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DETERMINING THE WATER QUALITY OF BABOL ROUD RIVER BASED ON MULTIPLICATIVE WEIGHTED INDEX

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Abstract

Considering the multilateral importance of Babol Roud river, this study has utilized multiplicative weighted index for various uses. Accordingly, total coliform parameters included BOD, DO, CL, PH and NO3 and some others were measured during 12 months in 7 stations of the Babol Roud river and considering the length of the river and urban, industrial and agricultural developments, the way of transferring stations was selected; the obtained amounts were compared with water stream gauges of Mazandaran province and Caspian Sea ecologic research center to be controlled. Finally, the water quality of Babol Roud river was determined based on obtained weighted indices for various uses. The obtained score of 50 for this rived indicated that the water of this river was not appropriate as a water-storage source and for recreation purposes and it can only be a home for fish and hardy shells. At the same time, the water of this river needs to be refined for agricultural and industrial uses.

Keywords; Babol Roud river, Multidimensional weight index of water quality, Caspian Sea ecologic research center.

Introduction

Since its creation, human being has placed his environment near water sources; water is one of the most important and great factors of life so that all animates` life such plants and animals is dependent upon water. Every country`s environmental sources are not only considered as productive potential storages having economic usage for the local or national societies, but also, they are rooted in the lives of the societies whose sustainable exploitation from their economic power as well as preserving ecologic values are in need of comprehending the relationship between alive and dead components (4). Water ecosystems of Iran, especially wetlands, inland lakes and rivers are in need of utmost importance and significance in using sources regarding the mentioned usages and the fact that this land has been placed in the dry cincture of north sphere and always faces limitations resulting from the lack of water. Therefore, environmental approach in managing and using the production power of water ecosystems in Iran has been turned into a necessary issue. Undoubtedly, losing any kind of water ecosystem in any level and volume means losing a food web, whose some rings can be a home for a specie that has no other mates in Iran; this absence means deleting one genetic storage, dissolved treasure and its services (11). Investigating the development histories in the industrial and urban agriculture as well as administering reconstruction plans and projects such as dam construction showed that in previous designs, like some of the developing countries, the importance and hidden value of natural resources have not been considered by decision makers and primary administrations without taking into account the observations and environmental foresights have led to various pollutions of home destructions and depletion of environmental sources was one of its consequences. Considering the constant amount of water in the nature and its ever-increasing usage and accordingly, the increase in the amount of sewages in the environment, the quantity of healthy water have been reduced and the amount of polluted water of the world have been increased. One of the other destructive activities imposed on rivers ending in Caspian Sea is the overuse of their seafloor sand. Although all these cases are physical obstacles in the way of the rivers (dams and bridges), they are also one of the important factors for the reduction of fish`s migration (9), which are entered from Caspian Sea into these rivers due to spawning; this itself is effective on protecting and survival of the species that select fresh water for spawning (1).

There have been various definitions presented regarding water pollution: Water is considered as polluted when there are some changes directly or indirectly in its combinations or properties due to human activities; so that as a result of these effects, water becomes considered as inappropriate for the uses that was previously utilized in a natural way (2). Contaminant sources of rivers` water can be categorized based on their circulated center as the point and non-point canoicals. Point canonicals are determined and limited, for example, industrial or urban sewages are evacuated to the rivers. Overall, point contaminants can be controlled through in-site refining (12). Non-point canonicals such as run-off are circulated and alternate and are effected by factors like land use, climate, hydrology, reliefs, vegetation and geology (4). Any canonical contaminant originates from a source. Pollution source has a certain importance since it is rational that pollution can be removed in its origin. As the contaminant is released from its origin, it can affect its acceptor. Acceptor is the thing affected by contaminants (8).

Methodology

Multiplicative Weighted Index

Dinius (1987) suggested water quality evaluation using exponential weighted indices (cited by 20). Exponential index is preferred to other indices since its geometrical mean is less affected by the terminal scope of the data compared to the arithmetic mean.
The index formula is as the following (20):

$$\mathbf{WQI} = \prod_{i=l}^{n} I_i^{W_i}$$

Ii= the sub index of each parameter
Wi= the weighted factor of each parameter
N= the number of parameters

12 parameters have been used in this index: Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Fecal and total coliform, alkalinity, hardness, chloride, conductivity, pH, Nitrate, color and temperature.
The relations required to obtain each of sub-indices and their weighted factors have been presented in Table 1 and the classification of various uses of water in different scopes of the index (0-100) have been provided in Table 2. Diaz and Lopez (2006) have utilized annual mean for obtaining the index of 17 stations in 25 years (1975-1999) in the Riolmera region of Mexico; they have drawn the results using Surfer 6.01 software in a three-dimensional figure and indicated that water quality improved in the last years (1998-1999) (20).

Table 1. The relationships regarding the calculation of sub-indices in the multiplicative weighted index (20).

Parameter	Ith sub-index	Weighted factor
Dissolved Oxygen (saturation percentage)		
Biochemical Oxygen Demand for 5 days (mg/L)		
Nitrate(mg/L)		
Total coliform (number in milliliter)		
Fecal coliform (number in milliliter)		
Alkalinity (mg/L)		
Hardness (mg/L)		
Chloride (mg/L)		
Temperature (centigrade) Ta= weather temperature Ts= water temperature		
Conductivity ($\mu S/cm$)		

Table 2. Classifying various uses of water in different ranges of multiplicative weighted index (0-100)

Pollution degree (best=100)	Water uses					
	Water storage source	Recreation	Fish	Shell	Agriculture	Industrial
	There is no need for water refining.	It is suitable for all kinds of aquatics.	It is suitable for all kinds of fish.	It is suitable for all kinds of shells.	There is no need for water refining.	There is no need for water refining.
	Slight refining is needed.				There is a need for slight refining of those products that needs high quality water.	There is a need for slight refining of those industries that needs high quality water.
	There is a need for full refining regarding the consumption.	It has been polluted but, it is acceptable regarding the number	Final range for sensitive fish	Final range for the sensitive shells	There is no need for refinement regarding most of the products	There is no need for refinement regarding common industries.

		of bacteria.	It is not suitable for sensitive fish.	It is not suitable for sensitive shells.		
	It is no suitable.	It is not suitable for water contacts	Only gritty fish	Only gritty shells	Broad refinement for most of the products	Broad refinement for most of the industries
			Only really gritty fish	Only really gritty shells		
	Unacceptable	Visible pollution	Unacceptable	Unacceptable	Only for tolerable products	Only for industries that do not need clean water.
0	Observable pollution-unacceptable				Unacceptable	Unacceptable

Conclusion

The results of measuring total coliform parameters, BOD, DO, CL, PH, NO3 and some other parameters during 12 months from May 2013 to April 2014 in 7 stations at the Babol Roud riverbed have been shown below.

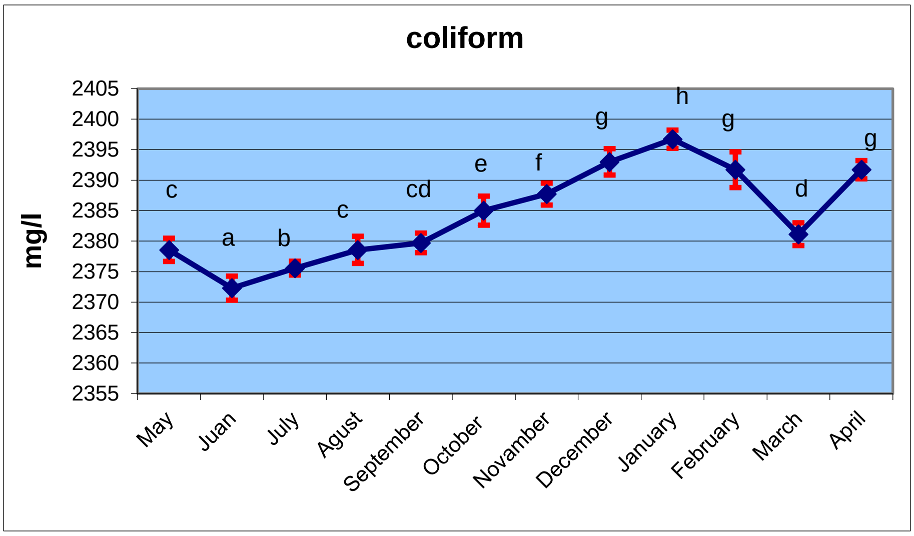

Figure 1. The amount of river coliform during the year

Standard deviation of coliform in July, January and April had the least amount of (1±) and in February, had the most amount of (±3). The highest amount was related to February that was due to the increase of underground water and as a result of pollution circulation from sewage wells.

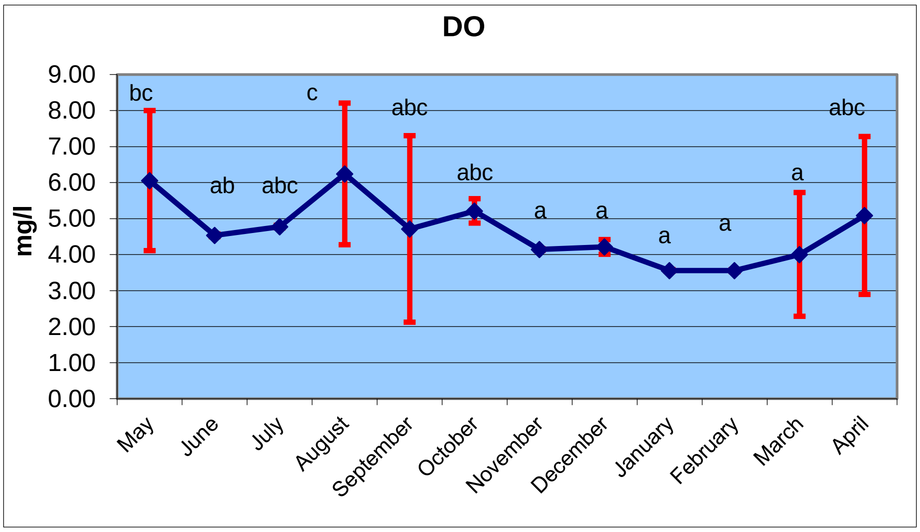

Figure 2. The amount of Do of the river during the year

Standard deviation of Do in December had the least amount of (±0.2) and in April, had the most amount of (±2.19). Dissolved oxygen density of water had a direct relationship and there was also significant difference between stations ($P<0.05$).

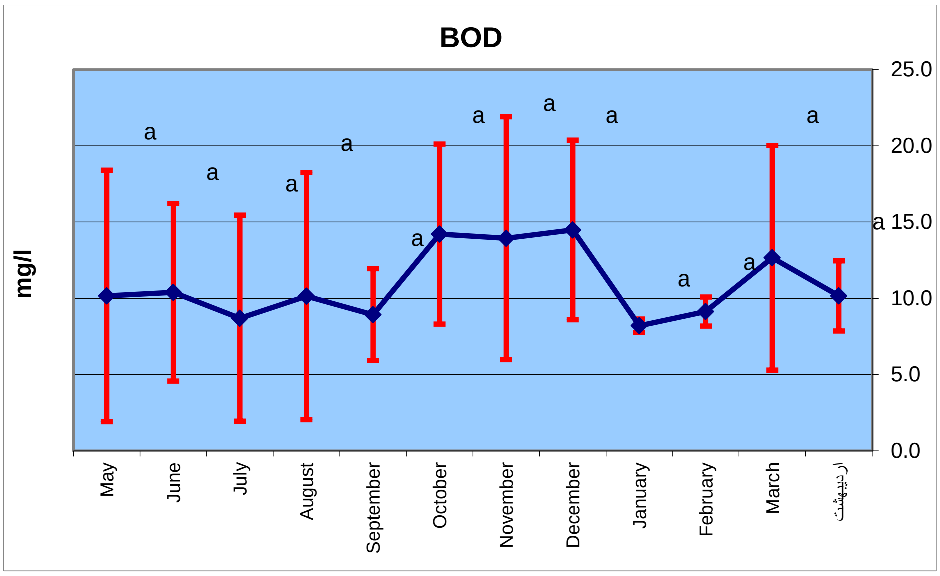

Figure 3. The amount of BOD of the river during the year

The amount of standard deviation of BOD in February was the least (±1.0) and it was the most in May (±8.2).

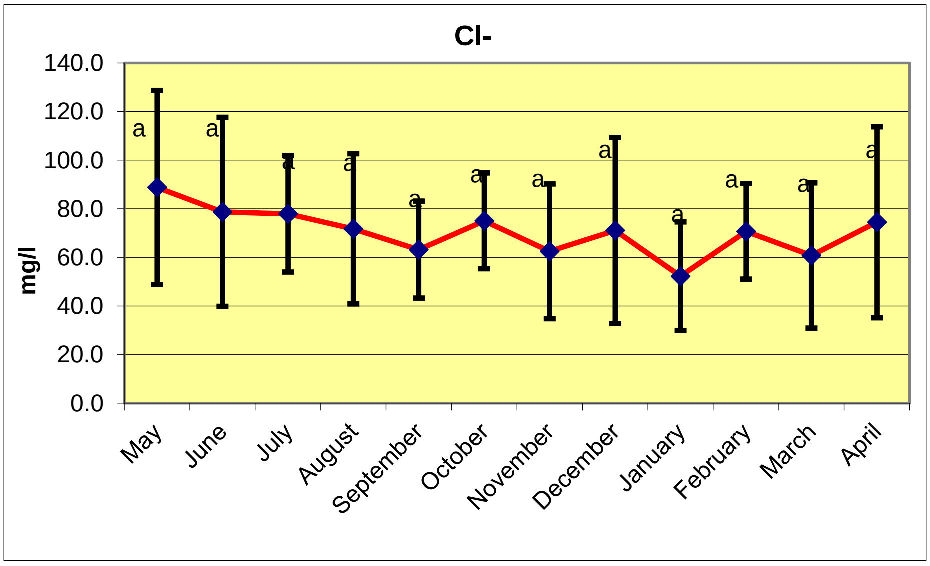

Figure 4. The amount of CL of the river during the year

The standard deviation of CL in February and October was the least (±19.7) and it was the most in May (±39.9). There was no significant differences between months ($P<0.05$). Having increased river discharge in some of the months of the year, the density of CL reduced.

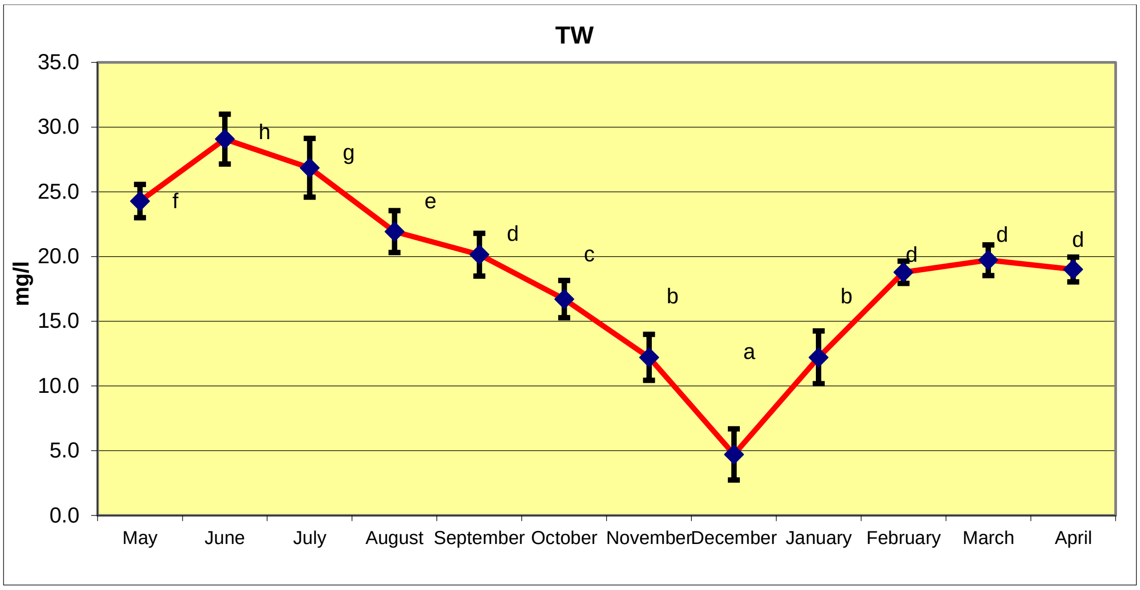

Figure 5. The temperature of river water during the year

The standard deviation of TW was the least in February (±0.9) and it was the most in July (±2.3). The highest temperature was measured in June and the least was related to December.

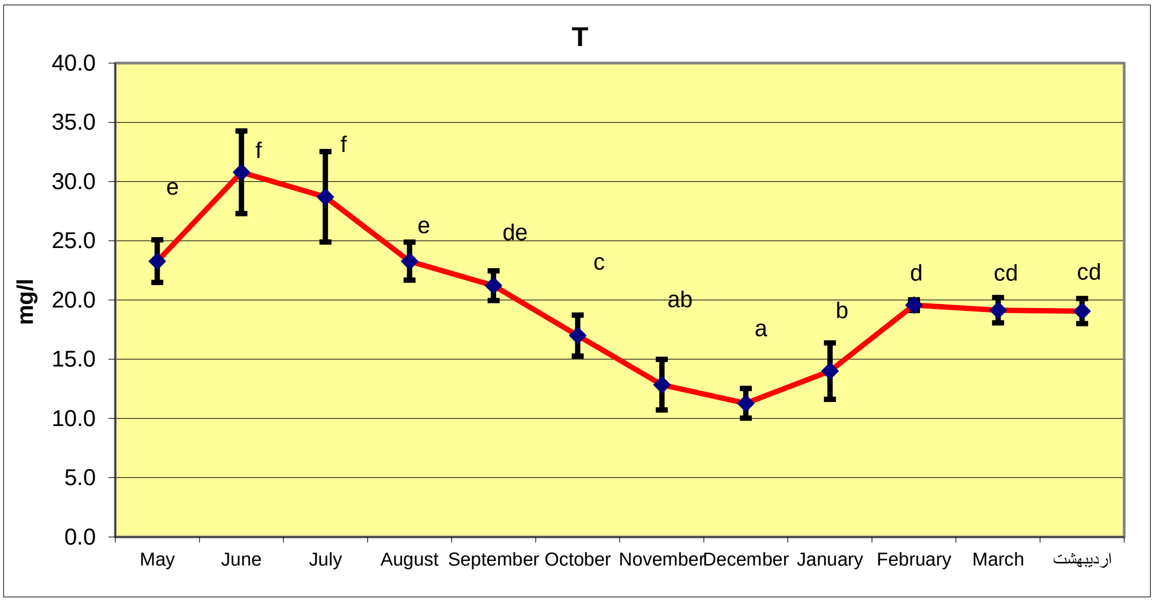

Figure 6. Weather temperature of the river during the year

Standard deviation of T was the least in February (±0.4) and it was the most in July (±3.8). Weather temperature was the most in June and it was the least in December.

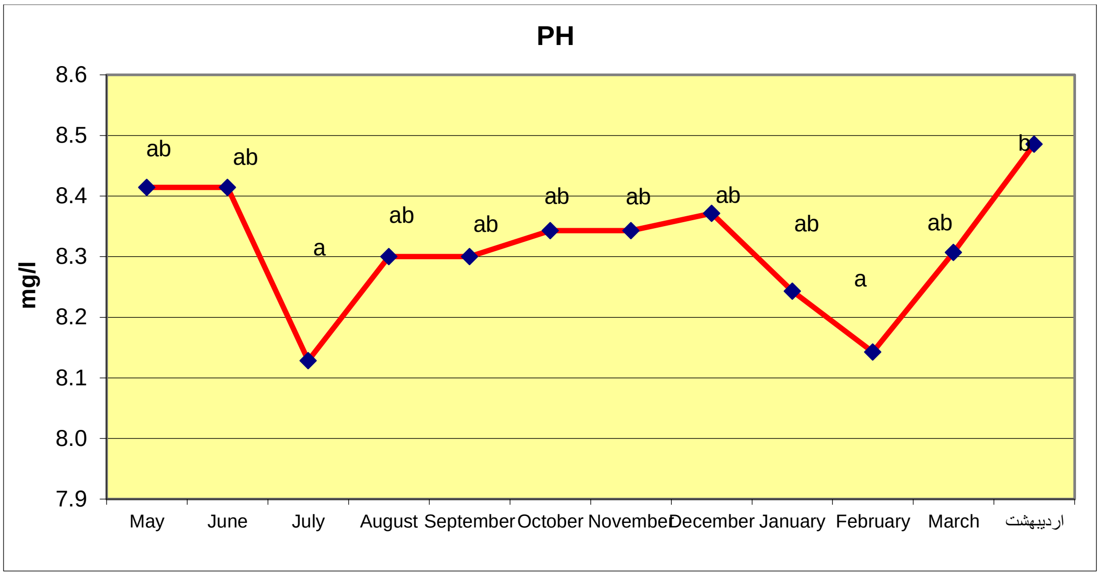

Figure 7. The amount of PH of the river during the year

The standard deviation of PH in May, June, August, November, January, March and April was the least (±0.2) and it was the most in July, September, October, December and February (±0.3). The difference was significant between February and April (P<0.05) and the least amount of PH occurred in July.

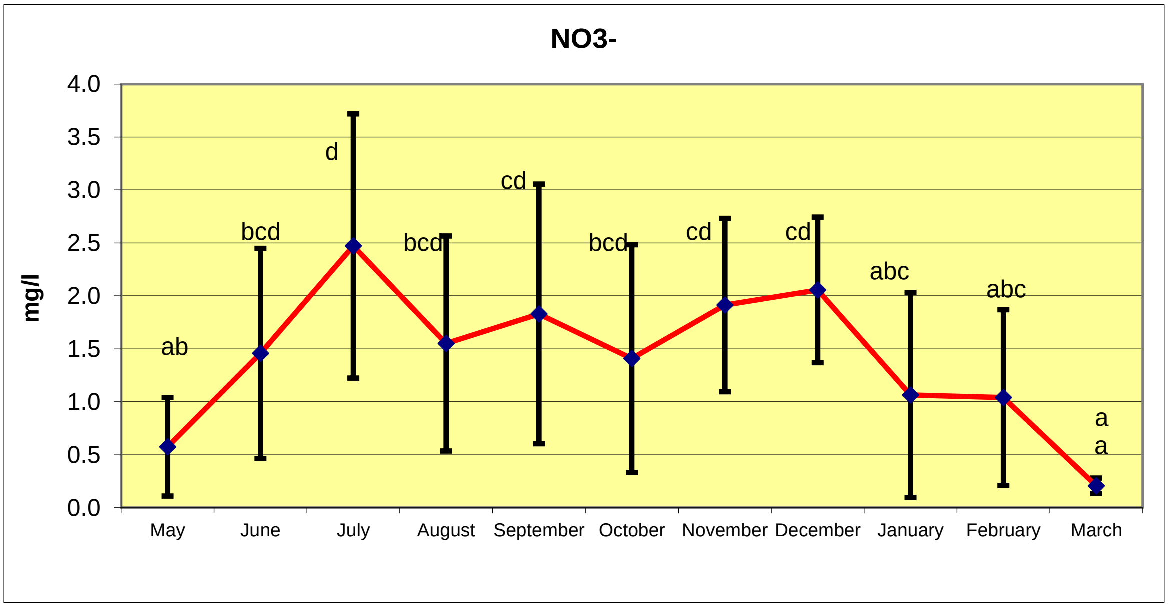

Figure 8. The amount of NO3 of the river during the year

The standard deviation of NO3 was (±0.5) in May and it had the highest amounts in July and September (±1.2). In summer, due to the usage of fertilizers, its amount reached the highest value in July and there was significant difference in some of the months (P<0.05).

Discussion and Final Conclusion

In this study, multiplicative weighted index was utilized regarding various uses of Babol Roud river. Accordingly, total coliform, BOD, DO, CL, PH, NO3 parameters and some others were measured during 12 months in 7 stations of the riverbed of Babol Roud. Finally, the water quality of Babol Roud river obtained based on weighted indices was determined for various uses. According to Table 2, score 50 was considered for this river, which shows that the water of the river was not suitable for storing and recreational purposes and it can only be a home for gritty fish and shells. At the same time, the water of this river needs to be broadly refined for agricultural and industrial uses. Considering the fact that most of the lands in the neighborhood of Babol Roud were attributed to agriculture, the increase of the amount of nitrate and chloride due to the entrance of agricultural wastewater to this river, has led to the reduction of water quality. Moreover, the entrance of domestic wastewater of cities such as Babol, Amir Kala and Babolsar affected the amount of PH and coliform and industrial cities like Babol Kenar, Eslam Abad and Chehreh had a role in increasing some of these parameters that overall, reduced water quality of the river and causes other restrictions to the usage of this river. Considering the self-purification power of rivers and the fact that rivers` water is provided through rainfalls, water quality of the river can be increased through refining industrial, agricultural and domestic wastewater ending to this river; this can itself cause new uses such as aquaculture, recreation and others.

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