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Surface Water Pollution from Urban and Industrial Waste – A Case Study of the Lumbardhi River Flow, Prizren (Kosovo)

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ABSTRACT

Surface water pollution is mainly due to large urbanization, agricultural waste and discharges of production. The purpose of this study was to evaluate the pollutant parameters of surface waters effluents contaminated by synthetic detergents and organic chemical substances. During the study, the following physico-chemical parameters were analyzed: phosphate ion (PO_4^{3-}), total phosphate (TP), sodium tripolyphosphate ($Na_5P_3O_{10}$), sodium perborate ($NaBO_3$ n H_2O), ammonium (NH_4^+), nitrate (NO^-_3.), nitrite (NO_2^-), water temp. (°C), and hydrogen ion concentration (pH). The correlation between the source water and the current level of pollution of this river was measured in four locations: (Prevalla L_1; Reqane L_2; City park L_3; Vlashnje L_4) along the surface course of the Lumbardhi River in Prizren. From the results of the study for both time periods, the chemical parameters values of phosphate ion (PO_4^{3-}) for May, 2022 according to monitoring of physico-chemical parameters in Lumbardhi River in Prizren were 0.01. The value of total phosphate (TP) was 0.002, for sodium tripolyphosphate ($Na_5P_3O_{10}$). The water quality of the Lumbardhi river directly depends on the amount of flows in the river. Poor quality of the water is more pronounced during the month of October, when the amount of flows in the river is smaller. Location (L_3) had higher pollution as a result of the discharge of urban sewage and city waste. Research has shown the presence of different forms of phosphorus that are higher in the (L_2 and L_3) locations.

Keywords: water, pollution, Lumbardhi river, ammonium (NH_4^+), Nitrate (NO^-_3.), total phosphate, Prizren.

INTRODUCTION

Human (anthropogenic) activities have increased because of demographic changes, consumer behavior, fast industrialization, and urbanization, as well as the rapidly growing population. Water resources are very important for human life, cultivated agricultural land, sustainability, human consumption, economic development and environmental systems (Akhetar et al. 2021). At the global level, over five billion inhabitants depend on underground and surface water, because people use these sources as drinking water, for housing, and in industrial production (Khatari et al. 2014; Akhetar et al. 2019).

Surface water occupies about 70% of the globe and it fills the oceans, lakes, rivers and all other points in the entire world. Human activity and industrial development have great impacts on the quality of surface waters and affect the introduction of pollutants of different origins into these waters (Pirsaheb et al. 2014).

Water resources are important factors for the economic and social development of the country. The destruction of water resources as a phenomenon can be caused by natural processes (geological factors, climate changes, water-rock interactions and by human activities (agricultural development, industry and urban waste), and by the presence of different chemicals (Nagraju et al. 2018), agricultural waste and urban horticulture (Balaj et al. 2022). The management of surface and underground waters as sources of their pollution remains a major environmental problem (Macdonal et al. 2002). Anthropogenic activities, natural rock/land phenomena, interact with water, affecting natural water cycles and water quality (Trabelsi et al. 2018).

In the hydrographic aspect, Kosovo is divided into 5 river basins: Drini i Bardhë, Ibri, Morava e Binça, Lepeneci and Pelgu Plave. The Republic of Kosovo has approached the EU's environmental standards and substantial progress has been made in the development of legislation related to environmental protection in general, including water protection. It is estimated that Kosovo has limited water reserves (MSPE, 2015). The rivers with the largest flow during the yearare in the Drini te Bardh Basin in the Dukagjin Plain (MESP/AMMK, 2010).

The impacts of untreated wastewater discharge have been analyzed in many studies regarding the impact of metals and pesticides on agriculture as well as human health worldwide (Singh et al. 2004), and the presence of different pharmaceutical compounds in freshwater systems in countries with low economic development (Bagnis et al. 2018).

The legislation dealing with the regulation of the water management sector in Kosovo consists of primary legislation and administrative instructions. The primary legislation consists of these basic laws such as Law No. 04/L-147 on the Waters of Kosovo. The purpose of this law is to ensure the sustainable development and use of water resources, which are essential for public health, environmental protection and socio-economic development of Kosovo, to ensure the protection of water resources from pollution, over-exploitation and misuse as well as to define the institutional framework for the administration of water resources accordance with the requirements of the Water Law of Kosovo, the Ministry of Environment and Spatial Planning. In cooperation with the competent authorities of the state administration has prepared, Draft National Water Strategy of the Republic of Kosovo.

MATERIAL AND METHODS

Study are

Location of this study was in region of Prizren in Republic of Kosovo. The study was conducted along the flow of the Lumbardhi river (Figure 1). The correlation between the source water and the current level of pollution of this river was measured in four locations: (Prevalla L_1; Reqane L_2; City park L_3; Vlashnje L_4) along the surface course of the Lumbardhi River in Prizren. During the study the following physico-chemical parameters were analyzed: phosphate ion (PO_4^{3-}), total phosphate (TP), sodium tripolyphosphate ($Na_5P_3O_{10}$), sodium perborate ($NaBO_3$ n H_2O), ammonium (NH_4^+), nitrate (NO_3^-), nitrite (NO_2^-), water temp. (°C), and hydrogen ion concentration (pH).

The monitoring of physico-chemical parameters was carried out in all samples of the location under study, in two time intervals during the months of May and October, in the year 2022.

Figure 1. Location of study, Lumbardhi river in Prizren, Kosovo, year study 2022

Table 1. Geographical data of locations (site samples) researched for the period May–October 2022

Location of study	Distance (km)	Geographical position	Longitude	Sea level (m)
Prevalla L_1	0 km	42° 16' N	20° 99' E	1946 m
Reqane L_2	11 km	42° 17' N	20° 62' E	822 m
City park L_3	24 km	42° 12' N	20° 43' E	403 m
Vlashnje L_4	30.5 km	42° 10' N	20° 31' E	401 m

The study was carried out in locations close to sources of surface water pollution, where there are two liquid detergent production industries and three agro-food industries as well as urban wastewater discharges.

The amount of precipitation, surface water flows in the Lumbardhi River of Prizren presented in Table 1, for m different periods of time represents: the minimum (Min), Average (Mes) and Maximum (Max) precipitation expressed in physical density or the Flow of water.

The amount of water flow and the volume of water is calculated according to the formula:

$$Q = V/t \quad (1)$$

where: Q – amount of water flow (m^3/s);
V – volume of water, (m^3);
t – water flow time (s).

The Lumbardhi River of Prizren is the left branch of the largest river in Kosovo Drini i Bardhe. The basin of this river has the following characteristics: the river basin has a total area of 264.13 km²; Length of the river L = 31.0 km; The highest point of the basin is at 2,540 m. The discharge point in the Drini i Bardhë river is at the quota around 295 m.

RESULTS AND DISCUSSION

The monitoring of physico-chemical parameters was carried out in all samples of the location under study, in two time intervals during the months of May and October, for year 2022, are presented in the following tables and figures.

Table 2 shows the values of phosphate ion (PO_4^{3-}) for May, 2022 according to monitoring of physico-chemical parameters in Lumbardhi River in Prizren, were 0,001. The value of total phosphate (TP) was 0.002, for sodium tripolyphosphate ($Na_5P_3O_{10}$) it was 0.00, while for Sodium perborate ($NaBO_3$ n H_2O) it amounted to 0.00. The measured values for ammonium (NH_4^+) were 0.00, nitrate 0,00 and for nitrite (NO_2^-) – 0.00. Water temperature and pH value at the measured location (L_1) were (5 °C and 7.5 pH).

Table 3 shows the values of phosphate ion (PO_4^{3-}) for May, 2022 according to monitoring of physico-chemical parameters in Lumbardhi River in Prizren, were 0,903. The value of total phosphate (TP) was 0.36, for sodium tripolyphosphate ($Na_5P_3O_{10}$) it amounted to 0.703, while for sodium perborate ($NaBO_3$ n H_2O) it was 0.36.

Table 2. Monitoring of physico-chemical parameters during the month of May, location Prevalla L_1

Physico-chemical parameters	Phosphate (PO_4^{3-})	Total phosphate (TP)	Sodium tripolyphosphate ($Na_5P_3O_{10}$)	Sodium perborate ($NaBO_3$ n H_2O)	Ammonium (NH_4^+)	Nitrate (NO^-_3.)	Nitrite (NO_2^-)	Water temp. (°C)	Hydrogen ion concentration (pH)
Value	0.001	0.001	0.00	0.00	0.00	0.00	0.00	5	7.5

Table 3. Monitoring of physico-chemical parameters during the month of May, location Prevalla L_2

Physico-chemical parameters	Phosphate (PO_4^{3-})	Total Phosphate (TP)	Sodium tripolyphosphate ($Na_5P_3O_{10}$)	Sodium perborate ($NaBO_3$ n H_2O)	Ammonium (NH_4^+)	Nitrate (NO^-_3.)	Nitrite (NO_2^-)	Water temp. (°C)	Hydrogen ion concentration (pH)
Value	0.903	0.36	0.703	0.38	0.721	1.89	0.59	10	7.4

Table 4. Monitoring of physico-chemical parameters during the month of May, location Prevalla L_3

Physico-chemical parameters	Phosphate (PO_4^{3-})	Total Phosphate (TP)	Sodium tripolyphosphate ($Na_5P_3O_{10}$)	Sodium perborate ($NaBO_3$ n H_2O)	Ammonium (NH_4^+)	Nitrate (NO^-_3.)	Nitrite (NO_2^-)	Water temp. (°C)	Hydrogen ion concentration (pH)
Value	1.902	0.38	0.903	0.36	1.112	4.89	0.538	16	8.14

The measured values for ammonium (NH_4^+) were 0.721, for nitrate 1.89 and for nitrite (NO_2-) –0.59. Water temperature and pH value at the measured location (L_2) were (10 °C and 7.4 pH).

Table 4 shows the values of phosphate ion (PO_4^{3-}) for May, 2022 according to monitoring of physico-chemical parameters in Lumbardhi River in Prizren, were 1.902 5. The value of total phosphate (TP) was 0.38, for sodium tripolyphosphate ($Na_5P_3O_{10}$) it equaled 0.903, while for sodium perborate ($NaBO_3$ n H_2O) it reached 0.36. The measured values for ammonium (NH_4^+) were 1.112, for nitrate 4.89 and for nitrite (NO_2-) – 0.538. Water temperature and pH value at the measured location (L_3) were (16 °C and 8.14 pH).

Table 5 shows the values of phosphate ion (PO_4^{3-}) for May, 2022 according to monitoring of physico-chemical parameters in Lumbardhi River in Prizren, were 0.015. The value of total phosphate (TP) was 0.323, for sodium tripolyphosphate ($Na_5P_3O_{10}$) it amounted to 0.215, while for Sodium perborate ($NaBO_3$ n H_2O) it reached 0.3323. The measured values for ammonium (NH_4^+) were 0.012, for nitrate 2.423 and for nitrite (NO_2-) – 0.00. Water temperature and pH value at the measured location (L_4) were (15 °C and 7.29 pH).

Table 6 shows the values of Phosphate ion (PO_4^{3-}) for october 2022 according to monitoring of physico-chemical parameters in Lumbardhi River in Prizren, were 0.002. The value of total phosphate (TP) was 0.011, for Sodium tripolyphosphate ($Na_5P_3O_{10}$) it amounted to 0.00, while for sodium perborate ($NaBO_3$ n H_2O) it equaled 0.00. The measured values for ammonium were (NH_4^+) 0.912, for Nitrate 0.99 and for Nitrite (NO_2-) – 0.321. Water temperature and pH value at the measured location (L_1) were (8.4 °C and 7.55 pH).

Table 7 shows the values of phosphate ion (PO_4^{3-}) for October, 2022 according to monitoring of physico-chemical parameters in Lumbardhi River in Prizren, were 0.188. The value of total phosphate (TP) was 0.181, for sodium tripolyphosphate ($Na_5P_3O_{10}$) it amounted to 0.946, while for sodium perborate ($NaBO_3$ n H_2O) it reached 0.507. The measured values for ammonium (NH_4^+) were 0.921, for nitrate 0.99 and for nitrite (NO_2-) – 0.321. Water temperature and pH value at the measured location (L_2) were (13 °C and 7.09 pH).

Table 5. Monitoring of physico-chemical parameters during the month of May, location Prevalla L_4

Physico-chemical parameters	Phosphate (PO_4^{3-})	Total Phosphate (TP)	Sodium tripolyphosphate ($Na_5P_3O_{10}$)	Sodium perborate ($NaBO_3$ n H_2O)	Ammonium (NH_4^+)	Nitrate (NO^-_3.)	Nitrite (NO_2-)	Water temp. (°C)	Hydrogen ion concentration (pH)
Value	0.015	0.323	0.215	0.323	0.012	2.423	0.00	15	7.29

Table 6. Monitoring of physico-chemical parameters during the month of October, location Prevalla L_1

Physico-chemical parameters	Phosphate (PO_4^{3-})	Total Phosphate (TP)	Sodium tripolyphosphate ($Na_5P_3O_{10}$)	Sodium perborate ($NaBO_3$ n H_2O)	Ammonium (NH_4^+)	Nitrate (NO^-_3.)	Nitrite (NO_2-)	Water temp. (°C)	Hydrogen ion concentration (pH)
Value	0.002	0.001	0.00	0.00	0.012	0.03	0.00	8.4	7.55

Table 7. Monitoring of physico-chemical parameters during the month of October, location Prevalla L_2

Physico-chemical parameters	Phosphate (PO_4^{3-})	Total Phosphate (TP)	Sodium tripolyphosphate ($Na_5P_3O_{10}$)	Sodium perborate ($NaBO_3$ n H_2O)	Ammonium (NH_4^+)	Nitrate (NO^-_3.)	Nitrite (NO_2-)	Water temp. (°C)	Hydrogen ion concentration (pH)
Value	0.188	0.181	0.946	0.507	0.921	0.99	0.321	13	7.09

Table 8. Monitoring of physico-chemical parameters during the month of October, location Prevalla L_3

Physico-chemical parameters	Phosphate (PO_4^{3-})	Total Phosphate (TP)	Sodium tripolyphosphate ($Na_5P_3O_{10}$)	Sodium perborate ($NaBO_3$ n H_2O)	Ammonium (NH_4^+)	Nitrate (NO^-_3.)	Nitrite (NO_2-)	Water temp. (°C)	Hydrogen ion concentration (pH)
Value	3.224	2.372	2.025	1.325	1.322	5.023	0.951	17.9	6.8

Table 9. Monitoring of physico-chemical parameters during the month of October, location Prevalla L_4

Physico-chemical parameters	Phosphate (PO_4^{3-})	Total Phosphate (TP)	Sodium tripolyphosphate ($Na_5P_3O_{10}$)	Sodium perborate ($NaBO_3$ n H_2O)	Ammonium (NH_4^+)	Nitrate (NO^-_3.)	Nitrite (NO_2^-)	Water temp. (°C)	Hydrogen ion concentration (pH)
Value	0.903	0.56	0.606	0.377	0.012	3.12	0.951	16.2	7.8

Table 8 shows the values of phosphate ion (PO_4^{3-}) for October, 2022 according to monitoring of physico-chemical parameters in Lumbardhi River in Prizren, were 3.224. The value of total phosphate (TP) was 2.37, for sodium tripolyphosphate ($Na_5P_3O_{10}$) it was 2.025, while for sodium perborate ($NaBO_3$ n H_2O) it amounted to 1.325. The measured values for ammonium (NH_4^+) were 1.322, for nitrate 5.023 and for nitrite (NO_2^-) – 0.951. Water temperature and pH value at the measured location (L_3) were (17.9 °C and 6.8 pH).

Table 9 shows the values of phosphate ion (PO_4^{3-}) for October, 2022 according to monitoring of physico-chemical parameters in Lumbardhi River in Prizren, were 0,903. The value of total phosphate (TP) were 0.56, for sodium tripolyphosphate ($Na_5P_3O_{10}$) it amounted to 0.606, while for sodium perborate ($NaBO_3$ n H_2O) it reached 0.377. The measured values for ammonium (NH_4^+) were 0.012, for nitrate 3.12 and for nitrite (NO_2^-) – 0.951. Water temperature and pH value at the measured location (L_4) were (16.2 °C and 7.8 pH).

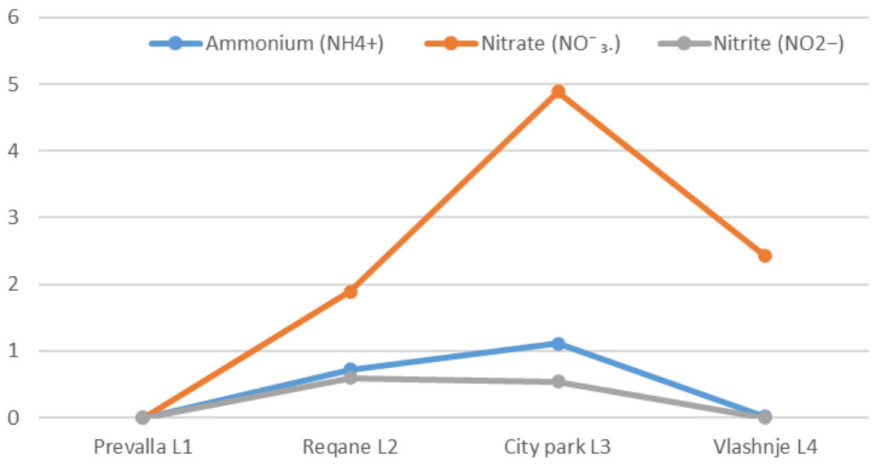

Figure 2. Physico-chemical parameters (NH_4^+, NO^-_3., NO_2^-), Lumbardhi River in Prizren, during month-May, 2022

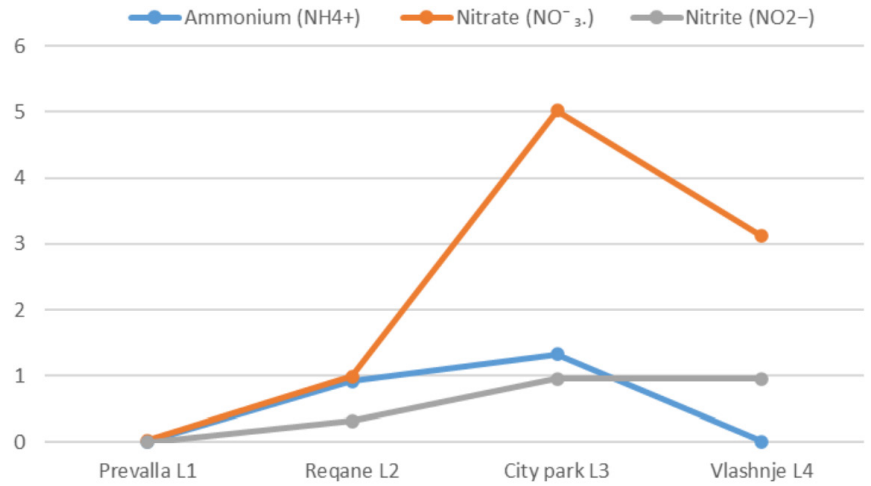

Figure 3. Physico-chemical parameters (NH_4^+, NO^-_3., NO_2^-), Lumbardhi River in Prizren, during month-October, 2022

Figure 2 shows the value of the results for physico-chemical parameters (NH_4^+, NO^-_3., NO_2^-), Lumbardhi River in Prizren in two time intervals. The highest pollution was reached in the month of October, while the third location (L_3) of the study in the city park in some parameters there were excesses from the average values.

According to the results of the analyses shown in Figure 3, the values of ammonium ion vary in the location (L_1) for both time periods up to the highest ones in the sampling site (L_3) in October 2022. The waters analyzed at the locations (L_2) and (L_3) of the pond are polluted for both time periods May-October 2022. The amount of nitrites is above the allowed values from 0.00 in the sample taken at the (L_1)source of surface water in both time periods May and October 2022 October at 0.92 mg/l for the October period in the sampling area (L_3) City Park.

Figure 4 shows the presence of different forms of phosphorus in water, which are higher than those allowed, especially in locations (L_2 and L_3). In turn, in location (L_4) the presence of phosphorus in the Lumbardhi river is smaller. The water pollution of the Lumbardhi River in the Reqan Location (L_2) and in the City Park (L_3) is a consequence of the mismanagement of industrial and domestic wastewater.

The values of the indicator of phosphorus vary for both time periods of May and October 2022 and higher concentrations are in the location (L_3) in the City Park. There was an increase in the location (L_2 to L_3) as a result of industrial activities, urban area and household services which are more pronounced at this point of the conducted research.

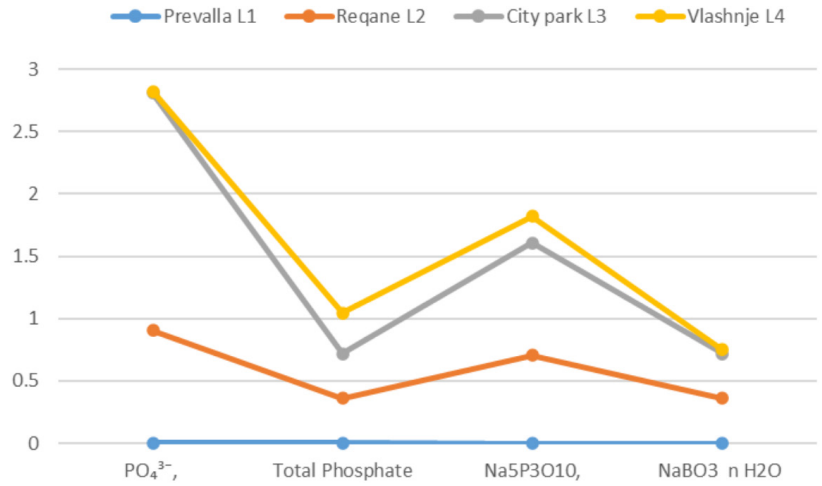

Figure 4. Physico-chemical parameters-Lumbardhi River (PO_4^{3-}, Total Phosphate, Na_5P_3O10, $NaBO_3$ n H_2O) in Prizren during month-May

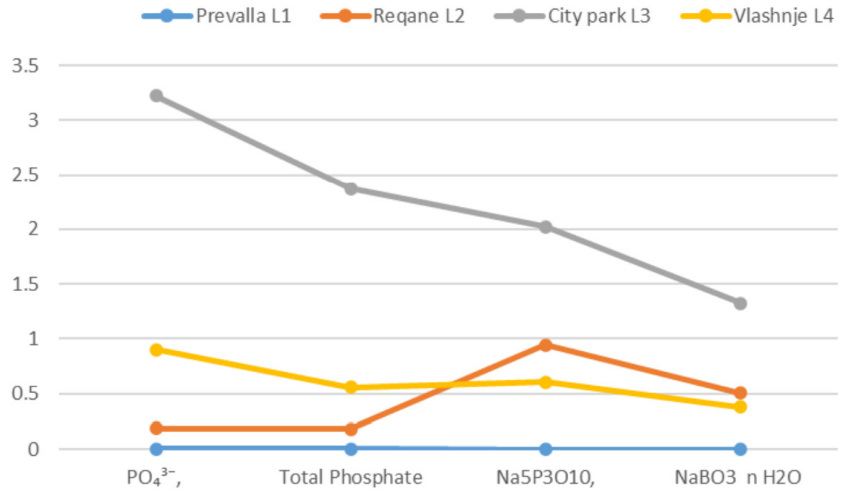

Figure 5. Physico-chemical parameters-Lumbardhi River (PO_4^{3-}, Total Phosphate, Na_5P_3O10, $NaBO_3$ n H_2O), during month-Octeber, 2022

CONCLUSIONS

This study focused one some of the important water resources pollution issues resulting from both natural and anthropogenic activities during the flow of the Lumbardhi river**.** Human activity and industry have great impacts on the quality of surface waters and the introduction of pollutants of various origins into these waters. An important problem for environmental researchers and decision-makers remains the improvement of understanding the extent and behavior of polluting chemicals on the water surface and subsurface. The results of the measurements and the analyzed parameters show that these waters are polluted in some locations and mainly belong to the second and third class of surface water quality, according to WHO. Among the pollutants, to a large extent are the products originating from detergents used in households, as well as the industrial and agricultural products of this area. Location study (L_3) had higher pollution as a result of the discharge of urban sewage and city waste. The water quality of the Lumbardhi river directly depends on the amount of flows in the river. Poor quality of the water is more pronounced during the month of October, when the amount of flows in the river is smaller. The water at the source of the Lumbardhi river, suffers significant pollution during its course up to the Drini i Bardhe river. Research has shown the presence of different forms of phosphorus that are higher in the (L_2 and L_3) locations. The water pollution of the Lumbardhi River in the Reqan Location and in the City Park is a consequence of the mismanagement of industrial and domestic wastewater.

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