Progressive Agriculture 27 (3): 355-361, 2016 **ISSN: 1017 - 8139**

Progressive Agriculture
Journal homepage:http://www.banglajol.info/index.php/PA

Assessment of water quality index: a case study in Old Brahmaputra river of Mymensingh District in Bangladesh

Z Muyen[1*], M Rashedujjaman[2], MS Rahman[3]

[1]Associate Professor, Department of Farm Structure & Environmental Engineering, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

Abstract

This study was conducted to measure the water quality parameters of old Brahmaputra River in Mymensingh district near Bangladesh Agricultural University to determine the water quality index (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. Three different locations were selected within the study area. Water samples were collected in April 2015 from these three locations along the river and analyzed for these physico-chemical parameters: pH, Dissolve Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammoniacal Nitrate (AN), 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 57.58, which falls in the class IV category and means that the water is "very polluted" and as of April 2015, this water is not suitable for public water supply, not suitable for recreational purpose, has limited potential for aquaculture but is suitable for irrigation.

Key words: Water quality parameters, physico-chemical, water quality index

 ***Corresponding Author:** zahida.muyen@bau.edu.bd

Introduction

One of the most important rivers of Bangladesh, the 3,000 km long Brahmaputra streaming through India enters into Bangladesh from the western side of the Garo Hills through Dewanganj Nalitabari, Jamalpur and Mymensingh. It meets with the river Meghna near Bhairab Bazar in Kishoreganj. The Old Brahmaputra river passes through the area near Bangladesh Agricultural University in Mymensingh district.

Rivers play a vital role in assimilating or carrying off industrial and municipal waste water, manure discharges and runoff from agricultural fields, streets and roads which are responsible for river pollution (Stoomberg *et al*., 1995; Ward and Elliot, 1995). The river system that flows though Bangladesh comprises the third largest sources of water to discharge to the oceans (Ali, 2002).

Water quality directly affects virtually all water uses. Fish survival, diversity and growth; recreational activities such as swimming and boating, municipal, industrial, and private water supplies, agricultural uses such as irrigation and livestock watering, waste disposal, 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 often a trigger for conflict in a watershed, simply because degraded water

quality means that desired uses are not possible or not safe (Heathcote, 1998). According to Sabbir *et al.* (2010), water quality focuses on the various aspects of the physico-chemical parameters of water that detect the status of pollution and suitability of a particular water body for various aquatic organisms. The quality of water is of vital concern for mankind, since it is directly linked with human welfare. The major sources of water pollution are domestic wastes from urban and rural areas, and industrial wastes, which are discharged into natural water bodies. Industrial pollutants that run into streams, rivers, or lakes can have serious effects on wildlife, plants and humans (Zuthi *et al.*, 2009). 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, 1992). The water qualityof a water body largely depends on the interactions of various physico-chemical factors (Momtaz *et al.*, 2010).

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 (Rahman *et al*., 2005). 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 *et al*., 2008). Pollution by organic matter and nutrients originates from anthropogenic sources, mainly as municipal wastewater (Vega *et al*., 1998).

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 policy makers and environmentalists. 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. 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 US National Sanitation Foundation Water Quality Index (NSFWQI), Canadian Council of Ministers of the Environment Water Quality Index (CCMEWQI), British Columbia Water Quality Index (BCWQI), and Oregon Water Quality Index (OWQI). This study used the WQI derived by the Department of Environment (DoE) of Malaysia in 1986.

Materials and Methods

Study area: The present study was conducted over a stretch of 3 kilometers along the river old Brahmaputra starting from the Shambhuganj Bridge of Mymemsingh District up to the last boundaries of Bangladesh Agricultural University campus. There were three sampling stations such as: (i) Bridge (ii) Kewatkhali (iii) “SheshMor” in Mymensingh district on the Brahmaputra river near Bangladesh Agricultural University. The distance between the sampling points were about one kilometer. Figure 1 shows the three locations.

Sampling: Samples were collected in April 2015. Three samples were collected from each location. A total of nine 250 ml plastic bottles were properly washed and rinsed with 1-2 ml 2% HCl and dried. All nine bottles were appropriately labeled. These bottles were rinsed again with the water to be sampled just prior to sampling. The samples were taken from points 12 inch below the surface of the water body. Once the bottles were filled, they were securely sealed. Precautions were taken during sampling to avoid aeration. Once

collected, the samples were carefully transported to the laboratory and analysis was done instantaneously. Table 1 shows the physico-chemical parameters analyzed for this study and the instrument/procedures employed.

Figure 1. Map of Mymensingh district showing the three locations within the study area.

Table 1. The physico-chemical parameters, their units and the methods/instruments of analysis

Parameters	Unit	Methods/Instruments
Temperature	^{0}C	Thermometer
pH(Hydrogen Ion Concentration)		Fisher scientific, Accumet XL600
DO (Dissolved Oxygen)	mg/l	Fisher scientific, Accumet XL600
BOD (Biological Oxygen Demand)	mg/l	Fisher scientific, Accumet XL600
COD (Chemical Oxygen Demand)	mg/l	Titration
SS (Suspended Solid)	Mg/l	HACH DR/870 Colorimeter
AN (Amoniacal Nitrate)	ppm	Titration

Figure 2 shows the instruments used in measuring pH, DO and SS.

Water Quality Index 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 2 shows the best fit equations of sub-index values and their ranges

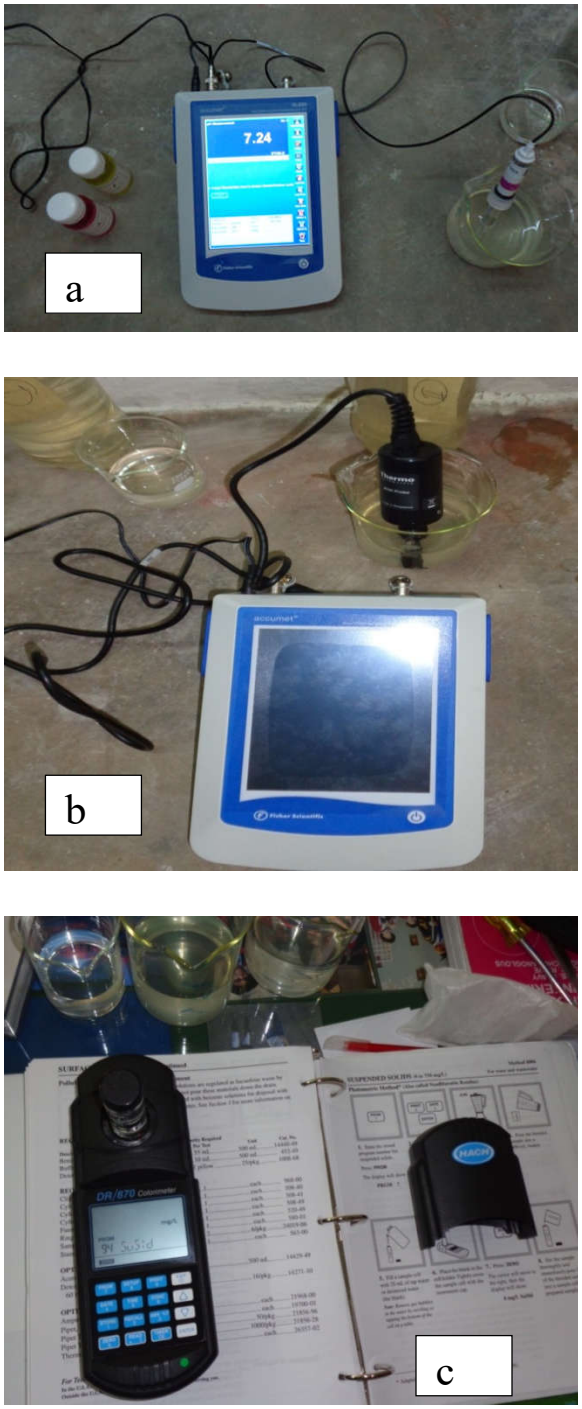

Figure 2. Measuring (a) pH and (b) Dissolved Oxygen (DO) with the Fisher scientific, Accumet XL60(c) Measuring Suspended Solids with HACH DR/870 Colorimeter.

Table 2. Best fit equations of sub-index values and their ranges (DoE, Malaysia, 1986)

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

Results

Table 3 shows the test results of different water quality parameters used in the calculation of WQI for old Brahmaputrariver. The SI values from Table 3 was used in the following equation to obtain the WQI.

$$WQI = .22*SI_{DO} + 0.19*SI_{BOD} + 0.16*SI_{COD} + 0.15*SI_{AN} + 0.16*SI_{SS} + 0.12*SI_{pH}$$

$$= (.22*0) + (0.19*98.57) + (0.16*98.03) + (0.15*0) + (0.16*119.18) + (0.12*320.94)$$

$$= 0 + 18.728 + 15.684 + 0 + 19.068 + 38.512$$

$$= 57.58$$

Table 4 is the general rating scale for WQI thus calculated. When this WQI of 57.58 is placed on the general rating scales of Table 4, the Brahmaputra river water in April 2015 can be classed as class IV. In its current class, this water is not suitable for public water supply, not suitable for recreational purpose, has limited potential for aquaculture but suitable for irrigation. Brahmaputra river water is currently being used for washing cloths and utensils, discharging of sewage and storm water, boating, fishing, open defecation and religious ritual activities. All these practices along the stretch of the river are generating serious threat to the biodiversity of the river by altering the physico-chemical concentrations of the river system.

Table 3. Test results of different water quality parameters

Parameters	Sampling Site	Sample	Average	Standard Deviation	Mean±SD	Sub-Index (SI)
pH	1	6.84	7.14	0.26	7.14±0.26	320.94
	2	7.24				
	3	7.35				
DO (mg/l)	1	0.54	0.53	0.02	0.53±0.02	0
	2	0.51				
	3	0.54				
BOD (mg/l)	1	0.53	0.51	0.02	0.51±0.02	98.57
	2	0.50				
	3	0.52				
COD (mg/l)	1	0.79	0.77	0.02	0.77±0.02	98.03
	2	0.75				
	3	0.78				
SS (mg/l)	1	17	19.34	8.74	19.34±8.74	119.18
	2	29				
	3	12				
AN (mg/l)	1	6.3	5.6	0.70	5.6±0.70	0
	2	5.6				
	3	4.9				
Temperature (^{0}C)	1	28	27.84	0.28	27.84±0.28	--------
	2	27.5				
	3	28				

Table 4. General Rating Scales for WQI (based on DoE, Malaysia, 1999)

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

Conclusion

The present study concludes that the Old Brahmaputra river water within the study area was not fit for drinking but might be used for agricultural purposes. This quality of water may cause harm to the aquatic life due to lower concentration of dissolve oxygen. 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, feedlots, 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.

Recommendations

As part of the regular monitoring program, seasonal and regional variations in the physic-chemical

parameters should be measured regularly and WQI determined to assess the extent of the pollution and pollution trends.

Reference

Ali MA (2002). Public Private Partnership for water resource management in Bangladesh Water. Department of Environment, The Government of Bangladesh.

Heathcote IW (1998). Integrated Water shed Management: Principles and practices. John Wiley and sons, Inc. New York.

Kar D, Sur P, Mandal SK, Saha T, Kola RK (2008). Assessment of heavy metal pollution in surface water. International Journal of Environmental Science and Technology, 5(1): 119-124.

Momtaz H, Alam AKMR, Hoque S (2010). A comparative study of phytoplankton diversity in relation to water quality of migratory birds visiting and non-visiting wetlands of Savar. Bangladesh Journal of Environmental Research, 8: 31-38.

Rahman MS (1992). Water quality management in aquaculture. BRAC Prokashana, Bangladesh, 84 p.

Rahman AKM, Sattar MA, Baten MA, Hossain MA (2005). Contamination of River waters. Bangladesh Journal of Environmental Science, 11(2): 319-322.

Sabbir W, Masud MAA, Islam SS, Rahman MA, Islam MR, Rahi ML (2010). 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.

Stroomberg GJ, Freriks IL, Smedes F, Cofino WP (1995). Quality Assurance in Environmental Monitoring, P Quevauviller edition, VCH, Weinheim.

Vega M, Pardo R, Barrado E, Deban L (1998). Assessment of seasonal and polluting effects on the quality of river water by exploratory data analysis. Water Research, 32(12): 3581-3592.

Ward AD, Elliot WJ (1995). In: Environmental Hydrology. AD Ward and WJ Elliot eds. CRC Press, Boca Ratan.

Zuthi MFR, Biswas M, Bashar MN (2009). Assessment of Supply Water Quality in the Chittagong city of Bangladesh. ARPN Journal of Engineering and Applied Sciences, 4(3): 73-80.