WATER QUALITY ASSESSMENT OF RIVER GANGA USING WQI AT PATNA, SOUTH BIHAR, INDIA

Md. Kashif Imam[1], Ankur Kishor[2], Tanuja Mehta[3],

[1] *Student, Department of Civil Engineering, Delhi Technical Campus, UP, India*
[2] *Student, Department of Civil Engineering, Delhi Technical Campus, UP, India*
[3] *Assistant Professor, Civil Engineering, Delhi Technical Campus, UP, India*

ABSTRACT

The study has been carried to assess the water quality index of Ganga River at Patna, Bihar . The samples were collected from 6 different locations and analyzed for various physico-chemical parameters like Temperature, pH, Dissolved Oxygen, Biochemical Oxygen Demand, Turbidity and TDS. Water Quality Index serves as the basis for environment assessment of water in relation to pollution load categorization and designation of classes. The value of Water Quality Index (WQI) at almost all location indicates that water of Ganga River at Patna is unfit for drinking purpose due to disposal of heavy amount of sewage into the River.

Keyword : - *River Ganga, Water Quality, Physico-chemical parameters, pH, DO, BOD, Turbidity, TDS, WHO and Water Quality Index.*

1. INTRODUCTION

Ganga is a trans-boundary river of Asia which flows through India and Bangladesh. The 2,525 km (1,569 mi) river rises in the western Himalayas in the Indian state of Uttarakhand, and flows south and east through the Gangetic Plain of North India into Bangladesh, where it empties into the Bay of Bengal. Ganga is the most sacred and worshipped river of Hindus, is now one of the most polluted river of the country. Today, over 29 cities, 70 towns, and thousands of villages extends along the Ganga banks. Nearly all of their sewage - over 1.3 billion liters per day - goes directly into the river, along with thousands of animal carcasses, mainly cattle [1]. Another 260 million liters of industrial waste are added to this by hundreds of factories along the rivers banks. Domestic and industrial wastewater constitute as a constant polluting source, whereas surface runoff is a seasonal phenomena mainly controlled by climate [2].

Patna is located in the southern part of the state of Bihar, at 25°59′N 85°13′E, it is an old and unique city in India. The industrial effluents as well as domestic sewage/wastes are disposed in these rivers either with partial or no pre-treatment and hence increasing concentration of different kinds of pollutants including that of heavy metals in the riverine water [3]. The indiscriminate dumping and release of wastes containing wide variety of organic and inorganic pollutants including solvents, oils, grease, plastics, plasticizers, phenols, heavy metals, pesticides and suspended solids are hazardous substances into rivers might lead to environmental disturbance which could be considered as a potential source of stress to biotic community.

In the present paper an attempt has been made to analyze the changes within 40 days from March-April (in the 2021 year) period, on the physiochemical properties of water of river Ganga at three selected sampling sites viz: Digha Ghat, Gandhi Ghat and Malsalami Ghat. The water of river Ganga at aforesaid site was analyzed for Temperature, pH, Dissolved Oxygen, Biochemical Oxygen Demand, Turbidity and TDS.

2. Aims and Objectives

- To Collect Sample
- To analyse the physico-chemical parameters of water of River Ganga in Patna city at different Ghats.
- To compare the results with the WHO standards.
- To calculate water quality index(WQI)

3. Materials and Methods

This Chapter describes details of methods used for experiments, performed during analysis of water samples. Selection of effective sampling sites is first important point for observation and analysis of various physico-chemical parameters. Temperature of water samples were recorded on the sampling sites immediately with the help of Celsius thermometer. DO was fixed on sampling sites with Manganous sulphate and alkaline Potassium iodide solution

3.1 Study Area

These are the following three selected sampling sites:

- **Ghat-1 (Digha Ghat)**
  This ghat is situated at 25.65 degrees North latitude and 85.09 degrees East longitude of river Ganga in Patna. Digha is on the upstream of the river Ganga at a place, where it enters Patna city. The sampling point is being used as bathing ghats by small population inhabited around it. It receives moderate amount of domestic pollution from nearby residential habitation. The upstream of this sampling site receives organic load from different sources. The river is subjected to various types of human activities like washing clothes by laundries, bathing and disposal of sewage alongside the bank of river.

- **Ghat-2 (Gandhi Ghat)**
  It is situated at 25.62 degrees North latitude and 85.170degrees East longitude of river Ganga in Patna. This ghat is in the middle of the stream, where an estimated 600 bodies per month are cremated or burned and unburned ashes are thrown into the river. This causes river water unfit for use. It is situated in the middle of city and receives domestic sewage as well as hospital discharges due to which it is highly polluted and completely filled with dirt and filth along its side.

- **Ghat-3 (Malsalami Ghat)**
  It is situated at 25.59 degrees North latitude and 85.24 degrees East longitude of river Ganga in Patna. This ghat is situated adjacent to the Patna Jail. All the small drains carrying sewage through Jail premises find its way to Ganga. Beside these drains, also the sewer lines of this locality that remain choked most of the time, as a result of which the sewage overflows and by passes into Ganga. Downstream to this location Ganga receives huge amount of domestic sewage, because of dense population in this area

3.2 Sampling and Analytical Design

Water samples were collected for physico-chemical analysis from three sampling stations namely Digha Ghat, Gandhi Ghat, Malsalami Ghat respectively. As per the norms of the APHA [13], wide mouthed plastic bottles of one liter size was used for collecting the samples. These are analysed using standard methods for physicochemical examination of water. Samples were analysed for following physico-chemical parameters viz. Temperature, pH, Dissolved Oxygen, Biochemical Oxygen Demand, Turbidity and TDS [13]. All the experiment was done with in 24 hr of sampling.

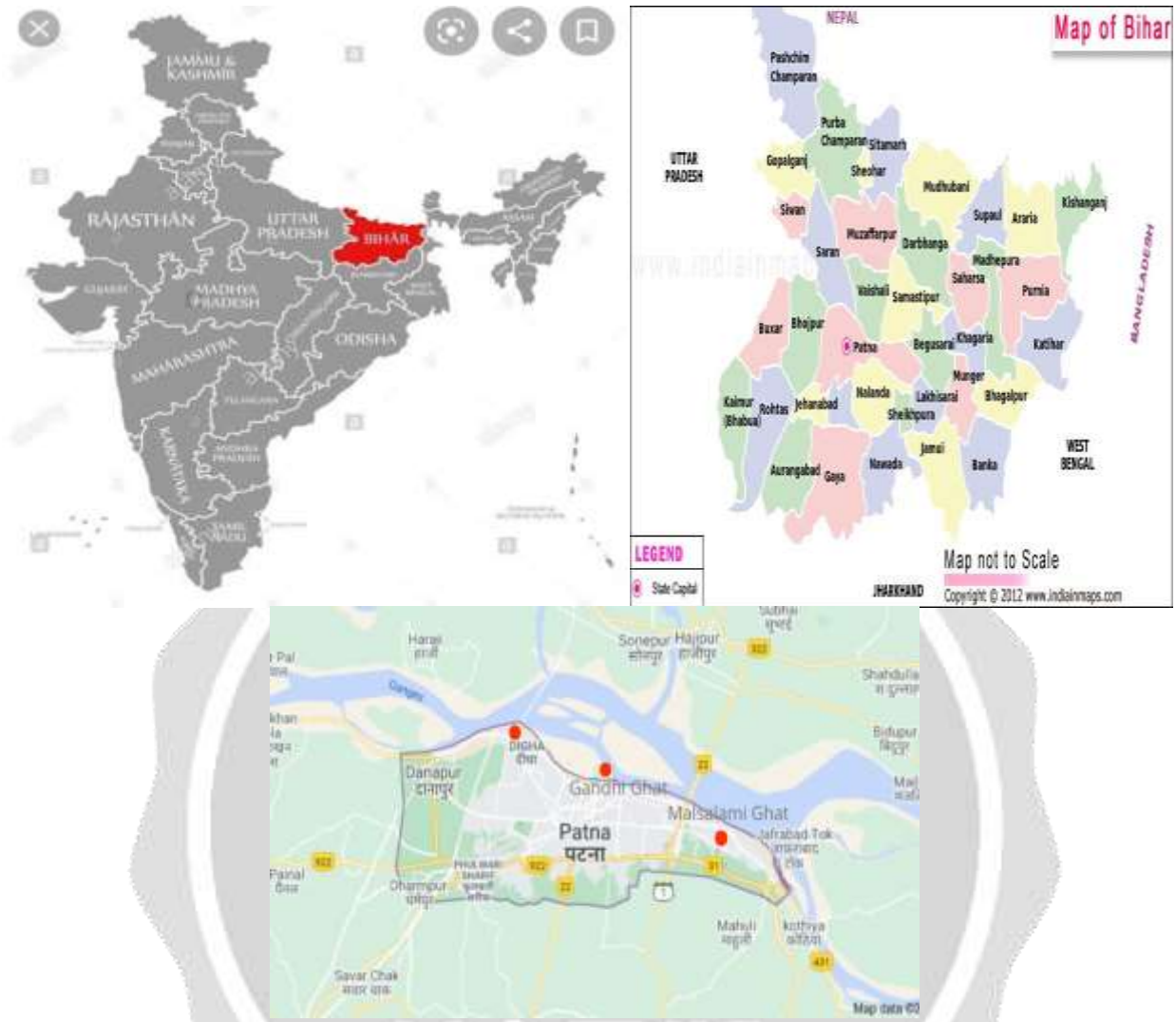

Fig-1 Map Showing Location of Sampling sites

4. Calculation of Water Quality Index

Water Quality Index is a very useful tool for communication the information on the overall quality of water [11]. The Bureau of Indian Standard and ICMR Standards have been considered for calculation of WQI. WQI was calculated using 3 steps:

- In the first step, the unit weight was calculated for each chemical parameter using the below equation
  : wi = k/Si
  Where, Si = Standard value of ith water quality parameter;
  k = Constant of proportionality and it was calculated by using the below equation:
  k = [1/(∑1/Si=1,2,…,i)]
- In the second step, qi was computed using the below equation:
  q*ii* = C*ii* *SSii* × 100
  Where, qi is the quality rating and Ci is the concentration of each chemical parameter in each water sample.
- In the third step, WQI is calculated by using the below equation:
  WQI = ∑qi × wi
  Water quality for drinking purpose has been usually classified into 5 categories:

WQI	STATUS
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very Poor
Above 100	Unsuitable for Drinking

Table 1. Water Quality Rating

5. Results and Discussion

The Results of the physico-chemical analysis of the samples collection from various sites is summarized in table-2. Various parameters including Temperature, pH, Dissolved Oxygen, Biochemical Oxygen Demand, Turbidity and TDS has been studied and discussed separately below.

Sampling Location	Temperature (°C)	pH	DO (mg/l)	BOD (mg/l)	Turbidity (NTU)	TDS (mg/l)
S1	30	7.4	9.2	6	20.6	560
S2	27	7.3	11.3	5	11.2	542
S3	28	7.2	1.2	12	9.9	1080
S4	30	7.2	1.5	16	14.4	1120
S5	32	7.1	0.8	22	12.6	660
S6	27	7.0	1.2	28	15.7	730

Table 2. Physiochemical properties of Ganga river water

5.1 Temperature

Temperature is mainly depending on the atmosphere and weather condition. It is basically important for its effects on certain chemical and biological reactions taking place in water and aquatic organisms [14]. Temperature of the river water was recorded as 30°C to 27°C, 28°C to 30°C and 32°C to 27°C respectively. Higher temperature at sample 5 was due to heating.

5.2 pH

pH of river water was maximum at sample 1. The variation can be due to the exposure of river water to atmosphere, biological activities and temperature changes [15, 16]. It was observed that the pollutant water directly influenced the pH of river. TOTAL SOLIDS

5.3 Dissolved Oxygen

Dissolved Oxygen is a factor which determines whether the biological changes are brought about by aerobic or anaerobic organisms. It reflects the physical and biological processes prevailing in the water. The oxygen present in water can be dissolved from air or produced by photosynthetic organisms [17]. Oxygen is generally reduced in the water due to respiration of biota, decomposition of organic matter, rise in temperature, oxygen demanding wastes and inorganic reductant such as hydrogen sulphide, ammonia, nitrites, ferrous iron, etc. [9]. DO was recorded as 9.2(mg/l), 11.3(mg/l), 1.2(mg/l), 1.5(mg/l), 0.8(mg/l), 1.2(mg/l). These values indicate relatively higher organic pollution. Thus, water of river cannot be used for fish culture as fishes needs at least 5 mg/l DO to survive.

5.4 Biochemical Oxygen Demand

BOD is the measure of degradable organic matter present in a water sample and it can be defined as the amount of oxygen required by micro-organisms in stabilizing the biodegradable organic matter under aerobic condition. The

aim of BOD test is to determine the amount of biochemically oxidisable carbonaceous matter [19]. The BOD observation was recorded as 6(mg/l), 5(mg/l), 12(mg/l), 16(mg/l), 22(mg/l), 28(mg/l). These variations are due to the addition of higher amount of organic matter.

5.5 Turbidity

Turbidity values was recorded as 20.6NTU, 11.2NTU, 9.9NTU, 14.4NTU, 12.6NTU, and 15.7NTU. The increased turbidity during these months was attributed to soil erosion in the nearby catchment and massive contribution of suspended solids from sewage. Surface runoffs and domestic wastes mainly contribute to the increased turbidity [18].

5.5 TDS

TDS is measure of the combined content of all organic and inorganic substances contained in a liquid in molecular, ionized or micro-granular suspended form. It is an important parameter for water quality. TDS was recorded as 560(mg/l), 542(mg/l), 1080(mg/l), 1120(mg/l), 660(mg/l) and 730(mg/l). Results shown that sample 4 contains maximum TDS due to huge discharges of industrial effluents without or partial pre-treatment. This TDS values having lower concentration as compared to WHO standards recommended.

6. Statistical Analysis

The statistical Analysis was done to check the suitability of water for human consumption.

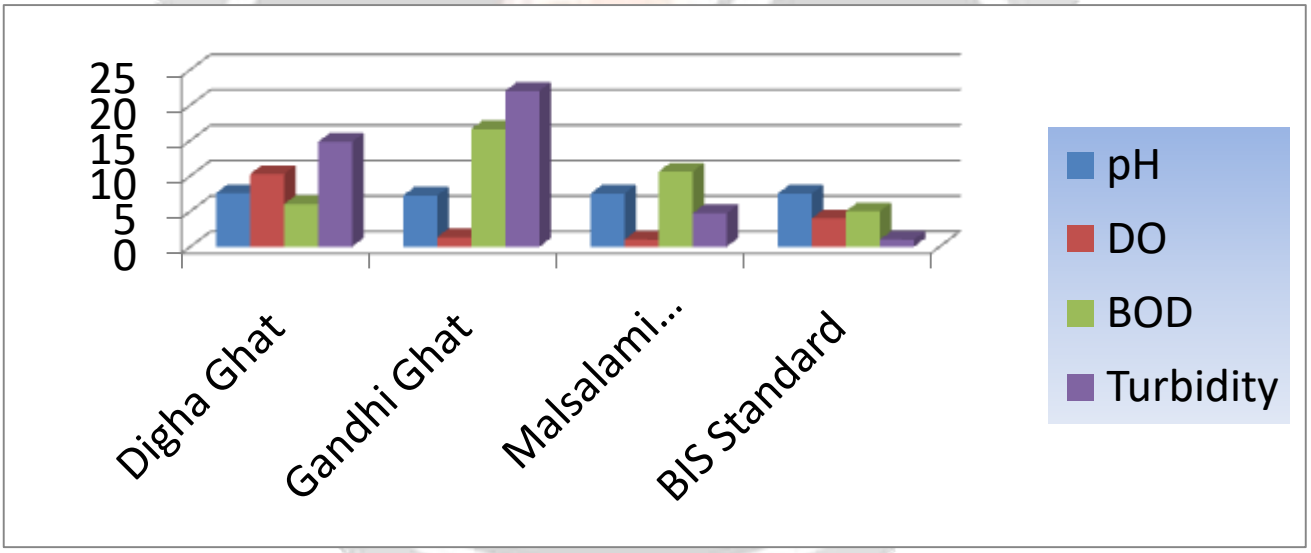

Fig-2 Comparison between different ghats according to this standard

7. Water Quality Index of the Study Area

The data was also used to calculate the Water Quality Index to get better understanding of overall water quality. The standards as per Bureau of Indian Standard and Indian Council of Medical Research for the drinking with its corresponding status categories of WQI are given in Table 1 and 3. The WQI in respect to individual sampling locations are provided in Table 4. The WQI ranged from 62.03 to 241.797 which indicate very poor to unfit for drinking purpose status of water quality.

Parameter	Standard	Unit Weight (wi)
pH	6.5-8.5	0.1756
DO	5	0.3733
BOD	5	0.2986
Turbidity	10	0.1493
TDS	500	0.003

Table 3. Unit Weight of parameters based on Indian drinking water standard

Sampling Site	Quality Rating = ∑qi	WQI = ∑qi × wi	Category
S1	515.607	90.662	Very Poor
S2	371.532	62.03	Poor
S3	694.745	136.625	Unfit for drinking purpose
S4	824.915	166.149	Unfit for drinking purpose
S5	835.547	200.362	Unfit for drinking purpose
S6	1009.415	241.797	Unfit for drinking purpose

Table 3. Quality Rating, Water Quality Index and Category of water of various water samples

8. Conclusions

This study provides an informative primary data on water quality parameters and helps to understand the contamination of Ganga River water and its possible influence on the ecological system. In the present study, an effort has been made to evaluate many physico-chemical parameters and its characteristic behavior of a river water samples at different sampling sites. Water Quality Index is a very useful tool to understand the water quality for drinking purpose. Water quality index of Ganga River varies from 62.03 to 241.797 which indicate that the quality of Ganga River is very poor to unfit for drinking purpose. This may be due to heavy discharge of effluent, domestic sewage and other anthropogenic activities. The study suggest immediate need to take extensive water quality monitoring studies and to find the remedial measures to protect this important natural water sources in the study area.

9. Acknowledgement

I would like to thank my colleagues for their valuable help during above assessment work at each step and Department of Civil Engineering, Delhi Technical Campus, Greater Noida, U.P. for providing me facilities for above study smoothly.

10. References

[1] M Alam; JK Pathak. Nature and Science, 2010, 8(11), 1-8.

[2] HS Mandal; Amrita Das. J. Chem. Pharm. Res., 2011, 3(6), 265-270.

[3] SN Thitame; GM Pondhe. J. Chem. Pharm. Res., 2010, 2(2): 316-320

[4] R Chandra; M Gupta; A Pandey. Rec. Res. in Sci. and Tech., 2011, 3(6), 16-18.

[5] MK Mustapha; JS Omotosho. African J. of App. Zoo. and Envtl. Bio., 2005, 7, 3-77.

[6] Nidhi Saxena; SN Misra; RN Shukla. J. Chem. Pharm. Res., 2011, 3(2):162-167.

[7] Suthar S., Sharma J., Chabukdhara M. and Nema A. K., Water quality assessment of river Hindon at Ghaziabad, India : Impact of industrial and urban waste water. Environ. Monit. Assess., 165(1),103-112, (2010).

[8] Khanna D. R., Bhutiani R. and Ruhela Mukesh, Fish diversity and their limnological status of Ganga river system in foothills of Garhwal Himalaya, Uttarakhand India, J. Environ. Res. Develop., 7(4), 1374- 1380, (2013).

[9] Trivedi R.C., Water quality of Ganga river : An overview., Aqua. Eco. Health Manage., 13(4), 347-351, (2010).

[10] Saksena D. N., Garg R. K. and Rao R. J., Water quality and pollution status of Chambal river in National Chambal Sanctuary, Madhya Pradesh., J. Environ. Biol., 29(5), 701-710, (2008).

[11] Banejee U.S. and Gupta S., Monitoring and assessment of river pollutant : A study on river Damodar and river Barakar of India using factor analysis, J. Environ. Res. Develop., 6(3A), 638-644, (2012).

[12] Khare Richa, Physico-Chemical analysis of Ganga river water physico-chemical analysis of Ganga river water, Asian J. Biochem. Pharmace. Res., 2(1), 12, (2011).

[13] Bhardwaj, D. Sensingh and A. K. Singh , J. Earth Syst. Sci.,2011, 119, 117.

[14] K. P. Singh, A. Malik, D. Mohan and S. Sinha., Water Res., 2004, 38, 3980.

[15] Aradhana Gupta , Devendra K. Rai ,Ravi S. Pandey and Bechan Sharma, Environ Monit Assess (2009) 157:449– 45

[16] Prakash, T.W., Asman, J. and Rastogi, G.S. 2007. IJEP, 27 (8): 733-736.

[17] Trivedi, R.K. and Goyal, P.K. 1986. Chemical and Biological Methods for Water Pollution Studies, Env. Publications, Karad, 35-96

[18] Bhargava, D.S. 1982. Indian Water Works. Assoc, 14(3):239-241.

[19] Y.J. Suh and P. Rousseaux. An LCA of alternative wastewater sludge treatment scenarios. Resource, Conservation and Recycling, vol. 35 (3), pp. 191-200, May 2002.

[20] M.P. Subin and A.H. Husna. “An Assessment on the Impact of Waste Discharge on Water Quality of Priyar River Lets in Certain Selected Sites in the Northern Part of Ernakulum District in Kerala, India.” International Research Journal of Environment Sciences, vol. 2 (6), pp. 76-84, June 2013.

[21] P.P. Baskaran and A.J.D. Britto. "Impact of industrial effluents and sewage on river Thamirabarani and its concerns." Bioresearch Bulletin, vol. 1, pp. 18-20, June 2010.

[22] E. Danulat, P. Muniz, J. Garcia-Alonso and B. Yannicelli. "First assessment of highly contaminated harbour of Montevideo, Uruguay." Marine Pollution Bulletin, vol. 44 (6), pp. 554-565, June 2002.

[23] R.C. Russo. "Development of marine water quality criteria for USA." Marine Pollution Bulletin, vol. 45 (1-12), pp. 84-91, September 2002.

[24] B.N. Sunkad. "Evaluation of Water Quality of Malaprabha River near Jalikoppa Bridge, Belgaum." Scholars Journal of Engineering and Technology, vol. 2 (1), pp. 73-79, 2014.