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Long-Term (1969-2013) Changes of Water Parameters in Neka and Tajan Rivers, Mazandaran, Iran

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ABSTRACT

Background: Iran is located in the global arid zone. With an average rainfall of less than 250 mm. 25 percent is Iran of located in hyper-dry area and 40 percent in the arid area. In 2007, the World Bank report declared the annual reduction of freshwater resources in Iran 6 times more than global standards and indicators. Since at present, in Iran most available fresh water enters the water ecosystems, their management is vitally important due to climate changes and water quality parameters.
Methods: In this study, long- term changes of some parameters including hardness, dissolved solids and EC, pH, HCO_3, Ca, Na, Mg, Cl and SO_4 were investigated for a period of 44 years in two key rivers (Neka and Tajan rivers) in the north of Iran.
Results: The results show that there was the same changes pattern in all parameters in both rivers. The highest level of correlation was between electrical conductivity and dissolved solids in both rivers. Also, due to the similarity of the hydrological characteristics of the rivers, the impact of area development by local people is playing a major role in the environmental health.
Conclusion: Although Iran's northern regions have high rate of precipitation, status of water quality parameters is an indicator of low levels of water quality and its pollution.

1. Introduction

Any development requires exploitation and use of natural resources, and any human activities, have some effects on the environment at different levels. On the other hand with the increasing demand for water worldwide, drinking water supply will not take long to become an international problem and the cause of conflicts and wars between different people and nations (1), Therefore, proper management of extraction and consumption is necessary. This is even more important for developing countries including Iran, because further development especially in the recent years, have been placed on the top of government programs (2). After all, this coin has two sides: one side of the coin is economic and social welfare resulting from development and the other side is the damaging effects on water quality parameters caused by hasty and unplanned development (3). The purpose of this study is to investigate the change process of some water quality parameters existing in two important rivers of Tajan and Neka in Mazandaran province. The correlation between these parameters is studied as well.

2. Material and Methods

2.1. The Tajan River

Tajan an in valuable ecosystem is located in Mazandaran province in northern Iran and the southern Caspian Sea. Tajan basin has a unique position in terms of economic, social and environmental issues due to its suitable and diverse climate and habitation (4). This river with a length of about 140 km emanates from The Mountains of Ali Khani, Darab Mountain and Sarkuh from the mountainous area of Hezarjarib on the northern slopes of the Alborz Mountains and falls into the Caspian Sea by crossing the east of Sari. Based on previous studies, it has been confirmed that the Tajan River has a suitable water Discharge and the most fish migration at the time of natural spawning (4). This river, has been selected as a pilot river for fishery projects among 115 rivers in north of country; as mentioned above this area is situated between the Caspian Sea and the northern slopes of the Alborz mountains and is limited from the north to the Caspian Sea, from east north to the Neka river Basin, from southeast to Damghan, from west to the basin of the Talar river and from south to Semnan, among which Damghan is part of the Tajan river sub-basin and Semnan is the sub-basin of the Hablehrud river (Figure 1).

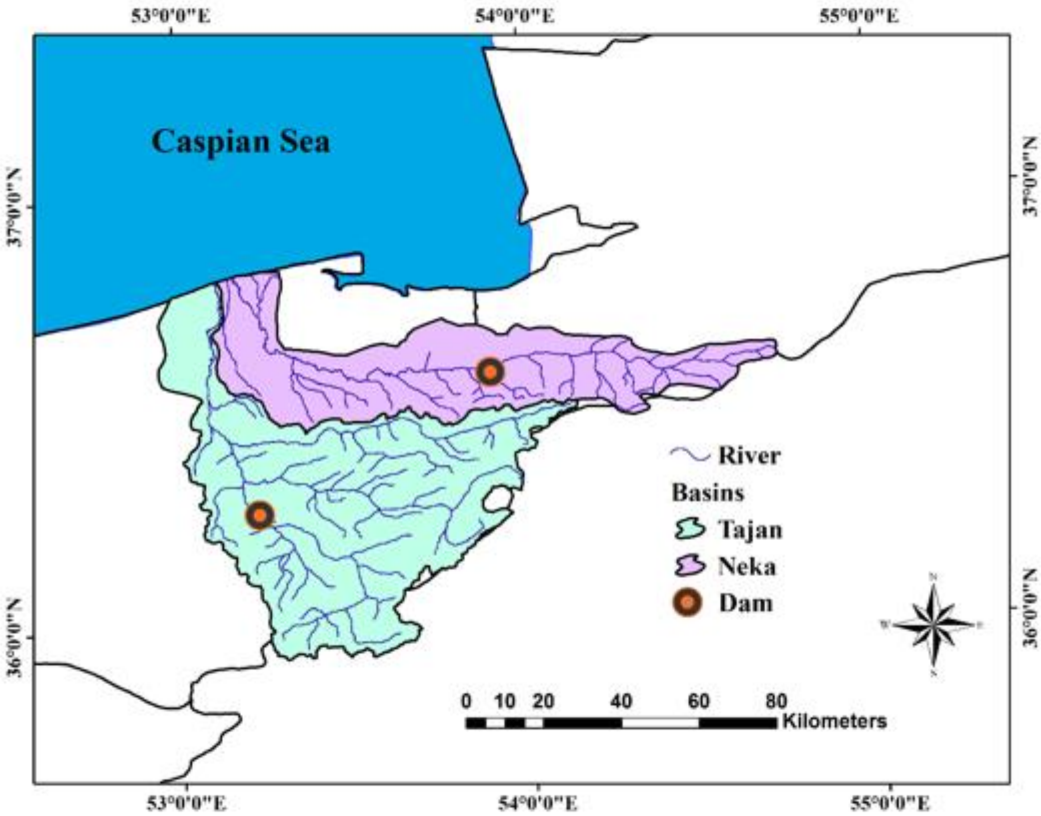

Fig. 1: The map of Case Study (Tajan and Neka rivers, Mazandaran, Iran).

2.2. The Neka River

The Neka River is derived as a form of small but numerous branches from the southern highlands of Mazandaran province (Figure 1). The area of Neka river basin is about 900 square km and its local base level is 22 meters. Following heavy rain, a terrible flood swept Neka city on August 5, 1999 during which 37 people were killed, 12 were lost and billions of rials damage to buildings, bridges and farms were inflicted. Also during the recent years we have confronted several warnings from the relevant agencies about overflow of the river with the last one in June 2016 in which the governor of the city declared a state of emergency warning the local people, especially residents near the river (5). The area of river`s runny basin is 1480 square km and the average annual runoff of the river is 112 million cubic meters and the average annual rainfall is 904 mm (6).

2.3. Statistical Analysis

For statistical analysis, the SPSS and Excel soft wares were used. According to the scientific sources, for analyzing the data, function Log (x + 1) is used for normalization; X is the parameter value (7). Also, different outputs can be shown all together by converting the data logarithmic unit (7, 8). According to normality of data, independent t-test was used to compare the two rivers and Pearson correlation at level of 95% was used to investigate the parameters correlation in each river. All data were measured by the Mazandaran Regional Water Authority (MRWA).

3. Results and Discussion

The long-term change process of parameters of total hardness, temporary hardness, total dissolved solids and electrical conductivity represents a regular change in the Tajan River (Figure 2). The amount of total hardness shows a sharp decline for 2008 and 2010. As regards there are no reports of any rainfall in the region at the time, the possibility of human error in measurement or probability of mechanical errors is high which is consistent with other studies. If there is a change in a parameter which does not occur in a variable, there is high probability of measurement errors and human errors as well (9). Also, the research results of Singh et al, confirm the obtained results by using statistical analysis (10).

Discharge fluctuations of water are affected by seasonal rainfall and at the same time by weather conditions. Therefore, there are significant changes in the water discharge (Figure 3). About the other evaluated parameters in the figure, if minor changes are ignored, a similar flow change can be seen in these parameters. Figure 4 as above diagrams, only represents the change process of anions and cations. It seems that other studied cations and anions have a similar flow of changes except magnesium.

General process of parameter changes in total and temporary hardness, dissolved solids and electrical conductivity in the Neka River show that almost all of the parameters have regular changes; but the amount of Total Hardness is recorded unusually low only in 2010 (Figure 5). In data record related to total hardness the possibility of human and mechanical error is high in 2010 as well documented already (11). In this year, as in the Tajan basin where there are not special weather conditions or much rainfall, there was not specific rainfall in the Neka basin either, so the possibility of error becomes stronger.

Water Discharge changes in the Neka River is as normal as the Tajan River and it seems that water discharge of Neka River is also strongly influenced by seasonal rainfall and climate conditions (Figure 6) (11). Changes in calcium and bicarbonate follow a quite similar trend but acidity change process of this river, is not consistent with the change process of parameters which seems that changes in the acidity of the Neka River is mostly affected by the situation of the area as Immerzell et al., concluded that changes in the acidity amount of an area, is more affected by bedrock and geology material of the area than climatic factors (12).

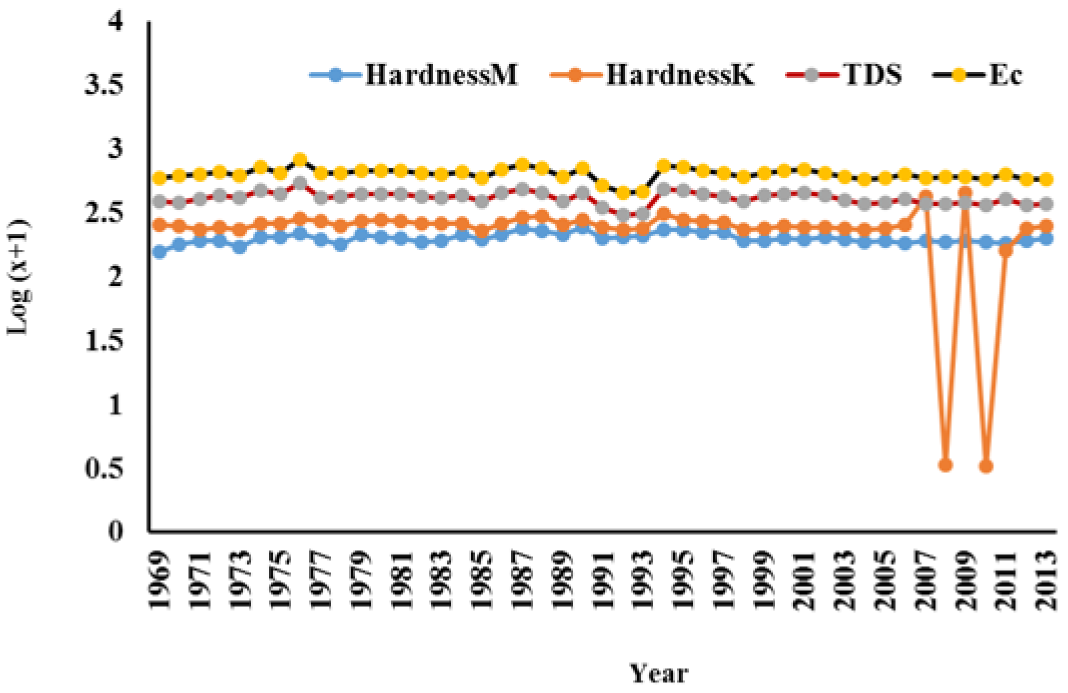

Fig. 2: Parameter changes of temporary hardness (HardnessM), Total Hardness (HardnessK), Dissolved Solids and Electrical Conductivity in the Tajan River.

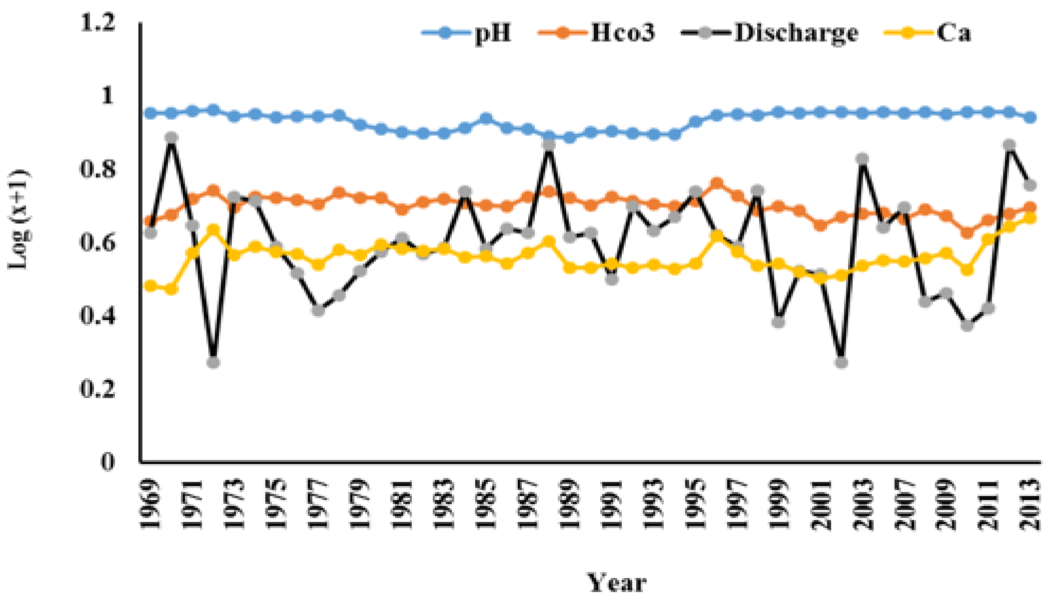

Fig. 3: Parameter changes in Acidity (pH), Bicarbonate, Discharge and Calcium in the Tajan River.

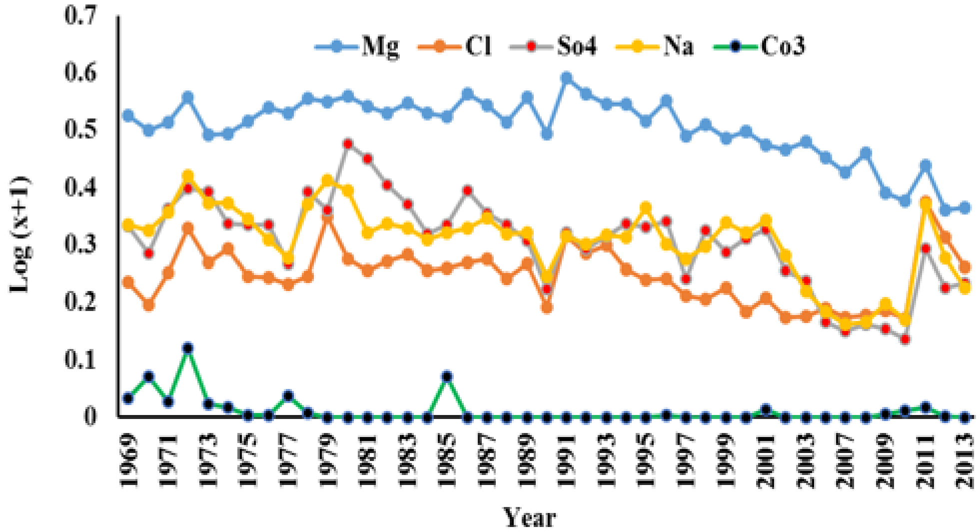

Fig.4: Parameter changes of Cations and Anions in the Tajan River.

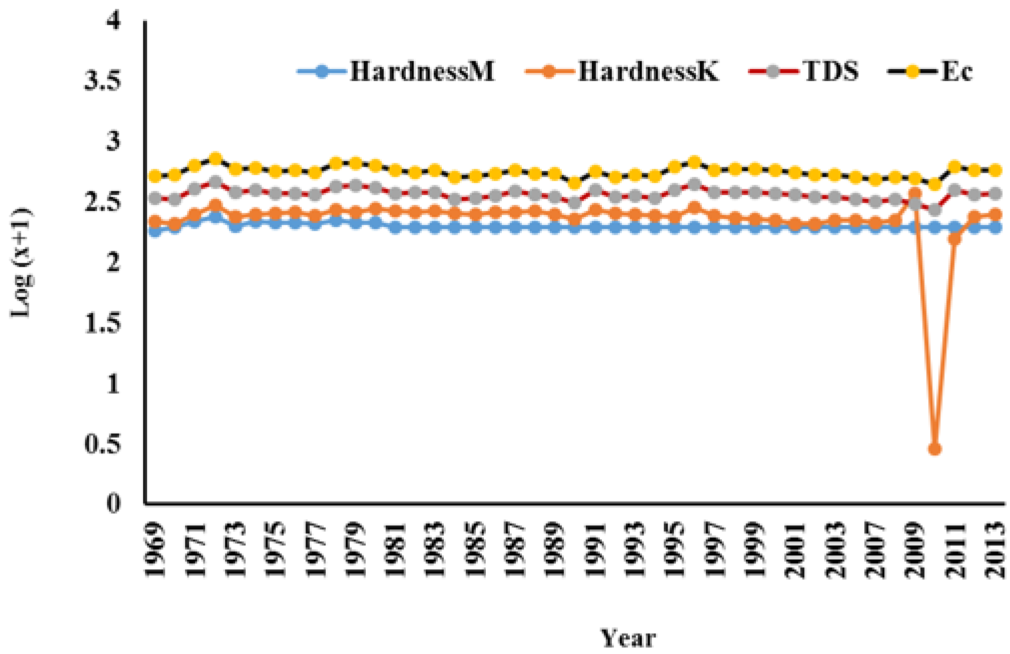

Fig. 5: Changes in parameters of Total and Temporary Hardness, Dissolved Solids and Electrical Conductivity of the Neka River.

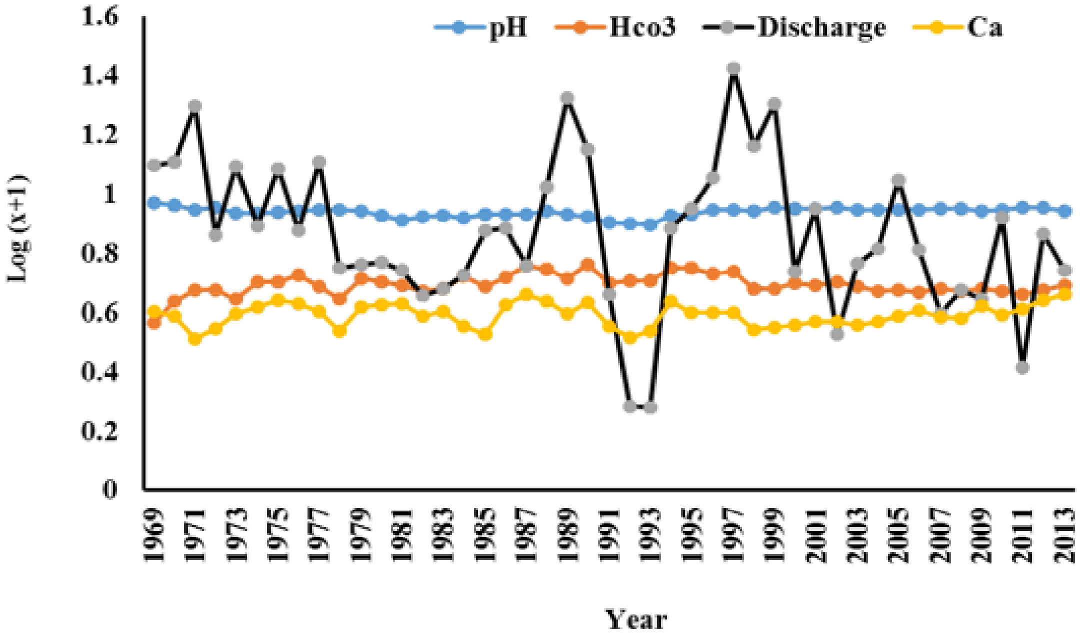

Fig. 6: Changes in parameters of Acidity (pH), Bicarbonate, Discharge and Calcium in the Neka River.

Almost all parameters of the Necka River had a decreasing trend in recent years (Figure 7). Of course the rate of changes in 2010 which has almost the lowest statistical data, is remarkable in comparison with 2011 which included the highest numerical values.

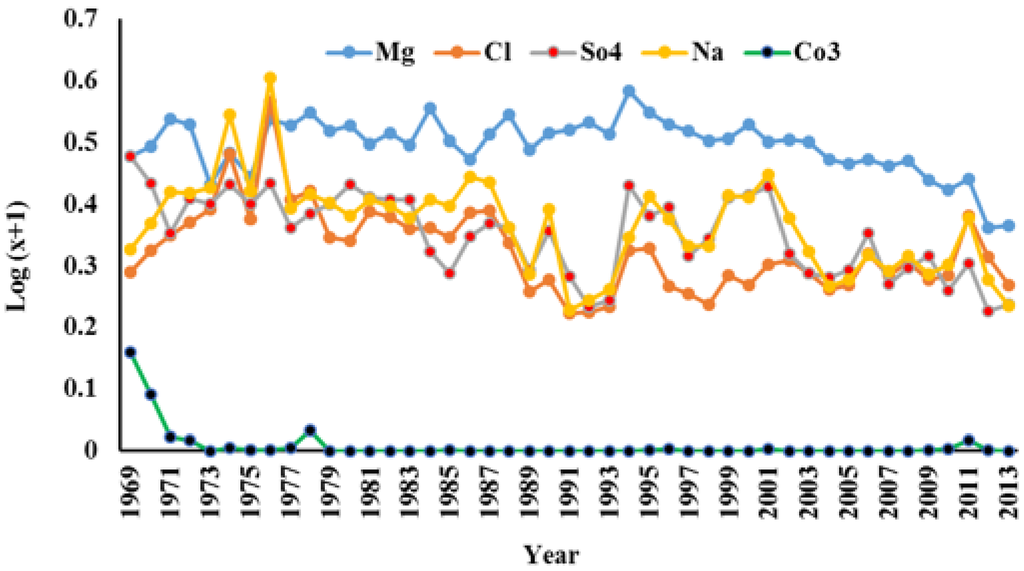

Fig. 7: Changes in parameters of Cations and Anions in the Necka River.

The t-test results of the annual average of the rivers for this period of time (1969-2013) only have significant changes in discharge and other parameters showed no statistically significant difference between the two rivers (Figure 8). Since these two areas are closely stuck the related can be very interesting. However, changes of water discharge are mostly affected by catchment basin`s vastness (13). It seems that the largeness of the Tajan`s catchment basin`s vastness has caused somehow to increase numerical values of discharge and finally the mentioned significant difference.

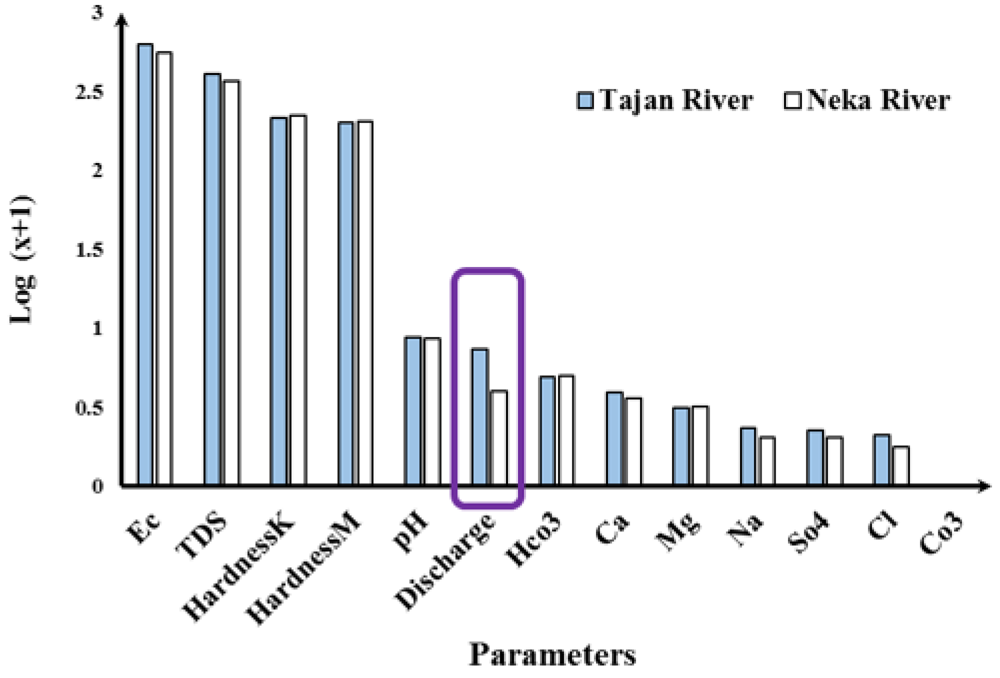

Fig. 8: Comparison of the annual average of the evaluated parameters for two rivers of the Tajan and Neka.

Many researchers in the world have confirmed the existence of linear and direct relationship between these parameters especially electrical conductivity and amount of dissolved solids by studying the correlation between water physicochemical parameters. For example, Bhandari and Nayal found direct and specific relations between physical parameters of water with the parameters of water quality (14). In analyzing the data from this study this correlation coefficient is more than 98 percent for the Tajan River and about 98 percent for the Neka River and this can be a reason to the reliability of measurement devices indicating desirable and acceptable accuracy of people (Table 1).

It should be mentioned that correlation between the amount of dissolved solids in the water and the amount of river`s water discharge is usually positive and this means that by reducing the amount of river`s water discharge, the amount of dissolved solids increases in the water; however, this enhancement is not very significant. This subject has been studied in Indian river (10, 14), but the important point is that this relationship depends very much on land use, vegetation and vegetation changes in the region (15). Thus, if there is no disturbance in the river and vegetation, the correlation between the two parameters is positive, otherwise based on human and natural factors it can have a variety of positive and negative relationships. In this topic, another important point is that usually the mentioned connection of parameters is not so that another amount could be predicted by acceptable estimate. It is noticeable, the hydrological condition of the mentioned rivers is very similar and it seems the impact of regional development is playing a major role in the environmental health.

4. Conclusion

Regarding the water crisis in Iran, it is also necessary to check other water quality parameters and monitor water quality indicator for a long period of time. The highest level of correlation was between electrical conductivity and dissolved solids in both rivers as well documented already.

Although Iran's northern regions have high rate of precipitation, status of water quality parameters is an indicator of low levels of water quality and its pollution. Also the use of aerial photographs and satellite images is recommended to assess and compare the quality conditions of the environment, the impact of long-term climatic conditions and the performance of dams built on the river in a long time. Economic evaluation of tangible and intangible elements of human intense activity should be considered according to the people`s tendency to villa building in northern regions of Iran and possible damages due to the lack of dams according to data and results from rainfall in the region.

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Table 1: The result of Spearman correlation among the studied parameters in the Tajan and Neka Rivers.

	TDS	Ec	Debi	pH	Co_3	Cl	So_4	Na	Hco_3	Ca	Mg	HardnessM	HardnessK
Tajan													
TDS	1	0.983**	0.334*	0.2	-0.12	0.670**	0.719**	0.835**	0.423**	0.445**	0.394**	0.454**	0.25
Ec		1	0.362*	0.27	-0.09	0.662**	0.694**	0.806**	0.400**	0.487**	0.345*	0.434**	0.18
Debi			1	0.399**	0.19	0.02	0.340*	0.23	0.02	0.11	0.05	0.06	0.06
pH				1	0.430**	0.1	0.23	0.14	-0.46	0.1	-0.29	-0.43	-0.13
Co_3					1	0.01	0.372*	-0.01	-0.67	-0.05	-0.01	-0.52	0.04
Cl						1	0.510**	0.835**	0.03	0.314*	0.14	0.04	0.1
So_4							1	0.708**	-0.09	0.21	0.434**	-0.01	0.26
Na								1	0.19	0.15	0.356*	0.22	0.16
Hco_3									1	0.29	0.400**	0.982**	0.17
Ca										1	-0.35	0.319*	0.09
Mg											1	0.454**	0.25
HardnessM												1	0.2
Neka													
TDS	1	0.974**	-0.13	0.02	0.2	0.615**	0.689**	0.760**	0.680**	0.510**	0.484**	0.694**	0.465**
Ec		1	-0.14	0.13	0.26	0.575**	0.638**	0.733**	0.616**	0.534**	0.386*	0.638**	0.420**
Debi			1	-0.28	-0.19	-0.01	0.04	-0.06	0.09	0.03	-0.07	0.04	0.23
pH				1	0.313*	-0.35	-0.42	-0.22	-0.4	0.03	-0.55	-0.35	-0.22
Co_4					1	0.19	0.18	0.315*	0.04	0.03	0.13	0.19	0
Cl						1	0.564**	0.685**	0.424**	0.487**	0.372*	0.447**	0.26
So_5							1	0.871**	0.531**	0.16	0.739**	0.531**	0.374*
Na								1	0.481**	0.14	0.616**	0.512**	0.351*
Hco_4									1	0.447**	0.650**	0.982**	0.511**
Ca										1	-0.18	0.447**	0.18
Mg											1	0.653**	0.395**
HardnessM												1	**0.495