ASSESSMENT THE WATER QUALITY OF BABOLROOD RIVER BASED ON THE NSF WATER QUALITY INDEX

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ABSTRACT

The present study was carried out to assess the water quality of Babolrood river, mazandaran province, north of Iran, by using NSF water quality index. For this purpose, 7 sampling stations were set up along the river mainstream and water samples were monthly collected from these stations during one year (from May 2012 to April2013); and 9 parameters including water temperature, turbidity, fecal coliform, NO3, TS, PO4, pH, DO, and BOD were measured and analyzed using NSFWQI method. Based on the results the river water quality values in the sampling stations varied from index value of 43 to 77. According to the NSFWQI method, the river water quality was categorized in: *good class*(with the average index value of 73) in upstream station(Quran Talar); *medium class*(with the average index value of 63)in midstream stations, including, Anarestan and Kharoon, Habibi Bridge, Mohammd Hasan Khan Bridg and *bad class*(with the average index value of 48) in 2 residue stations i.e. Amirkola and Babolsar in downstream. Results showed that during the period of the study the water quality of the Babolrood river had the best and worst condition respectively in "Quran Talar" station, where is located at upstream with no much receiving of wastes and waste waters and the "Amir Kola" and " Babolsar" stations, which are located at downstream where the Babolrood river pass through or besides the main irrigated lands, urban and industrial complexes as well as aquaculture and recreational units and therefore it can receives much more wastes and waste waters as well.

Keywords: Water Quality Index, NSF method, Babolrood River

INTRODUCTION

"Water, water everywhere and not a drop to drink."That quote from *Rhymes of the Ancient Mariner* is how an outside observer might look at our planet and respond since there is very little fresh water available. In fact, only three percent of all water on Earth is fresh, meaning not salty. Of that three percent, one percent is accessible for domestic use. We use this water in our homes, our work and our recreation. We rely on this percent for our health and our way of life (Tom Bennett *et al*, 1996). The same water that is used for crop and animal production can also be shared with the public and the aquatic and terrestrial ecosystems (Cooper*etal.,*1998). However, water is a unique resource because of its essential role for all life, the water resources are of great environmental issues. It is a basic need of all human being to get the adequate supply of safe and fresh drinking water.

When fresh water is contaminated with certain substances it is no longer useful. Nature helps purify the fresh water by way of the water cycle but humans need to help in the purification process because we are using so much water that the water cycle can not keep up. Both the anthropogenic influences such as urban, industrial and agricultural activities increasing exploitation of water resources as well as natural processes, such as precipitation inputs, erosion, weathering of crustal materials, degrade surface waters and damage their use for drinking, industrial, agricultural, reaction or other purposes (Jarvieetal.,1998; Simeonov et al.,2003; Mahvietal.,2005; Nourietal.,2008; Karbassi etal.,2008). Rivers play a major role in assimilation or transporting the municipal and industrial wastewater discharge constitutes a constant polluting source, whereas surface run off is a seasonal phenomenon, largely affected by climate within the basin(Singhetal.,2004; Karbassi et al., 2007; Karbassietal.,2008; Najafpour,2008).Due to increasingproblem of deterioration of river water quality, it is necessary to monitor the water quality in order to evaluate the production capacity(Mishra et al., 2009).

This is where the field of engineering comes into play. Different types of engineers play a significant, individual role in keeping the water in our world safe for us and our environment. Water and its characteristics as volume, temperature, salinity, pH and level of its quality for various purposes as irrigation of the farmlands, industrial use, aquaculture and drinking uses, has been studied by a wide range of specialists as hydrologists , engineers, ecologists, geologists and geo-morphologists (Kumar and Dua, 2009). For

instance, an environmental engineer may study the effects of runoff around stockyards or agriculture areas and suggest ways to decrease the amount of nitrates or phosphates that are entering a nearby water supply. A civil and environment engineer may sample the water at cities water treatment facilities and make appropriate changes to the purification process to maintain safe water discharge from the site and will ensure that the water entering and leaving the city is not contaminated and are adequately safe for our use and the HSE managers may develop ways of decreasing the amount of heavy metals discharged from an industrial complex or a mining operation to lower contamination of groundwater or the receiver surface water in the area. One of the ways engineers do this is to sample the water at cities water treatment facilities and make appropriate changes to the purification process to maintain safe water discharge from the site as for healthy living, potable safe water is absolutely essential.

One of the most effective ways to communicate water quality is Water Quality Index (WQI), where the water quality is assessed on the basis of calculated water quality indices. Quality of water is defined in terms of its physical, chemical, and biological parameters. However, the quality is difficult to evaluate from a large number of samples,

each containing concentrations for many parameters (Almeida, 2007). Horton (1965) proposed the first WQI, a great deal of consideration has been given to the development of index methods. A water quality index provides a single number that expresses overall water quality at a certain location on several water quality parameters and turns complex water quality data into information that is understandable and useable by the general people.WQI is a mathematical instrument used to transform large quantities of water quality data into a single number which represents the water quality level while eliminating the subjective assessments of water quality and biases of individual water quality experts. Basically a WQI attempts to provide a mechanism for presenting a cumulatively derived, numerical expression defining a certain level of water quality (Miller*etal.,*1986).

Numerous water quality indices have been formulated allover the world which can easily judge out the overall water quality within a particular are a promptly and efficiently. For example, US National Sanitation Foundation Water Quality Index (NSFWQI) (Sharifi1990), Canadian Council of Ministers of the Environment Water Quality Index (CCMEWQI) (Lumb2006), British Columbia Water Quality Index (BCWQI), and Oregon

Water Quality Index (OWQI) (Debels et al. 2005; Kannel et al. 2007; Abbasi 2002). These indices are based on the comparison of the water quality parameters to regulatory standards and give a single value to the water quality of a source (Khan et al. 2003; Abbasi 2002). One of the methods that has led to an improvement over the old indices is the comparison of these indices with each other. In this regard, the first comparison among quality indices of water was conducted by Ottin1971; he compared two indices which had been created by Land or and Deninger and revised the quality indices in USA. Two indices which were presented by them belong to general and particular consumption indices. Such research has also been conducted in European countries. Brokel and Helmond proved through the results of their research about environmental indices that around 30 indices can be applied throughout the world to classify water quality. They showed that all indices include between 3 to 72 variables which have been selected from NH4+N,PO4+P,NO3+N,PHand total solid(RamirezandSolano,2004). In Iran water quality indices are under consideration too, such as the research conducted by Tajrishi and Norouzianin1998using a fuzzy classification technique on the Karoon and Dez rivers whereby these rivers were zoned qualitatively

(Norouzian,1998; Parvizietal., 2004).

In this paper, the WQI is assessed along the Babolrood River for different sampling campaigns from 2012 to 2013. The results are compared with water quality indices of the U.S. National Sanitation Foundation (NSFWQI).

MATERIALS AND METHODS

2.1 Study area

The present study was conducted along the Babolrood River, one of the most important rivers of Mazandaran province in North of Iran which is of about 120 km in length. Babolrood River with about 1659 square kilometers in area originates from Alborz mountain in south of Babol county by joining of three main tributaries namely - Azarrood, Karsangrood and Esklimrood. The study area with 7 sampling stations is shown on Figure 1.The parameters temperature, pH, dissolved oxygen (DO), Biochemical oxygen demand(BOD), total solids (TS), phosphate, Nitrates, Turbidity and Fecal coliform (FC) of 7 different locations along Babolrood River during of the year 2012 to 2013 (May to April) was collected and analyzed immediately at the sampling site using standard equipment.. Considering the length of the river, variation of developments and study of the effects of these developments and working with the stations being studied by the

Environment Protection Office in Mazandaran were selected seven stations. Sampling stations were numbered arbitrarily for convenience of records. Sampling date, place and time were recorded on the sampling bottles. The method of measuring the parameters is based on the methods presented in the standard method.

Table (1): The location and distribution of stations measuring water quality

| Serial No.	StationName	Geographical Situation	The Nearest City, town and villages	
			Before	After
1	Quran Talar	36, 18 Latitude – 52, 46 longitude	Lafur/village	Marzi Kola/village
2	Anarestan	36, 34 Latitude – 52, 49 Longitude	Anarestan /village	Darun Kola/village
3	Kharun	36, 29 Latitude – 52, 35 Longitude	TorkMahale/village	Darzi Kola/village
4	Habibi Bridge	36, 39 Latitude – 52, 39 Longitude	Darzi Kola/village	Babol city
5	Mohammad Hassan Khan Bridge	36, 31 Latitude – 52, 39 Longitude	Babol city	Babol city
6	Amir kola/town	36, 35 Latitude – 52, 39 Longitude	Babol city	Mir Bazar/village
7	Babolsar	36, 42 Latitude – 52, 38 Longitude	Babolsar city	Caspian Sea
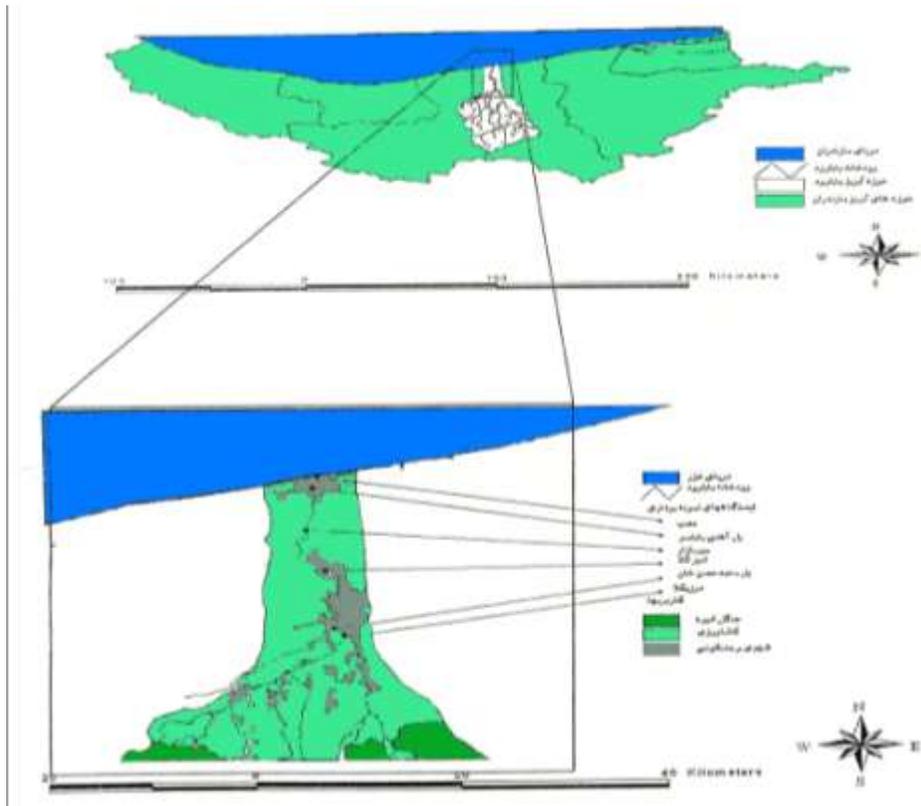
Figure (1): Location of Babolrood River Watershed

METHODOLOGY

To analyze and interpret the kinds of parameters measured along the range of a river, there are various mathematical methods that are used such as water quality index. It is one of the simplest methods with wide applications. In this method a considerable amount of data resulting from measurements

of water quality are converted to a single and dimensionless number in a rated scale with interpreted quality and conception. In general, water quality indices are divided into many methods (Sobhani, 2003), and the public indices is one of these methods which ignores the kind of water consumption in the evaluation process, NSFWQI, is among public indices (Ott, 1978) (Horton, 1965). Among the public water quality indices, NSF is the most applicable index in this regard. On the other hand, the parameters considered in this index are mostly the parameters that are measured in the river water quality monitoring programs and environmental assessment (Zandberg and Hall, 1988).

2.3 NSF Water Quality Index:

A Water Quality Index for the United States of America was developed by the National Sanitary Foundation (NSF) in1970 to monitor the variation trend in river water quality. It has been used throughout the USA by the executive agencies. This index represents the general water quality status of monitoring stations using 9 quality parameters. This index has the capability of being estimated using existing data from water quality parameters, if data for some parameters are lost. Parameters that are required for this index are as follows: fecal coliforms, BOD5, turbidity, pH, TSS, DO, N03, P04 and ΔT. Measured parameters

according to the sub-index of each of them are achieved on conversion curves. Then, to estimate the final index the following equations are used (NSF, 2003):

$$NSFWQI = \sum_{n-1} W_i q_i$$

qi = Sub-index of each parameters

Wi = Weighting factor

N = Number of sub-indices

Table 2 shows the ranking criteria of NSF water quality index and, in Table3, the weights of the water quality parameters are presented.

According to the book Field Manual for Water Quality Monitoring, the National Sanitation Foundation surveyed 142 people representing a wide range of positions at the local, state, and national level about 35 water quality tests for possible inclusion in an index. Nine factors were chosen and some were judged more important than others, so a weighted mean is used to combine the values so that field measurements could be converted to index values, respondents were asked by questionnaire to graph the level of water quality (0 through 100) corresponding to the field measurements .The curves were then averaged and are thought to represent the best professional judgment of the respondents. When test results from fewer

than all nine measurements are available, we preserve the relative weights for each factor and scale the total so that the range remains 0 to 100.(Sharif Vaghefi et al, 2012)

In this study the NSF water quality method has been used to assess the quality of Babolrood River in 7 selected stations. The present study aims at the assessment and classification of the Babolrood River water quality using National Sanitation Foundation water quality index (NSFWQI) in comparison with the recommended water quality standards for various purposes and provides WQI references values and the trend for the environment.

Table 2-Importancerateand parameters weight in NFSWQI (NSF water quality index ranking).

Water Quality Factors and Weights	
Factor	**Weight**
Dissolved oxygen	0.17
Fecal coliform	0.16
pH	0.11
Biochemical oxygen demand	0.11
Temperature change	0.10
Total phosphate	0.10
Nitrates	0.10
Turbidity	0.08
Total solids	0.07

Table 3: Water quality value

		Quality
90-100	Verygood	
70-90	Good	
50-70	Medium	
25-50	Bad	
0-25	Verybad	

RESULTS AND DISCUSSIONS

In this study, sampling was done in 7 sampling stations, where are located along the Babolrood River from upstream(Quran Talar) to downstream (Babolsar)The sampling have been done for one year from May, 2012 to April, 2013 which was measured monthly for the parameters. In Table 3 the values of the final index for each station in each season have been shown separately based on measuring results in the water considered, after the calculate with NSF modeling.

Due to the lack of expert study and in section of the water quality of most rivers of Iran, using water quality indices for particular consumption is considered as a simple method for the primary recognition of river water quality level. The achieved qualitative index has been located in the extent of 43 to 77, and based on the classified table of the qualitative index (table 5), most of stations have been located at the average class.

Due to qualitative evaluation along the Babolrood river, all the urban wastewater of cities of Babol, Amirkola and Babolsar as well as industrial and agricultural effluents enter into the Babolrood River at stations 5, 6 and7.Therefore this river water is not appropriate for drinking in the area where the recent stations are located i.e. from entering of the river to the Babol plain to the Caspian

Sea. However the water quality at the most of stations is suitable for farmlands irrigation and aquaculture. Due to the abovementioned issues, to improve the river water quality Mazandaran Water and Wastewater Company had started to build a waste water treatment plant for Babol city as well as a network for gathering and conducting the sewage and urban wastewater the this treatment plant. Table 5 show the result Water quality index by NSF.

Table4-Water Quality monitoring along with Babolrood River

Season	Station	Water Quality index									total res
		TO	DO	NO	Turbidi	FC	pH	BOD	PO	TS	
Summer	1	93	57	94	73	96	80	19	98	51	73
	2	88	60	93	65	84	81	14	93	50	69
	3	85	56	92	56	50	85	11	95	50	63
	4	85	73	89	48	58	79	15	92	49	65
	5	84	61	87	32	56	80	11	96	50	63
	6	72	64	79	25	42	75	14	89	49	56
	7	70	50	74	25	32	58	8	72	43	47
Fall	1	93	72	96	84	98	79	18	96	49	77
	2	93	59	88	77	83	57	19	93	53	68
	3	86	64	81	74	66	55	11	92	47	63
	4	85	60	85	72	65	54	12	89	45	62
	5	84	58	79	64	49	52	9	85	46	57
	6	73	46	69	48	43	49	8	81	41	49
	7	72	42	66	46	40	48	7	79	40	47
Winter	1	93	61	93	58	98	88	18	94	64	74
	2	90	60	69	57	88	82	12	91	52	67
	3	85	56	64	42	71	86	13	95	52	63
	4	87	45	60	27	63	87	9	96	53	58
	5	89	59	85	25	45	84	17	93	49	60
	6	71	41	59	18	42	48	12	89	43	45
	7	69	40	57	15	41	45	6	82	42	43
Spring	1	93	57	92	48	90	80	14	95	76	71
	2	90	52	84	37	68	70	12	94	62	62
	3	85	58	83	33	68	79	10	97	70	64
	4	89	55	80	31	55	67	9	94	68	60
	5	91	53	79	32	60	71	11	91	67	61
	6	85	46	61	30	50	49	9	83	47	50
	7	68	31	52	25	43	48	7	81	42	43

Table5-Water quality index (NSF result)

Station	Spring	Summer	Fall	Winter
1	Good	Good	Good	Good
2	Medium	Medium	Medium	Medium

3	Medium	Medium	Medium	Medium
4	Medium	Medium	Medium	Medium
5	Medium	Medium	Medium	Medium
6	Medium	Bad	Bad	Bad
7	Bad	Bad	Bad	Bad

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