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Investigation of Qualitative Condition of Nekarud River and Tajan River by NSFWQI Index

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Abstract

Rivers are exposed to large amounts of impurities. The first step for keeping river water quality and purification of polluted parts is obtaining information on the qualitative changes of river water in dimensions of time and place and also, determination of major sources and various water pollutants. Analysis of measured parameters alone or in combination, gives incomplete information on water quality because of variety of parameters, samples and stations. WQI is a mathematical and statistical tool for conversion of quantitative values of large quantity of water quality data into single number which presents a simple and understandable tool for qualitative assessment. Samples were collected seasonally from stations at upstream, middle stream and downstream of two rivers in east of Mazandaran province (Nekarud River, Tajan River) in a 2 years interval of 2011-2012 years, and analyzed in laboratory of Environmental Protection agency of Mazandaran according to standard methods. The values of NSFWQI (water quality index of America's national health organization) were calculated for all stations and all of the stations were located on the level of unsuitable conditions. The condition of Tajan River was relatively better than Nekarud River due to lower residential villages and towns around the river.

Keywords: NSFWQI, Mazandaran province, River, Pollution, Quality.

Introduction

Rivers long have been required for utilization of appropriate water resources, so human communities and agricultural and industrial centers mostly been set up near the rivers. Over time and expansion of these communities and consequently, the increased use of water resources, unnatural manipulation and changes in river water quality have been increased. In all around the world, human activities have profound effects on rivers and lakes. Rivers are exposed to large amounts of household wastewater, industrial swages, agricultural swages, mine wastes, urban wastewater, radioactive materials, pesticides and numerous other contaminants (Wongsupapa, C., et al., 2009)

The first step for keeping river water quality and purification of polluted parts is obtaining information on the qualitative changes of river water in dimensions of time and place and also, determination of major sources and various water pollutants (Oguchi, T., 2009, Saha P., 2010).

Soluble materials in river water are classified into several types depending on whether they are dissolved or suspended, organic or inorganic and also, based on their chemical characteristic. Regular analysis and description of qualitative data of river makes it possible to besides its use in different ways, appropriate and suitable management methods should be adopted to gradually reduce the river contaminants and towards an acceptable quality standard (Khadem et al. 2006).

Analysis of measured parameters alone or in combination, give incomplete information on water quality because of variety of parameters, samples and stations. Mathematical-computer qualitative modeling of river water also needs broad hydrodynamic and hydrological information (Silva f., et al., 2000, Ormsbee, L., 2006). Water quality index (WQI) is developed to solve this problem. WQI is first represented by Brown in 1970.

WQI is a mathematical and statistical tool for conversion of quantitative values of large quantity of water quality data into a single number. It provides a simple and understandable tool for managers and policy makers to obtain information on water quality and decide to allow the permitted uses of water. Also, application of WQI specifies the process of variations and qualitative trends of water resources (Brian O., 2005) and also allows the classification of water quality. Published indicators have various types that developed according to specific methods of each region and available standard in it, such as NSFWQI, OWQI and BCWQI and so on.

To determine the NSFWQI index, 9 parameters are measured for reasons as described below:

1) Biological oxygen demand (BOD): BOD is measured based on the amount of oxygen consumed by bacteria which are found in water. Bacteria consume organic materials and reduce the oxygen of water. BOD test gives an approximate estimation of the amount of biodegradable waste materials in the water. Biodegradable waste materials are usually consists of organic waste such as leaves, grass and fertilizers.

2) Dissolved Oxygen (DO): DO test specify the amount of required dissolved oxygen for continuity of life in water. This oxygen is available for fishes, invertebrates and all animals living in the water. Most of the animals and plants require oxygen to survive. In fact, fish are dying when dissolved oxygen is low in water. Decrease of dissolved oxygen is a sign of probable pollution in water (Abraham W.R., 2011, Yau, J., 2003).

3) Fecal coliform: Fecal coliform is a bacterium available in human and animal waste.

4) Nitrate: Nitrate is calculated from the amount of oxidized oxygen and is one of the major parts of food available in water. Nitrates are harmful for human because oxidize into nitrite and affects on the ability of red blood cells that carry oxygen. Nitrites also cause very acute disease in fish.

5) pH: The amount of pH is obtained from amount of acid available in water. Most of aquatic organisms are very sensitive against the pH. Appropriate pH for survival in river is usually from 6.5 to 8.5 (Nwajei, G., et al., 2012; Kowalkowskiab T., et al., 2007)

6) Temperature: Water temperature is very important in rivers. Most of the physical, chemical and biological are directly under influence of temperature. Most of the aquatic animals and plants survive in a certain range of temperatures and tolerate extreme changes.

7) Total dissolved solids (TDS): TDS is dissolved materials in river water includes salts, some of organic materials and wide range of other items such as nutrients, toxic materials and so on. A certain amount of mineral materials is crucial for aquatic life, very high or low concentration of dissolved materials affects on the growth and lead to death of aquatic life (Parihar, S., et al., 2012; Murhekar H., et al., 2012)

8) Total phosphate: Phosphate is a chemical composition composed of phosphor and oxygen elements that are essential for the growth of animals and plants. Phosphate appears in various forms in the aquatic environment. So total phosphate shows the available values of phosphate in aquatic resources.

9) Turbidity: Turbidity is calculated by using light scattering in water column due to suspended solids. High turbidity will cause more water darkness (Muthusamy P., et al. 2012). If

water became very dull, its ability in maintaining most of plants and microorganisms will be removed.

In this study, classification of two river`s water quality in the east of Mazandaran province is investigated by NSFWQI index.

Materials and methods

NFSWQI

After measuring of 9 above mentioned factors, each sub-index is obtained according to the conversion curves (appendix). The following equation (1) is applied for calculation of final index.

$$\text{NSFWQI} = €_{i=1}^{n} KI \qquad (1)$$

Where, n is the number of sub-index, k is weighting factor and I is sub-index obtained from conversion curves according to Table 1.

Table 1. Weight factor of NSFWQI

Parameters	turbidity	BOD	DO	Fecal coliform	nitrate	PH	T	TS	Total phosphate
Weighting factor	0.08	0.11	0.17	0.16	0.10	0.11	0.10	0.07	0.10

NSFWQI index is a reduction index namely it is decreases with increasing of water pollution. This index has a value between 0 to 100 and is classified according to Table 2 (Khadem, I.M., et al., 2006; Banjaka D., et al., 2012).

Table 2 . Water quality classification according to NSFWQI

Index	Water quality
91-100	Excellent
71-90	Good
51-70	Medium
26-50	Unsuitable
0-25	Very unsuitable

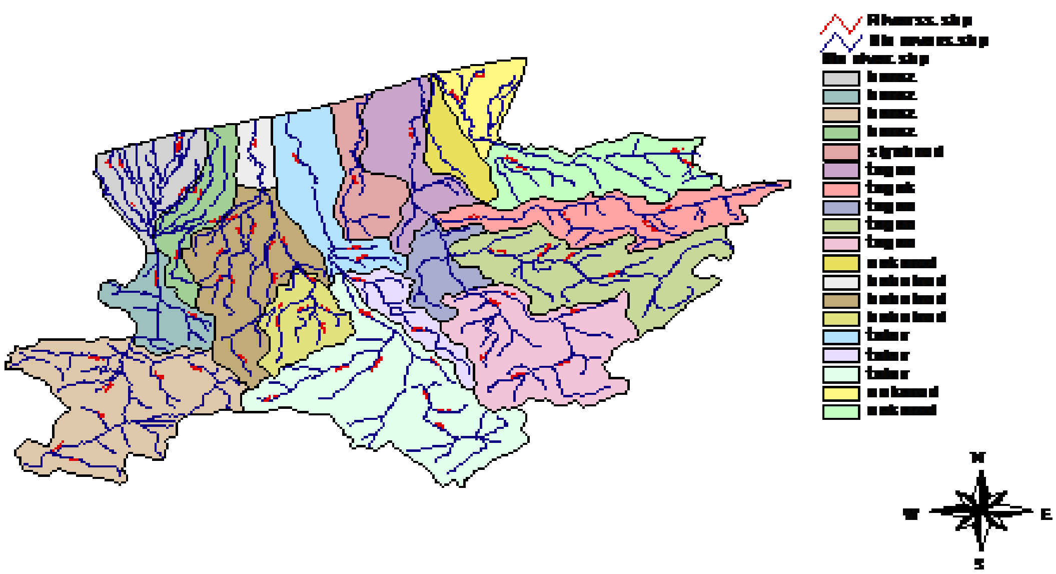

Figure 1. Basin of studied rivers

Sampling method and analysis of factors

Samples were collected seasonally from stations at upstream, middle stream and downstream of rivers (Nekarud River, Tajan River) in a 2 years interval of 2011-2012 and analyzed in laboratory of Environmental Protection Agency of Mazandaran, Iran according to the standard methods (APHA, 2005).

Results and Discussion

The obtained results in a 2 years of 2011-2012 from stations of upstream, middle stream and downstream is calculated and measured and is as follows (Table 3):

Table 3 . Average values of water quality variables

Parameters		Turbidity	BOD	DO	Fecal coliform	Nitrate	pH	Temp	TS	Total phosphate
Nekarud River	upstream	565	8	4.1	2400	2.3	8.51	16	686	0.24
	middlestream	268	6	3.6	2400	2.24	86	19	538.4	0.25
	downstream	27	28	3.6	2400	2	8.33	20	777	0.04
Tajan River	upstream	238.5	10.5	4.74	936	0.096	8.19	13.33	586.8	0.18
	middlestream	406.5	17.33	4.65	1816	0.28	8.22	13.11	646.74	0.17
	downstream	282	13.76	3.79	1364	0.31	8.03	15.66	938.02	0.25

The obtained values of NSFWQI at stations are as follows, which shows that the water quality at all stations are unsuitable according to Table 4 and Figure 2.

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Table 4 . NSFWQI values in monitoring stations

	Station	NSFWQI	DO
Nekarud River	upstream	38	4.1
	middlestream	39	3.6
	downstream	39	3.6
Tajan River	upstream	41	4.74
	middlestream	43	4.65
	downstream	44	3.79

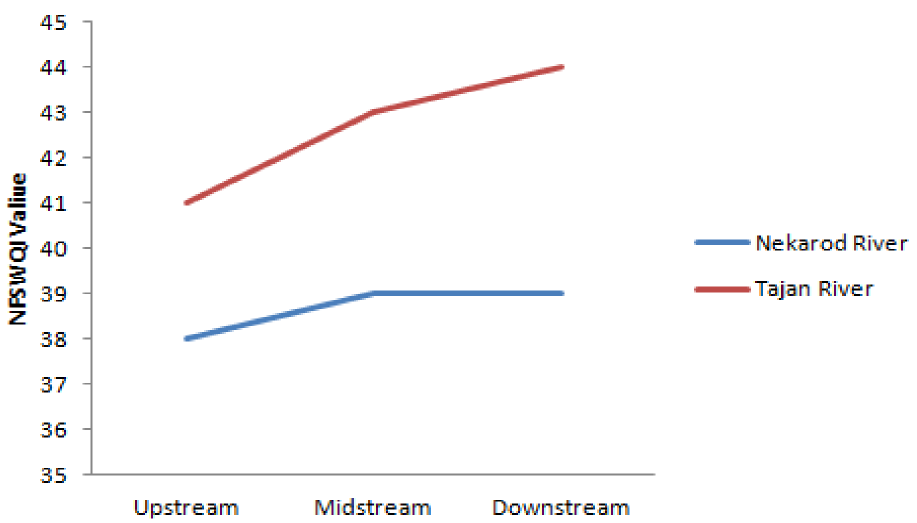

Figure 2. NSFWQI values in six rivers of Mazandaran province

Above diagram shows that upstream of Nekarud River had a much worse situation than other river, due to discharge of numerous factories swages in to the river. Tajan River condition was relatively more appropriate than Nekarud Rivers due to placement of upstream at a more pristine region relative to other up streams and less villages and residential cities around the river.

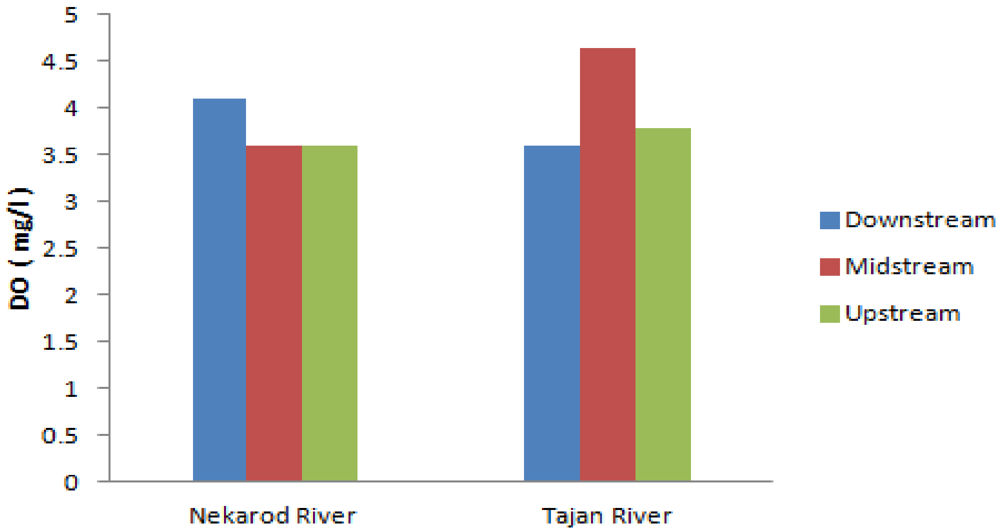

Figure 3. DO values in Nekarud and Tajan River

Selection of monitoring stations in Department of Environmental Protection was so that upstream stations were determined at appropriate distance before the entrance of cities, middle stream at city center and downstream near the sea entrance. The graph shows that middle stream of the rivers have better condition than upstream and qualitative condition of downstream is slightly improved because of self-purification of the rivers according to Figure 3.

Conclusions

According to the obtained results, it is required that each river be investigated more closely as case study and with selection of more stations to specify the sources of pollutants. And by investigation of other available indexes and matching them with hydrological and climatic conditions of Mazandaran`s Rivers, design the convenient and reliable index. The obtained results showed that qualitative condition of Mazandaran`s Rivers is unsuitable and appropriate management measures such as construction and operation of urban wastewater treatment plant, construction and optimization of wastewater treatment systems of industries, qualitative and quantitative optimization of toxins and modification and optimization of cropping pattern are required for reduction of rivers pollution.

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