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Analysis on Water Quality of Haora River in Agartala with an Assessment of Water Quality Index

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Abstract

Sampling of surface water from Haora River, flowing in the city of Agartala,in the north-eastern state of Tripura was carried out over a stretch of 30 kilometers and based on the various physiochemical parameters analyzed a study was performed. A total of 12 different sampling sites were chosen, starting from Kalabagan to Joynagar, on the downstream of the river taking into account the point sources of waste discharge and samples of water were collected during the summer, pre-monsoon, post-monsoon and winter season from these locations. Tests were performed by analyzing 13 parameters namely pH, conductivity, turbidity, dissolved oxygen (D.O.), total dissolved solids (TDS), phosphate, nitrate, copper, fluoride, iron, calcium, magnesium and total hardness. The test results were compared with the standard permissible limits of the different parameters prescribed by various regulatory bodies. It was noted that many of the parameters exceeded the prescribed permissible limit. The total hardness was found to be well within the permissible limit. High concentration of iron was found in the Haora River at all the locations with a maximum value of 9.81mg/l at Reshambagan. An analytical study to determine the water quality index at different locations was performed by using standard methods of analysis and the water samples were categorized into five distinctions i.e. from excellent to poor. Most of the samples varied from poor to fair as revealed from the test results analysis. It was also found out that the water was comparatively less polluted in the upstream than that in the downstream and thus unfits to be used for drinking purposes. Appropriate treatment is hence needed to enhance the water quality.The water quality index will thus be an effective tool for the water managers and will help them in future planning.

Keywords: CCMEWQI; Haora River; water quality index; Agartala water contamination.

1. Introduction

Agartala (23.8333° N, 91.2667° E)is the capital of Tripura which belongs to the North-Eastern part of India consisting of the contiguous seven sister states. The Khowai, Manu, Haora, Muhuri and Gomati are the most important rivers of Tripura among which Gomti is the largest. The average rainfall in Agartala is around 230 cm per annum. As a result of relatively lesser rainfall, the rivers and streams contain insufficient water almost throughout the year. So far no effective measures to provide safe drinking water to the people of this state have been taken nor have any programs been launched for the remediation of these problems.

Water is one of the most important natural resources to sustain life and thus ascertaining its quality is of prime importance before its use for drinking, agricultural, industrial or recreational purpose. In view of the present needs to safeguard the freshwater resources, river water quality monitoring programs could be launchedon the basis of existing water quality information and anthropological effects on it (Sharma et al., 2011). The water quality index (WQI) is a single mean of representation to summarize a large number of complex water quality data into simpler terms (Cude, 2001) for reporting it to the public and management authorities in a consistent manner. However, it becomes a tedious job to assess and present the data in a single unit when a large number of samples and parameters are considered (Pesce et al., 2000). The concept of WQI lies on the comparison of the various water quality parameters with respective standards as specified by the various standard regulatory authorities. There is no single water quality index globally accepted although many indices have been developed (Sargaonkar et al., 2003; Lumb et al., 2006). The Canadian water quality index was used in our study as it facilitates a large number of parameters and it has been the model for the development of the other global water quality indices.

2. Materials and Methods

2.1 Outline of CCME WQI

An index was formed by the CCMEWQI technical sub-committee which can be well accepted and used globally (Cash et al., 2001; Khan et al., 2003). A set of physiochemical as well as biological parameters can be used based on the availability of data from each sites. Regulatory guidelines or objectives are required for the application of this method. Canadian Council of Ministers of the Environment (CCME 2001) recommends that a minimum of four variables sampled at least four times should be used for index calculation. It should also be ascertained that the variables chosen must provide relevant information about a particular site (CCME 2001). The index calculation mainly involves the calculation of three components or factors:

(1) Scope (F_1): It has been adopted directly from the British Columbia index as the percentage of variables whose objectives are not met at least once during the

time period of consideration with respect to the total number of variables measured:

$$F_1 = \left(\frac{Number\ of\ failed\ variables}{Total\ number\ of\ variables}\right) X\ 100$$

(2) Frequency (F_2): It represents the percentage of individual tests that do not meet the objectives:

$$F_2 = \left(\frac{Number\ of\ failed\ test}{Total\ number\ of\ tests}\right) X\ 100$$

(3) Amplitude (F_3): It represents the extent by which the failed test values do not meet their objectives and is calculated as follows:

(i) The amount by which the failed test value is greater than the objective is termed as the excursion and is expressed as:

$$\text{Excursion} = \left(\frac{Failed\ Test\ Value}{Objective}\right) - 1$$

(ii) For the cases in which the test value must not fall below the objective, excursion is given as:

$$\text{Excursion} = \left(\frac{Objective}{Failed\ Test\ Value}\right) - 1$$

(iii) The amount by which the individual tests exceed from their objectives is summed up and divided by the total number of tests to find the normalized sum of excursions or nse:

$$nse = \frac{1}{No.\ of\ Tests}\sum_{i=1}^{n} excursion$$

(iv) F_3 is calculated using an asymptotic function that scales the nse to range in between 1 and 100:

$$F_3 = \frac{nse}{0.01nse + 0.01}$$

Once the factors are obtained the Canadian Water Quality Index is calculated as follows:

$$CCMEWQI = 100 - \frac{\sqrt{F1^2 + F2^2 + F3^2}}{1.732}$$

CCME (2005) ranks the water quality into five distinctions as poor, marginal, fair, good and excellent and is shown in Table 1.

Table 1: Categorization of WQI by CCME 2005.

Categorization	Index Value	Remark
Excellent	95-100	Water quality is protected with a virtual absence of threat
Good	80-94	Conditions rarely depart from desirable levels
Fair	65-79	Conditions sometimes depart from desirable levels
Marginal	45-64	Conditions often depart from desirable limits
Poor	0-44	Conditions usually depart from desirable limits

2.2 Study Methodology and Testing

The sampling and analysis was done using standard methods given in APHA 1998 for four seasons namely summer, pre monsoon, post monsoon and winter from 12 locations along Haora River starting from Kalabagan and 30 km downstream till Joynagar Bridge as shown in Fig. 1. A total of 13 parameters were tested and analyzed using the following instruments as shown in Table 2. These results were compared with the standard permissible limit prescribed by the standard regulatory bodies as shown in Table 3.

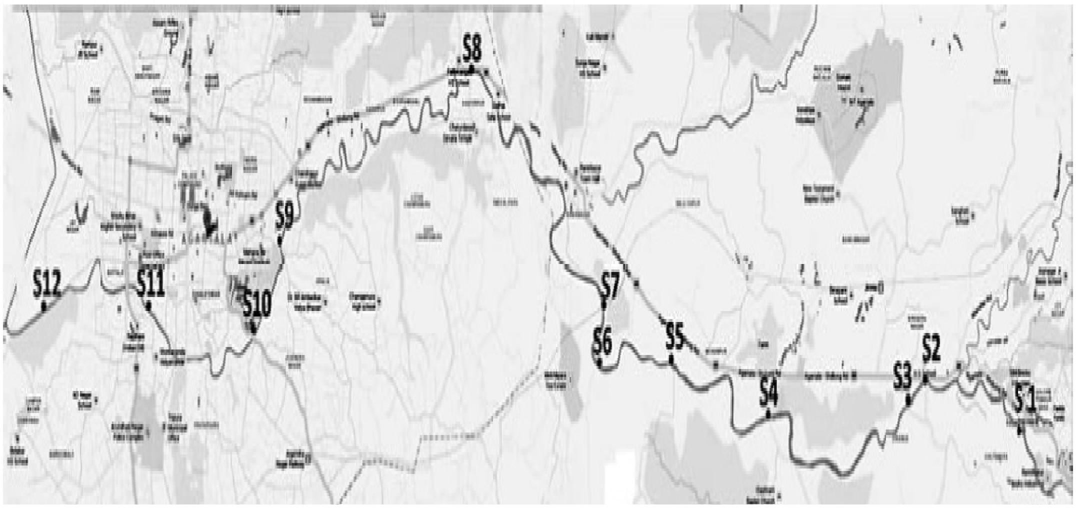

Fig. 1: Sampling stations along the stretch of Haora River.

Table 2: Parameters and Instruments used for testing.

Parameter	Instrument Used
pH, Turbidity, Electrical Conductivity, Total Dissolved Solids, Dissolved Oxygen,	Water Quality Meter
Phosphate, Fluoride, Copper, Nitrate	UV Visible Photo Spectrometer
Calcium, Magnesium, Iron, Total Hardness	Atomic Absorption Spectrophotometer

Table 3: Standard Permissible Limits of Parameters.

Parameter	Permissible Limit	Reference	Parameter	Permissible Limit	Reference
pH	6.5-8.5	IS 3025,Part 11,1983	Phosphate	5.0 mg/l	IS 10500, 1992
TDS	1000 mg/l	IS 3025,Part 16,1984	Nitrate	50 mg/l	IS 3025, Part34,1988
Conductivity	300 µS/cm	CPCB	Iron	0.3 mg/l	WHO 2004

D.O.	6.0 mg/l	IS 10500, 1992	Copper	2 mg/l	WHO 2004
Fluoride	1.5 mg/l	23 Of IS 3025,1964	Turbidity	10 NTU	WHO 2004
Calcium	200 mg/l	IS 3025: Part 40;1991	Total Hardness	600 mg/l	IS 3025,Part 21,1983
Magnesium	100 mg/l	IS 3025;Part 46;1994			

3. Results and Discussion

The results of the analysis of the physiochemical parameters reveal that mainly three parameters namely turbidity, phosphate and iron were found exceeding the permissible limits at almost all the locations during the period of study of one year. Nitrate and dissolved oxygen were also found deviating from the desirable vales at some sampling stations.

3.1 Iron

Increase in the level of iron in water may be attributed to the excess of iron in the soil and corresponding siltation and it may cause staining of utensils, plumbing, may impart bad taste to foods. The WHO guideline is 0.3 mg/l whereas the average concentration in Haora River is 4.08 mg/l which is much higher.

3.2 Turbidity

Turbidity is caused due to the presence of suspended and colloidal particles such as finely divided particles, silt, clay etc. The average turbidity was found to be 197.8 NTU as compared to the WHO guidelines of 10 NTU which is much higher. The turbidity was high in the rainy seasons due to heavy rainfall and also in the summer seasons when the water was less.

3.3 Phosphate

The presence of phosphates may be attributed to anthropogenic activities, animal wastes, laundry, industrial effluents and fertilizer runoff. It may cause eutrophication in the water body which in turn fills the river bed and makes it shallow. The average concentration of phosphate found was 7.9 mg/l and the CPCB guideline is 10 NTU.

3.4 Water Quality Index (WQI)

The overall water quality of the Haora River was found to range in between poor to fair with the fair quality of water obtained from the upstream at Kalabagan and ADC Choumuni. The quality of water deteriorated along the downstream with the poor quality found near Joynagar Bridge. The water quality index values calculated using CCME 2001 are shown in Fig 2.

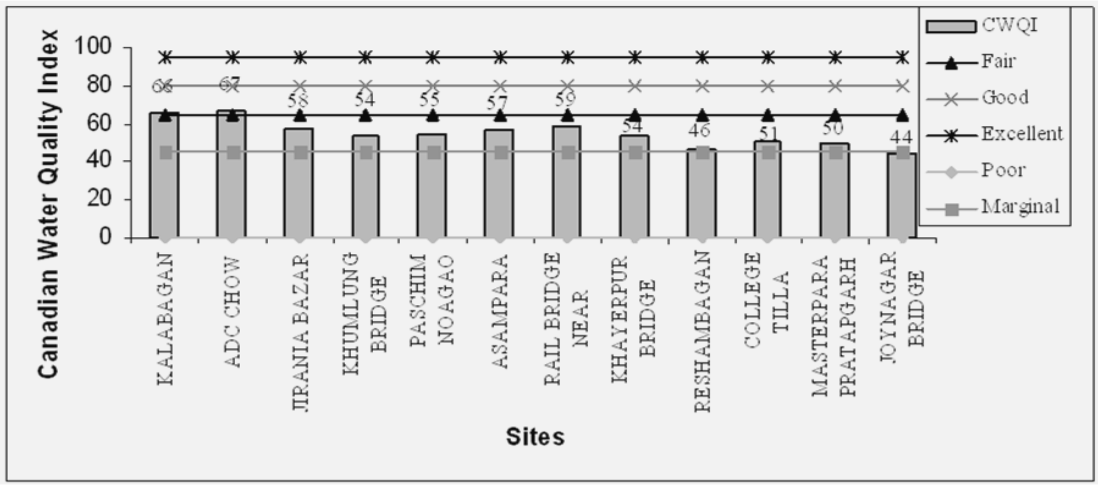

Fig. 2: Canadian Water Quality Indices at various sampling stations.

4. Conclusion

Higher concentration of iron, phosphate and turbidity makes Haora River water unfit for consumption without treatment. The river water on an average was found to be of marginal quality. Due to lesser amount of water in river during the summer and winter seasons the concentration of contamination was found relatively higher than other seasons. The determination of water quality index will be used for assessment and management purposes over time and space and will act as a key indicator towards the changes in environmental parameters.

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