.5	250	250	250
SO_4 mg/L	424.16	250	250	250
PO_4 mg/L	0.59	-	-	0.4

4. Conclusion

The results of the present study showed that waste from agricultural activities, trocar water, sewage, and Al-Masab Alamm water are the main sources of excessive values of trace elements in river water and high salt concentrations, plant fertilizers, pesticides, and pathological microorganisms would increase the degree of pollution in river water that exceeds the acceptable limits set by international and Iraqi water standards. The water at all study stations becomes unsafe for use in agriculture and households due to pollution.

Water quality varies due to a variety of environmental factors, including high temperatures, turbidity, pH, and water level changes. Since pollutants flow along riverbeds and because agricultural and domestic pollution originate from similar sources, the amounts of trace elements in riverbeds tend to be similar. Rising river water levels can also improve water quality and remove pollutants through mitigation. Excessive use of agricultural fertilizers, pesticides, and chemicals should be limited, and their access to river waters should be prevented. Conducting advanced treatments for trocar water, Al-Masab Alamm, and untreated wastewater before being released to the river, and working on training competent cadres to ensure the operation of the treatment system is good. The work on cleaning the environment surrounding the two sides of the river by the relevant authorities through lifting mud loads and organic residues proved their contribution to affecting the characteristics of river water, especially when rains fall.

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