Journal of Civil Engineering and Environmental Technology
p-ISSN: 2349-8404; e-ISSN: 2349-879X; Volume 4, Issue 1; January-March, 2017, pp. 64-67

http://www.krishisanskriti.org/Publication.html

D.O. Modelling and Water Quality analysis of River Brahmaputra in Guwahati, Assam

Digvijay Kumar[1], Tandon Abhilash Borthakur[2] and Anupam Singhal[3]

[1,2,3]Department of Civil Engineering, BITS-Pilani
E-mail: [1]f2013125@pilani.bits-pilani.ac.in, [2]f2013623@pilani.bits-pilani.ac.in,
3anupam_singhal@pilani.bits-pilani.ac.in

Abstract—*Water quality of Brahmaputra River has been deteriorating at a rapid rate as a result of frequent floods, soil erosion and effluent disposal. This piece of work deals with research, experimentation and analysis of the cause and impact of pollution on river water mainly due to effluent disposal. In the present work, water samples are collected from three different points along the river Brahmaputra in Guwahati city during monsoon (August 2016) and water quality assessment is carried out. Water quality assessment parameters like pH, Turbidity, Dissolved Oxygen and Fluoride content values are determined using laboratory tests at BITS-Pilani to identify the highly correlated and interrelated parameters. Modelling of Dissolved Oxygen is done using Streeter Phelps model to analytically arrive at the DO sag curve. Calculated Dissolved Oxygen values are compared with the observed values to obtain a fair idea about the variation of Dissolved Oxygen consequent to the impact of nonpoint/unregulated sources of pollution along the river. Higher pH value was obtained from the water sample collected at site-2(Fancy Bazar, Guwahati), sample obtained from site -1(Narangi, Guwahati) is least turbid, sample obtained from site-3(Saraighat, Guwahati) has maximum amount of dissolved oxygen but there is no fluoride content in any of the samples. The mean values of all the measured physicochemical parameters of Brahmaputra river water are compared with the desirable limit set by W.H.O. Considerable variations of DO values of predicted and tested levels have been observed and subsequent conclusions have been derived with appropriate suggestions. General measures are suggested to reduce the adverse impact of water pollution on and by human settlement along the river taking broad view of environmental sustainability.*

Keywords: *Water quality, effluent, WHO, physiochemical, desirable limit, DO sag, Streeter Phelps, non-point sources*

1. INTRODUCTION

Rivers play an important role in socio economic development of a nation. India is privileged to have a number of rivers running through its lengths and breadths, but the quality of water in these rivers has become a cause of concern. Population growth, rapid industrialization and urbanization have been a major cause of the increasing pollution levels of the rivers. Consequently aquatic life and the environment of the rivers are facing serious threat due to discharge of wastewaters without prior treatment. A significant decline in the population of Irrawaddy dolphins and Ganges river dolphin has also been observed. Therefore, it is important to focus the research towards the development of water quality models that are capable of generating scenarios with the variation in critical water quality parameters.

Present study focuses on water quality assessment of Brahmaputra river (particularly the stretch flowing through Guwahati).The Brahmaputra river system is one of the largest river systems in the world.The Brahmaputra originates in the Mansarovar Lake, China. It flows eastward, parallel to the Himalayas reaching Namcha Barwa takes a U-turn around it and enters India in Arunachal Pradesh. In India, it flows through Arunachal Pradesh and Assam, and is joined by several tributaries.

2. MATERIALS AND METHODS

Description of study Area:

Guwahati is the largest city of Assam, a major riverine port city and one of the fastest growing cities in India.Guwahati is a densely populated city and has a population of 809,895 as per 2011 census. Guwahati lies between the banks of the Brahmaputra River and the foothills of the Shillong plateau.

We strategically chose three sampling stations to collect our water samples for laboratory testing. The first point was near the entrance of the river to the outskirts of the city. The second point was about 4 Km downstream at about the middle of the city. The third point was further 15 Km downstream and was towards the end of the city.

Sampling Stations:

Sampling Station 1: Narangi, Guwahati. (Just before reaching the city of Guwahati)

Sampling Station 2: Fancy Bazar, Guwahati. (Mid city, 4 Km downstream from station 1)

Sampling Station 3: Saraighat, Guwahati. (End of city, 15 Km downstream from station 2)

Map showing the sampling stations:

Fig: 1- Location of Brahmaputra river water sampling points

3. LABORATORY TEST RESULTS :

pH: The presence of hydrogen ion concentration is measured in terms of pH range. In the investigations carried out, the average value of pH of water at three sites is shown below. This was within the permissible range 6.5 to 8.5, prescribed by BIS drinking water standards. The graph below shows correlation between pH at 3 different sites.

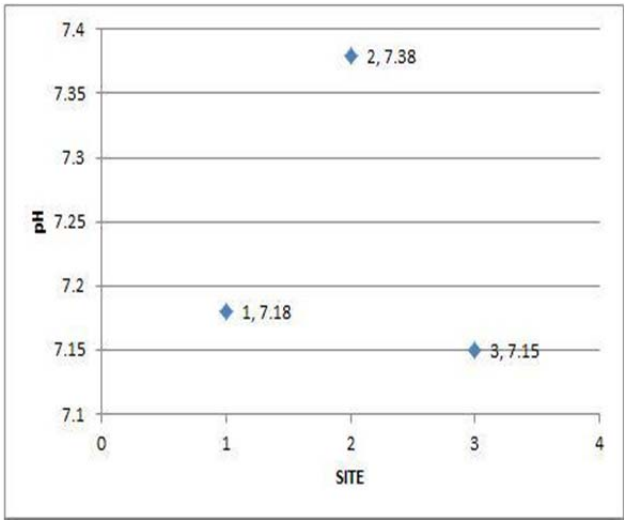

Fig. 2: A graph showing variation of pH at three different points along the river

Turbidity: Turbidity is the muddiness or haziness of a fluid caused by large number of individual particles that are generally invisible to the bare eye. The measurement of turbidity is a key test of water quality assessment. Maximum turbidity was measured at site-2 whereas minimum turbidity was measured at site-1.

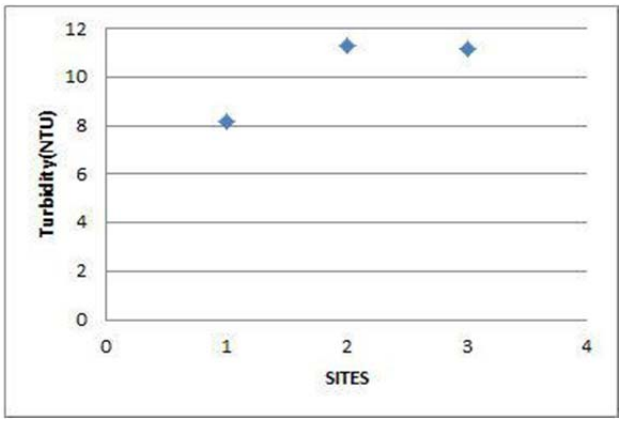

Fig. 3: A graph showing variation of turbidity at three different sites.

Dissolved oxygen (DO): Refers to microscopic bubbles of gaseous oxygen that are mixed in water and available to aquatic organisms for respiration—a critical process for almost all organisms.

In our laboratory test, maximum Dissolved Oxygen was found at site-3 whereas minimum Dissolved Oxygen was found at site- 2. The variation is shown through the below graph.

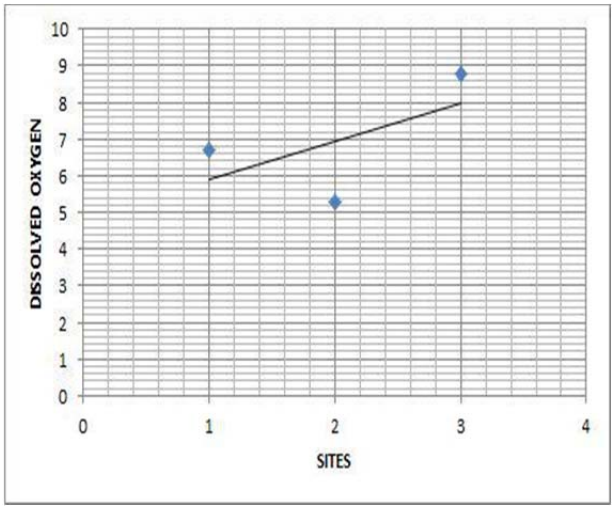

Fig. 4: A graph showing variation of Dissolved Oxygen at three different points along a river.

Fluoride Content: No fluoride content was found at any of the three sampling sites.

4. STREETER PHELPS MODEL

Streeter and Phelps (1925) developed a water quality model which was first used for the US Public Health Service based on field data obtained from the Ohio River. In the present study, Streeter Phelps model has been used for modelling BOD of the Brahmaputra river basin in a given stretch. Biochemical Oxygen Demand (BOD) is a measure of the

dissolved oxygen consumed by microorganisms during the oxidation of reduced substances in water and wastes.

$$D_t = \frac{K_D L(10^{-K_D t} - 10^{-K_R t})}{K_R - K_D} + D_o 10^{-K_R t} \quad (1)$$

K_D is the deoxygenation rate.

K_R is the reaeration rate.

D_0 is initial dissolved oxygen.

L is the initial oxygen demand of organic matter in water

Temperature Correction

Both the deoxygenation rate, K_D and reaeration rate, K_R are temperature corrected using the following general formula.

$$K = K_{20}\theta^{(T-20)} \quad (2)$$

Normally θ has the value 1.048 for K_D and 1.016 for K_R .

Furthermore, case study has been carried to understand the implications of the Streeter Phelps model.

5. CASE STUDY

The main objective of the case study is modelling of BOD using Streeter Phelps model and comparison of calculated BOD values with the observed ones to obtain a fair idea about contribution of BOD from nonpoint sources of pollution. The case study has been explained with the model.

6. DEVELOPMENT OF STREETER PHELPS MODEL

The Streeter Phelps model developed herein helps in predicting the DO at the sampling stations. For illustration, the step by step methodology adopted for predicting the values of DO during summer season is described below.

Step 1 (Calculation of 'k' values):

The deoxygenation constant ' K_D ' is calculated using equation (2). The average temperature value during summer season is obtained from CPCB. The value of ' K_D ' during summer season (T = 26.78^{0}C) comes out to be equal to 0.1d^{-1}and the value of K_R comes out to be 0.25 d^{-1}.

Average velocity of the river = 0.1913m/s. Time taken to travel between Sampling station1(Narangi) to Sampling Station2(Paltan Bazar) is 0.544day whereas time taken to travel between Sampling station2(Paltan Bazar) to Sampling Station3(Saraighat) is 0.44 day.

Step 2 (Calculation of DO):

Substituting the values obtained in step1 and step2, DO concentration for sampling station 1 is obtained as 5.3mg/l and that at sampling station 2 is 8.85 mg/l.

The values obtained from the model are compared with the laboratory values.

The comparison suggest a lower observed value of DO then the suggested value of the model, indicating presence of non-point sources along the river bank of the city.

Further, plots have been made to correlate the DO values obtained after physical tests and derived out of the Streeter Phelps model.

Step 3 : DO sag curve plot with comparison.

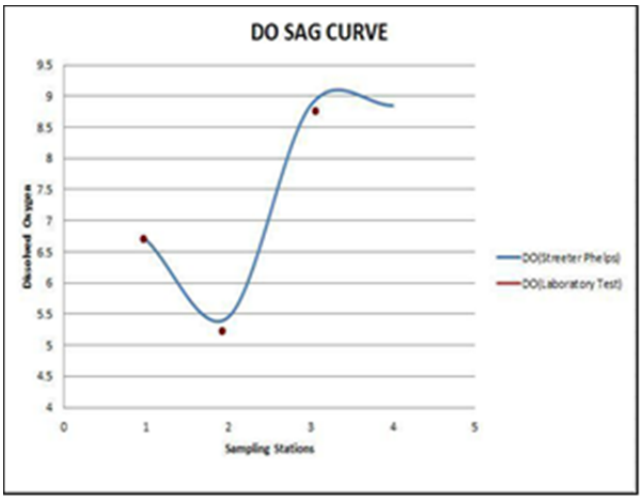

Fig. 5: A graph showing comparison of laboratory results and predicted values at three different sites.

7. A COMPARATIVE STUDY

The Central Pollution Control Board has over the years done various studies on water parameters of river Brahmaputra. In this segment a comparative study of CPCB data of 2012 with collected sample data tested in BITS Pilani laboratory has been attempted.

The comparison of DO values is as follows;

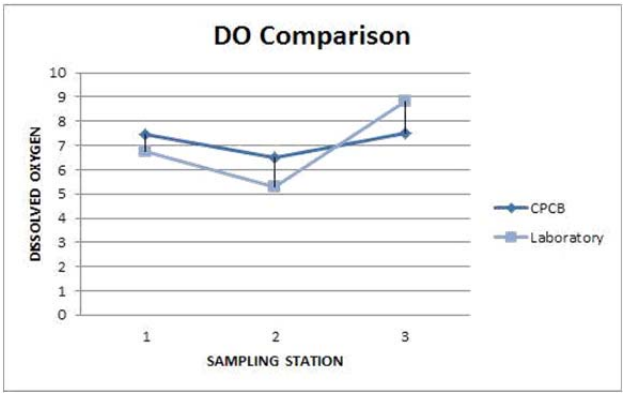

Fig. 6: A graph showing comparison of laboratory results and CPCB data for three different sites.

The comparison of pH values is as follows;

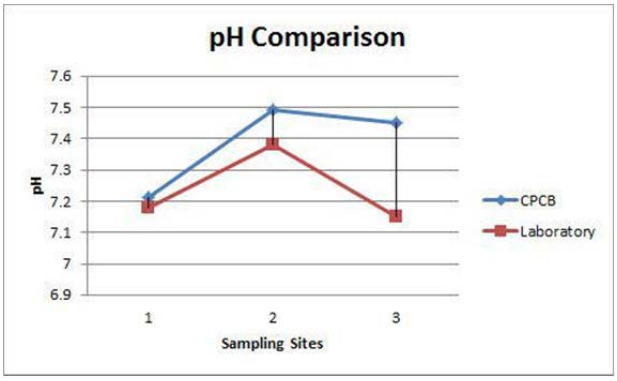

Fig. 7: A graph showing comparison of laboratory results and CPCB data for three different sites.

8. A TEMPORAL STUDY OF WATER STANDARDS

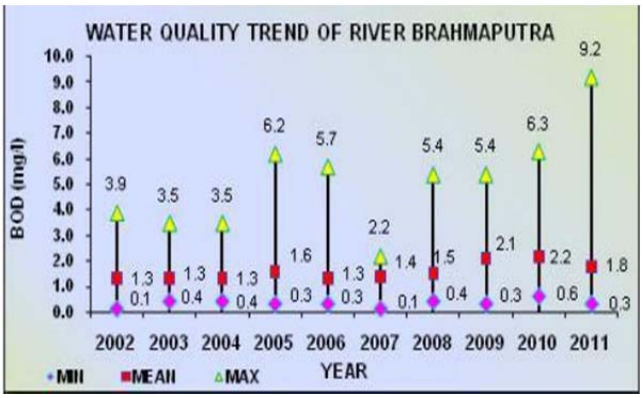

Fig. 8: Variation of BOD at site 2 as recorded by CPCB.

The impact of rapid industrialization can be clearly seen. Guwahati turning into an industrial and economic hub of the North East has rapidly impacted the water quality of the river. This could be seen in the ever increasing level of BOD as can be seen from the graph. With adequate flow, the mean value has remained constant; however, seasonal implications on the range of the BOD level could be clearly seen.

9. DISCUSSION

The results of present investigation makes it clear that the values of water quality parameters obtained at site-2 is high as compared to site-1 and site-3 except for the values of Dissolved Oxygen. This shows high pollution level at site-2 as compared to site-1 and site-3.

The variation of DO value in the Streeter Phelps model suggests the presence of some unregulated non-point sources along the river bank.

However, comparison of parameter values with IS codes and relative comparison with rivers like Ganga suggest a fairer quality of water in the Brahmaputra.

Rapid industrialization has impacted the river quality and stringent measures to control the expansion of polluting industries along the river and sustainable methods of agriculture should be adopted to prevent the river quality worsening further.

10. ACKNOWLEDGEMENTS

The authors would like to extend their gratitude towards BITS-Pilani for providing with the required infrastructure to carry out the required experiments. The authors would also like to thank Mr. B. Borah for the help provided in collection of samples from Brahmaputra River**.**

REFERENCES

[1] Brahmaputra Board, MoWR, GoI.

[2] Streeter HW, Phelps EB (1925) A Study of the Pollution and Natural Purification of the Ohio River. Public Health Service, Washington DC 146

[3] Smith BD, Braulik G., Strindberg S, Ahmed B, Mansur R (2006) Abundance of Irrawaddy dolphins (Orcaella Brevirostris) and Ganges river dolphins (Platanista Gangetica Gangetica) estimated using concurrent counts made by independent teams in waterways of the Sundarbans mangrove forest in Bangladesh. Marine Mammal Science, 22: 527–547

[4] Central Pollution Control Board (CPCB) New Delhi (2013) Pollution Assessment of river Brahmaputra. (data.gov.in)

[5] Comair, F.G., Gupta, P., Ingenloff, C., Shin, G. and McKinney, D.C. (2012) 'Water resources management in the Jordan River Basin', Water and Environment Journal, Vol. 27, No. 4, pp.495–504.

[6] Awadallah, A.G. and Yousry, M. (2012) 'Identifying homogeneous water quality regions in the Nile River using multivariate statistical analysis', Water Resour Manage., Vol. 26, No. 7, pp.2039–2055, doi 10.1007/s11269-012-9997-0.