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Assessment of Water Quality Index of the Brahmaputra River of Guwahati City of Kamrup District of Assam, India

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***Abstract*—Water quality index (WQI) provides a single number that expresses overall water quality at a certain location and time based on several water quality parameters. The objective of a WQI is to turn complex water quality data into information that is understandable and useable by the public. This study was conducted to measure the water quality parameters of the Brahmaputra river in Guwahati city of Kamrup district of the state Assam, India to determine the WQI of the river Brahmaputra. Water quality focuses on various aspects of the physico-chemical parameters by which the quality of the water body can easily be elucidated. Five different locations were selected within the study area. Water samples were collected in March 2017 from these five locations along the river and analyzed for these physico-chemical parameters: Hydrogen ion concentration (pH), Dissolve Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammoniacal Nitrate (AN) and Suspended Solids (SS). The values of these parameters were used to calculate the WQI based on the equation derived by the Department of Environment (DoE) Malaysia. The WQI was found to be 61.71, which falls in the class IV category.**

Keywords*— *Physico-Chemical; Water Quality Index; Water Quality Parameters

I. INTRODUCTION

The river Brahmaputra is one among the mighty rivers of India. It makes very brisk descent from its origin in Tibet and after roving a distance of 1625 km, enters India in the state of Auranchal Pradesh. It is known as Siang and Dihang in the upper and lower reaches in Arunachal Pradesh respectively. It flows from left at Kobo, Assam. Then it enters Assam and is called Brahmaputra. The 2906 km long Brahmaputra river streaming through India finally enters into Bangladesh from the western side of the Garo Hills (Water Resources Department, Government of Assam). A river plays a fundamental role in draining water that falls in upland areas, assimilating or carrying off municipal and industrial wastewater, fertilizer discharges and runoff from agricultural fields, streets and roads which are responsible for river pollution (Stoomberg G.J., Freriks I.L., Smedes F. and Cofino W.P., 1995; Ward A.D. and Elliot W.J., 1995). A prime reason for this is that all three major sources of river water pollution (domestic, industry, and agriculture) are concentrated along the rivers.

The quality of water is of vital concern for mankind since it is directly linked with human welfare. The quality of water directly affects practically all water uses. Aquatic life and livelihood; municipal, industrial, and private water supplies; agricultural uses such as irrigation and livestock watering; recreational activities; and general aesthetics-all are affected by the physical, chemical, biological, and microbiological conditions that exist in watercourses and in subsurface aquifers. Water quality impairment is a prime concern because degraded water quality means that desired uses are not possible or not safe. Water quality focuses on the various facets of the physico-chemical parameters of water that detect the status of pollution and suitability of a particular water body for various aquatic organisms (Sabbir W., Masud M.A.A., Islam S.S., Rahman M.A., Islam M.R. and Rahi M.L., 2010). The key sources of water pollution are domestic wastes from urban and rural areas, and industrial wastes, which are discharged into natural water bodies. These pollutants that run into the water bodies can have deleterious effects on wildlife, plants and humans. The quality of aquatic environment generally depends on four kinds of factors, such as physical, chemical, biological and meteorological factors. Water quality is controlled and determined by the combinations of all kinds of factors in various ways and intensities (Rahman M.S., 1992).

Water quality assessment is one of the prime concern and a major challenge in all over the world. Water quality criteria are directly related to the health factors. Water quality determines the goodness of water for particular purpose. Water quality tests gives information about the health of the water body. By testing water over a period of time, the changes in the quality of the water can be seen. According to Rahman A.K.M., Sattar M.A., Baten M.A. and Hossain M.A., 2005, water quality assessments are technical reviews of physical/chemical data and information to determine the quality of water resources to make decisions on whether a water body is supporting or not supporting its designated uses such as aquatic life support, fishing and drinking water Municipal wastewater, anthropogenic activities like disposal of treated and untreated effluents from different industries and also the indiscriminate use of heavy metal containing fertilizers and pesticides in agriculture resulted in deterioration of water quality rendering serious environmental problems (Kar D., Sur P., Mandal S.K., Saha T. and Kola R.K., 2008).

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Water quality index (WQI) is a tool for assessing water quality through the determination of physico-chemical parameters of surface water. It can act as an indicator of water pollution because of natural inputs and anthropogenic activities. WQI is one of the most effective tools to provide feedback on the quality of water to the environmentalists and policy makers. It provides a single number expressing overall water quality status of a certain time and location. It is actually the categorization counting the combined influence of different important water quality parameters as it is calculated based on the concentration of several important attributes. Thus, it acts as a simple indicator of water quality. The advantage of the WQIs is that they efficiently give the overall water quality of a specific area. Examples of different water quality indices developed worldwide are British Columbia Water Quality Index (BCWQI), Canadian Council of Ministers of the Environment Water Quality Index (CCMEWQI), Oregon Water Quality Index (OWQI) and US National Sanitation Foundation Water Quality Index (NSFWQI). This study used the WQI derived by the Department of Environment (DoE) of Malaysia in 1986.

II. MATERIALS AND METHODS

A. Study Area

The present study was conducted over a stretch of 11 kilometres along the river Brahmaputra starting from the Uzanbazar Ghat up to the Pandu Ghat of Guwahati city of Kamup District of the state Assam, India. There were five sampling locations (points) such as: (i) Uzanbazar Ghat (ii) Panbazar Ferry Ghat (iii) Machkhowa (iv) Shantipur (v) Pandu Ghat in Guwahati city of Kamrup District on the Brahmaputra river. The distance between the sampling points were irregular and more than one kilometre. Fig. 1 shows the five sampling locations.

B. Preparation of map of sampling stations

The ArcGIS software was utilized to develop the sampling location map from thematic maps. The locations of five sampling points in the study area were obtained by using a handheld GPS instrument GARMIN GPS-60 receiver. GPS technology is useful for enhancing the spatial accuracy of the data integrated in the GIS. The sampling station location data was imported to ArcGIS using GCS_Everest_India_Nepal projection and attributes were assigned to each sampling station. The digitized maps of India, Assam, Greater Guwahati and Survey of India (SOI) topographic sheet no. ng46 were used in ArcGIS to generate the final study area map. Based on the location data obtained, the location map was prepared showing the five position of sampling points (Fig. 1) from where the river water samples were collected. Also, the places of Guwahati city within the city boundary were digitized using the point feature of the editor toolbar in ArcGIS. The GPS data and the map thus obtained forms the spatial database.

C. Sampling

River water samples were collected in March 2017. Two samples were collected from each location. A total of ten 500 ml plastic bottles were properly washed, dried and labelled. These bottles were rinsed again with the river water to be sampled just prior to sampling. The samples were taken from the sampling points 1 foot below the surface of the river. Once the bottles were filled, they were securely sealed. Precautions were taken during sampling to avoid aeration. For the analysis of DO, fixation was done immediately at the site in DO bottles after collecting the samples. Once collected, the samples were warily transported to the laboratory and analysis was done instantaneously. Table I shows sample numbers along with the respective five sampling locations.

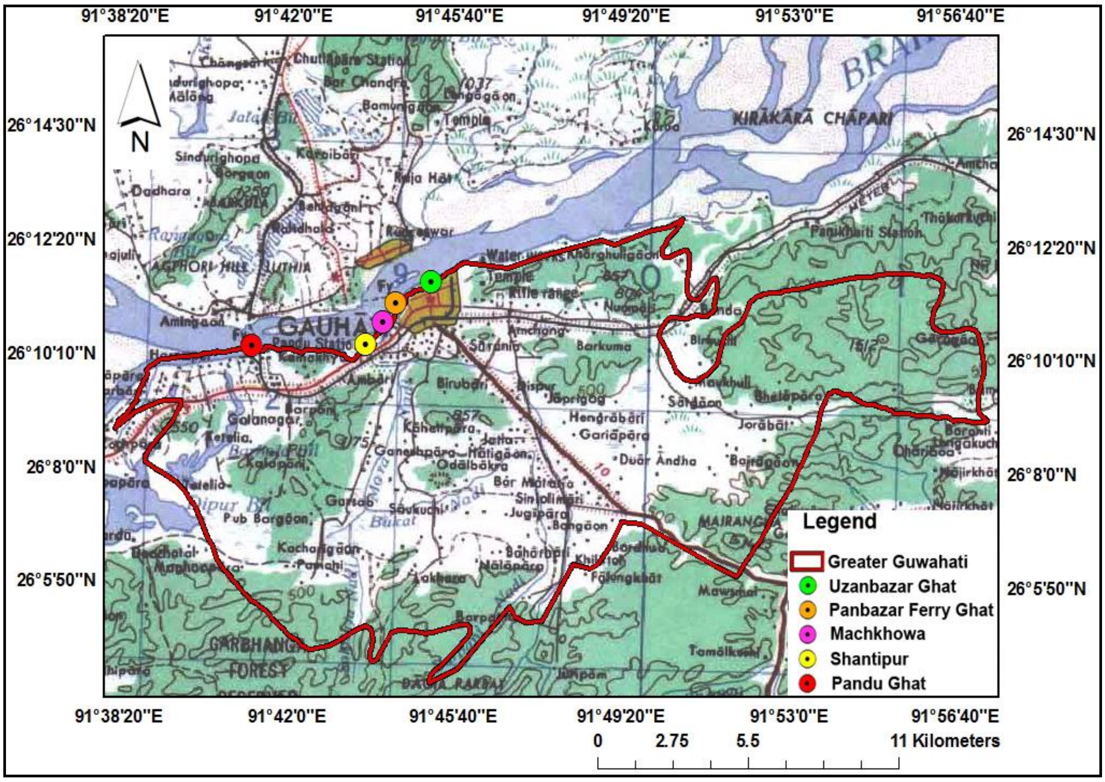

Fig. 1. Map of the study area showing the five sampling locations.

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TABLE I. SAMPLE NUMBERS AND SAMPLING LOCATIONS

Sample number	Location	Latitude N in degrees	Longitude E in degrees
1	Panbazar Ferry Ghat	26.186379	91.738371
2	Machkhowa	26.180241	91.734026
3	Shantipur	26.173346	91.727636
4	Pandu Ghat	26.172329	91.685945
5	Uzanbazar Ghat	26.193389	91.751406

Table II shows the physico-chemical parameters analyzed for this study and the instruments/method.

TABLE II. THE PHYSICO-CHEMICAL PARAMETERS, THEIR UNITS AND THE METHODS/EQUIPMENTS OF ANALYSIS

Parameter	**Unit**	**Method/Instrument**
Temperature	ºC	Thermometer
Hydrogen ion concentration (pH)		pH meter
Dissolved Oxygen (DO)	mg/l	Titration (Winkler method)
Biological Oxygen Demand (BOD)	mg/l	3 days BOD at 27ºC
Chemical Oxygen Demand (COD)	mg/l	Spectroquant TR 320 and Spectroquant Pharo 100
Suspended Solids (SS)	mg/l	Filtration
Amoniacal Nitrate (AN)	ppm	Titration

Fig. 2 shows some of the methods/instruments used for water quality parameter analysis.

Fig. 2. (a) Measuring pH, (b) BOD measurement after incubation.

D. *Water Quality Index (WQI) formula*

The following formula was used to calculate the WQI with their respective regulatory standards:

$$WQI = 0.15 * SI_{AN} + 0.19 * SI_{BOD} + 0.16 * SI_{COD} + 0.22 * SI_{DO} + 0.16 * SI_{SS} + 0.12 * SI_{pH}$$

Where, SI is the sub-indices of those parameters.

Table III shows the best fit equations of sub-index values and their ranges.

TABLE III. BEST FIT EQUATIONS OF SUB-INDEX VALUES AND THEIR RANGES (DOE, MALAYSIA, 1986)

Sub-index	WQI calculation	For the ranges
SI_{DO}	0	$x \le 8$
	100	$x \ge 92$
	$-0.395 + 0.03x^2 - 0.0002x^3$	$8 < x < 92$
SI_{BOD}	$100.4 - 4.23x$	$x \le 5$
	$108e^{0.055x} - 0.1x$	$x > 5$
SI_{COD}	$-1.33x + 99.1$	$x \le 20$
	$103e^{0.0157x} - 0.04x$	$x > 20$
SI_{AN}	$100.5 - 105x$	$x \le 0.3$
	$94e^{0.573x} - 5\|x - 2\|$	$0.3 < x < 4$
	0	$x \ge 4$
SI_{SS}	$97.5e^{0.00676x} + 0.05x$	$x \le 100$
	$71e^{0.0061x} - 0.015x$	$100 < x < 1000$
	0	$x \ge 1000$
SI_{pH}	$17.2 - 17.2x + 5.02x^2$	$x < 5.5$
	$-242 + 95.5x - 6.67x^2$	$5.5 \le x < 7$
	$-181 + 82.4x - 6.05x^2$	$7 \le x < 8.75$
	$536 - 77x + 2.76x^2$	$x \ge 8.75$

III. RESULTS

Table IV shows the test results of different water quality parameters used in the calculation of WQI for the Brahmaputra river. The SI values from Table 3 were used in the following equation to obtain the WQI.

$$WQI = 0.22*SI_{DO} + 0.19*SI_{BOD} + 0.16*SI_{COD} + 0.15*SI_{AN} + 0.16*SI_{SS} + 0.12*SI_{pH}$$

$$=> WQI = (0.22*3.33) + (0.19*86.02) + (0.16*86.68) + (0.15*0) + (0.16*153.31) + (0.12*56.83)$$

$$=> WQI = 0.73 + 15.76 + 13.87 + 0 + 24.53 + 6.82$$

$$=> WQI = 61.71$$

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TABLE IV. TEST RESULTS OF DIFFERENT WATER QUALITY PARAMETERS OF THE RIVER WATER SAMPLES

Parameters	Sample number	Parameter value	Average	Standard deviation (SD)	Mean ± SD	Sub-index (SI)
pH	1	7.95	8.26	1.11	9.37	56.83
	2	7.60				
	3	7.47				
	4	10.19				
	5	8.10				
DO (mg/l)	1	8.4	7.86	2.90	10.76	3.33
	2	11.4				
	3	8.2				
	4	3.3				
	5	8.0				
BOD (mg/l)	1	0.70	1.73	2.39	4.12	82.97
	2	0.5				
	3	0.77				
	4	6.0				
	5	0.69				
COD (mg/l)	1	3.24	5.48	3.86	9.34	86.68
	2	3.25				
	3	5.95				
	4	12.04				
	5	2.93				
SS (mg/l)	1	60	62.20	1.64	63.84	153.31
	2	63				
	3	63				
	4	64				
	5	61				
AN (mg/l)	1	4.9	5.4	0.52	5.92	0
	2	5.6				
	3	6.2				
	4	5.3				
	5	5.0				
Temperature (ºC)	1	24	24.20	0.45	24.65	-----
	2	24				
	3	24				
	4	25				
	5	24				

Fig. 3 shows the general rating scale for WQI thus calculated. According to the DoE, Malaysia, 1999, the scale for WQI is divided into five categories: (a) Class I (clean) (b) Class II (slightly polluted) (c) Class III, Class IV and Class V (polluted). When this WQI of 61.71 is placed on the general rating scales of Table 4, the Brahmaputra river water in March 2017 can be classed as class IV. It means that the Brahmaputra river water is polluted.

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<table>
<tr><th>Usage</th><th>10</th><th>20</th><th>30</th><th>40</th><th>50</th><th>60</th><th>70</th><th>80</th><th>90</th><th>100</th><th>WQI</th></tr>
<tr><td>General</td><td colspan="6">Very Polluted</td><td colspan="2">Slightly Polluted</td><td colspan="3">Clean</td></tr>
<tr><td>Water Class</td><td colspan="4">V</td><td colspan="2">IV</td><td colspan="2">III</td><td>II</td><td colspan="2">I</td></tr>
<tr><td>Public WS</td><td colspan="4">Not acceptable</td><td colspan="2">Doubtful</td><td colspan="2">Necessary Treatment Becoming More Expensive</td><td>Minor Purification Required</td><td colspan="2">Purification Not Required</td></tr>
<tr><td>Recreation</td><td colspan="2">Not Acceptable</td><td>Obvious Pollution Appearing</td><td>Only for Boating</td><td>Doubtful For water contact</td><td colspan="3">Becoming polluted, still need bacteria count</td><td colspan="3">Acceptable for all sports</td></tr>
<tr><td>Fish Shellfish Wildlife</td><td colspan="3">Not Acceptable</td><td>Course fish only</td><td>Handy fish only</td><td colspan="2">Doubtful for sensitive fish</td><td>Marginal for trout</td><td colspan="3">Acceptable for all sports</td></tr>
<tr><td>Irrigation</td><td colspan="3">Not Acceptable</td><td>Obvious pollution appearing</td><td colspan="7">Acceptable</td></tr>
<tr><td>Treated Water Transportation</td><td colspan="2">Not Acceptable</td><td colspan="9">Acceptable</td></tr>
<tr><td>Usages</td><td>10</td><td>20</td><td>30</td><td>40</td><td>50</td><td>60</td><td>70</td><td>80</td><td>90</td><td>100</td><td>WQI</td></tr>
</table>

Fig. 3. General rating scales for Water Quality Index based on DoE, Malaysia, 1999.

IV. CONCLUSION

The present study concludes that the Brahmaputra river water within the study area is doubtful and not fit for drinking, but might be used for agricultural purposes. This quality of water may cause harm to the aquatic life and aqua-environment. This water is currently being used for washing clothes and utensils, discharging of sewage, boating, fishing, open defecation and religious ritual activities. Biological and organic impurities resulting from fertilizers, municipal wastewaters, septic systems, municipal and agricultural runoff are affecting the quality of the water on a daily basis. It is important that the water is subjected to continuous monitoring and treatment process if the water is to be used for drinking, agricultural and domestic purposes.

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REFERENCES

[1] Kar D., Sur P., Mandal S.K., Saha T. and Kola R.K., "Assessment of heavy metal pollution in surface Water," International Journal of Environmental Science and Technology, 5(1): 119-124, 2008.

[2] Rahman M.S., "Water quality management in aquaculture," BRAC Prokashana, Bangladesh, 84 p, 1992.

[3] Rahman A.K.M., Sattar M.A., Baten M.A. and Hossain M.A., "Contamination of River waters," Bangladesh Journal of Environmental Science, 11(2): 319-322, 2005.

[4] Sabbir W., Masud M.A.A., Islam S.S., Rahman M.A., Islam M.R. and Rahi M.L., "Some Aspects of Water Quality Parameters of the Mouri River, Khulna: an Attempt to Estimate Pollution Status," Bangladesh Research Publication Journal, 4(1): 95-102, 2010.

[5] Stroomberg G.J., Freriks I.L., Smedes F. and Cofino W.P., "Quality Assurance in Environmental Monitoring," P Quevauviller edition, VCH, Weinheim. 1995.

[6] Ward A.D. and Elliot W.J., "Environmental Hydrology," AD Ward and WJ Elliot eds. CRC Press, Boca Ratan, 1995.

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