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## Study of hydrobiological factor of Gandak River, Sonpur, Bihar

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**Abstract-** The present study investigates the hydrobiological characteristics of the Gandak River at Sonpur, Bihar, India, over a 12-month period from August 2019 to September 2020. Monthly water samples were collected and analyzed for key physical and chemical parameters, including temperature, turbidity, pH, total hardness, total dissolved solids (TDS), dissolved oxygen (DO), electrical conductivity, phosphate, iron, free chlorine, and ammonia. The observed values were compared with standard limits prescribed by the Bureau of Indian Standards (BIS) and the World Health Organization (WHO) to evaluate the river's water quality and pollution status. Results indicated that water temperature reached a maximum of 32.2°C in July 2020, turbidity peaked at 28 NTU in September 2020, and conductivity was highest (188 µS/cm) in December 2019. The pH remained above 7 throughout the study, with the highest values recorded during winter. Maximum total hardness (275 mg/L) and TDS (86 mg/L) were observed in August and December 2020, respectively. Dissolved oxygen peaked at 9.0 mg/L in November 2020, while ammonia levels reached up to 0.5 mg/L during several months. Free chlorine concentrations were highest (2.0 mg/L) in August 2019 and September 2020. Notably, phosphate was not detected in any samples. The overall findings reflect seasonal variations in water quality, with most parameters remaining within permissible limits, indicating moderately healthy conditions for aquatic life.

**Keywords:** hydrobiological, total dissolved solids, Gandak River, phosphate, iron, free chlorine, and ammonia.

### INTRODUCTION

Water is a precious resource essential for the survival of all living organisms on Earth. However, only about 0.3 to 0.5% of the total water available is accessible as fresh water for human use, making its judicious utilization imperative. In the present scenario, unplanned urbanization, rapid industrialization, and the indiscriminate use of artificial chemicals have contributed significantly to severe and diverse forms of pollution in aquatic environments. This has led to the deterioration of water quality and the depletion of aquatic fauna, including fish.

Understanding water chemistry is essential for interpreting biological phenomena, as the chemical characteristics of water provide insights into the ecosystem's metabolism and help explain hydrobiological interrelationships. Rivers, in particular, are vital and vulnerable freshwater systems crucial to sustaining life. However, the declining quality of river water poses a significant threat to their ecological sustainability and is a growing concern worldwide. Rivers serve as strategic water resources, supporting domestic, industrial, and agricultural needs.<sup>1</sup>

Hydrobiological characteristics play a key role in determining the occurrence and abundance of aquatic

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species. The discharge of urban, industrial, and agricultural waste has increased the load of various chemicals entering river systems, significantly altering their hydrobiological profiles. Nutrients such as phosphorus and nitrogen, commonly originating from domestic waste and fertilizers, accelerate the process of eutrophication. While natural factors like dust, storms, runoff, and mineral weathering also contribute to eutrophication, they do so at a much slower rate.

Although several researchers have studied hydrobiological and biological parameters, including fish diversity in freshwater bodies,<sup>2-6</sup> there remains a lack of comprehensive baseline data on the physicochemical parameters of the Gandak River, with the notable exception of a study by Kumar *et al.* (2016)<sup>7</sup>. Therefore, the present study was undertaken to assess the hydrobiological characteristics of the Gandak River in relation to pollution and fisheries.

## MATERIALS & METHODS

### Study area

The Gandak River, a key tributary of the Ganga River system in eastern India has been selected for this study. It is endowed with rich aquatic biodiversity of flora and fauna. The study was conducted at Kaali ghat Sonpur.



Fig 1: map showing location of study area

### Sampling and Analysis

The surface water samples were collected from Kaali ghat Sonpur, (Figure 1). Totally, 12 water samples were collected during the study period. The sampling was done in the middle of every month from August 2019 to September 2020. Two months was not studied i.e., April and May 2020 due to Nation-wide lockdown. Samples of

water were collected in Plastic bottle. Some of the parameter was tested at the site of sampling like pH, TDS, Conductivity and temperature. Apart from that sample is also fixed at the site of sampling for dissolved oxygen analysis. On site findings are recorded separately. Collected water samples immediately carried to the laboratory for analysis. The analysis of physicochemical parameters was carried out by using standard methods of American Public Health Association.<sup>8</sup> The parameters pH and EC ( $\mu\text{S}/\text{cm}$ ) were analysed on spot with portable pH, TDS, and EC meters, while rest of the parameters including Dissolve Oxygen ( $\text{DO}-\text{mg}/\text{l}$ ), Total Hardness ( $\text{mg}/\text{l}$ ), Phosphate ( $\text{mg}/\text{l}$ ), Chloride ( $\text{mg}/\text{l}$ ), Turbidity (NTU) etc. were analysed in laboratory.

Table 1- Showing hydrobiological factors and instrument/method used

Parameter	Instrument / method used
Appearance	.....
Temperature	Digital Thermometer
pH	pH liquid
Conductivity	Conductivity meter
Total dissolved solids	TDS meter
Total hardness	Total hardness testing kit
Phosphate	Phosphate testing kit
Ammonia	Ammonia testing kit
Free Chlorin	Chlorin testing kit
Dissolved oxygen	DO testing kit
Turbidity	Turbidity meter

## RESULTS & DISCUSSION

The monthly variations of different Hydrobiological factors of water in Gandak River shown in chart. The results are also summarized on the monthly basis and compared with the surface water quality standard.

### pH

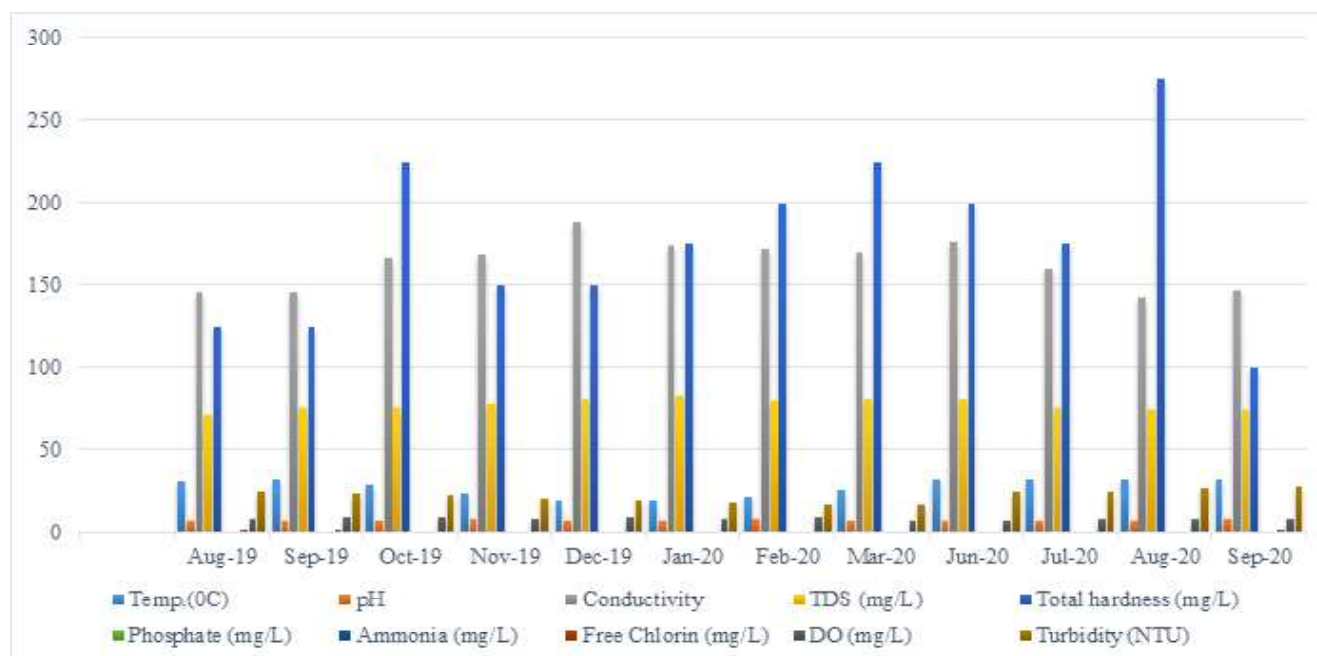
Water pH is one of the important parameters which plays a crucial role in different life-sustaining chemical reactions. pH indicates acidic and alkaline nature of water. Generally, confined inland waters in India are alkaline in nature. In this study, pH of surface water varied from 7 to 8. It was minimum during the month of February, while maximum value was observed in December 2020. The nature of water was neutral to alkaline in nature throughout the study period. the mean pH of the Gandak River water was observed 7.25 (Table 1). All the samples were observed under the range of safe limit (6.5-8.5), suggested by BIS for surface water quality.

**Table 2: Showing variations in hydrobiological factor**

Month	Appearance	Temp. (°C)	pH	Conductivity (µs/cm)	TDS (mg/L)	Total hardness (mg/L)	Phosphate (mg/L)	Ammonia (mg/L)	Free Chlorin (mg/L)	DO (mg/L)	Turbidity (NTU)
August 2019	Murky	31.0	7	145	71	125	00	0.5	2.0	8.0	24.3
September 2019	Murky	31.5	7	145	76	125	00	0.5	1.6	9.0	23.6
October 2019	Murky	28.3	7	166	76	225	00	0.5	00	9.0	22.9
November 2019	Murky	23.6	8	168	78	150	00	0.25	00	8.0	20.6
December 2019	Clear	19.3	7	188	81	150	00	0.50	00	8.5	19.7
January 2020	Clear	18.9	7	174	83	175	00	0.25	00	8.0	17.8
February 2020	Clear	21.7	8	171	80	200	00	0.50	00	8.5	15.9
March 2020	Clear	25.4	7	169	81	225	00	0.25	00	7.0	16.3
June 2020	Murky	32.0	7	176	81	200	00	0.50	00	7.0	24.6
July 2020	Murky	32.3	7	160	76	175	00	0.25	00	8.0	25.1
August 2020	Murky	32.0	7	142	75	275	00	0.50	00	8.0	26.7
September 2020	Murky	31.6	8	147	75	100	00	0.50	2.0	7.5	28

**Table 3: Showing Mean, SD and SEM of Hydrobiological factors**

Parameters	Minimum	Maximum	Mean	Standard deviation	standard error of the mean (SEM)
Temperature (°C)	17.2	32.2	27.3	5.02	1.45
pH	7	8	7.25	0.43	0.12
Conductivity (µs/cm)	142	188	162.58	14.14	4.08
TDS (mg/L)	71	86	933	3.34	0.96
Total hardness (mg/L)	125	275	177.08	48.36	13.96
Phosphate (mg/L)	00	00	00	00	00
Ammonia (mg/L)	0.25	0.50	0.41	0.11	0.03
Free chlorin (mg/L)	00	2.0	0.46	0.81	0.23
DO (mg/L)	7	9	8.04	0.62	0.18
Turbidity (NTU)	15.9	28	22.12	3.84	1.11

**Graph 1: Chart showing variations in hydrobiological data :- Conductivity (µs/cm), Turbidity (NTU), DO (mg/L), Free Chlorin (mg/L), Ammonia (mg/L), Total hardness (mg/L), TDS (mg/L), Temp.(°C)**

**Electrical conductivity (EC)**

The electrical conductivity of water is a measure to confirm the presence of different ions in it and also about its purity. It depends on the concentration of different ions, nutrients, and dissolved solutes. The EC recorded for water samples in this study was ranged between 142 $\mu$ S/cm to 188 $\mu$ S/cm. The minimum value of EC was observed in during August 2020 while the maximum was in December 2019. The mean conductivity of the Gandak river water was observed 162.58. The high value of EC is an indication of pollution and eutrophic status of an aquatic ecosystem. EC of all samples was observed under the prescribed limit (< 2250  $\mu$ S/cm) by BIS.<sup>9</sup>

**Dissolved Oxygen (DO)**

Dissolved Oxygen is very important, particularly for the fauna of aquatic ecosystems. Low DO value indicates about the organic pollution; while relatively high DO confirm the good health of an aquatic ecosystem. The variation of DO in this study was observed in a range of 7.0 mg/l to 9.0 mg/l. The Mean DO of the lake water was observed 8.4 mg/l. It is reported in different studies that the DO is high during active photosynthesis, while it used to reduce when water temperature, organic load and microbial activity increase in the aquatic system. The fish needs at least 5 mg/l dissolved oxygen therefore the water of river is suitable for development and growth of fish.<sup>10</sup>

**Total Hardness**

Hardness is the capacity of water to react with detergent. It is mainly because of Calcium and Magnesium salts. Total hardness of river water during this study was found in a range of 125 mg/l to 275 mg/l. The minimum and maximum value of hardness was observed during the months of August, September 2019 and August 2020 respectively. The values of total hardness were always found below the prescribed limit (300 mg/l) by BIS, for all the samples during the study period. Kiran (2010)<sup>11</sup> reported that water can be categorized according to degree of hardness as soft (0-75 ppm), moderately hard (75-150 ppm) and hard (150-300 ppm). Thus, the water of the Gandak river hard.

**Phosphate**

Phosphorous is one of the most important micronutrients in deciding the productivity of an aquatic system. It occurs in different forms, including particulate phosphorous, active phosphate, orthophosphate etc. The concentration of phosphate in water samples was not found

in the present study. Stone and Thomforde (2004)<sup>12</sup> stated that phosphate content  $\leq 0.06$  mg /L is suitable for pisciculture.

**Turbidity**

The Turbidity of any water sample is the reduction of transparency due to the presence of particulate matter such as lay or slit, finely divided organic matter, plankton and other microscopic organisms. In the present study, the higher turbidity was evident in the month of September 2020 and lower in February 2020. The highest and lowest value 15.9 NTU (minimum value) and 28.0 NTU (maximum value) reported respectively.

**Ammonia**

Ammonia generally arises from aerobic and anaerobic decomposition of nitrogenous organic matter. Urine of men and animals yields large quantities of ammonium carbonate and hence sewage is rich in free ammonia. Mean of Ammonia concentration was found 0.41 mg/l. The maximum ammonia concentration was recorded 0.50 mg/l while minimum was recorded 0.25 mg/l.

**Total dissolved solids (TDS)**

The highest total dissolved solids (TDS) were observed as 86 mg/L during December 2020 while the lowest TDS was observed 71 mg/L during august 2019. The maximum limit for TDS as suggested by W.H.O<sup>13</sup> is 500 mg/L which indicated that the recorded TDS signifies the normal range.

**Temperature**

Temperature is an important factor, which regulates the biogeochemical activities in the aquatic environment. The temperature of Gandak River ranges between 17.2°C to 32.2°C. The maximum temperature was recorded during July 2020 and the minimum was recorded in December 2020.

**Free chlorin**

Despite the chlorine properties that can control the water bone diseases, its side effects required regulations and standards to limit to a minimum level. World health organization (WHO)<sup>13</sup> set the free chlorine residual in drinking water should be around 0.2 - 0.3 mg/L for 30 min contact time. Chlorin are found in all-natural surface waters, but in very low concentration freshwaters. It imparts a salty taste to water. The concentration of Chloride ions in water samples was found in a range of 00 mg/l to 2.0 mg/l. The minimum concentration of chloride was observed in several months of 2019-2020 and maximum

in month of August 2019. Its concentration in all water samples was always found below the given standard limit BIS standard for surface waters.

Similarly, Bhagde *et al.* (2020)<sup>4</sup> reported dissolved oxygen levels ranging from 3.6 mg/L to 6.2 mg/L, hardness between 58 mg/L and 120 mg/L, temperature from 28.2°C to 32.3°C, and pH values between 7.2 and 8.1 in Nizerneshwar Pond, Ahmednagar, Maharashtra. Manendra Kumar and Radha Sinha (2019)<sup>14</sup> observed water temperatures ranging from 25.1°C to 30.2°C, pH values between 7.8 and 8.5, dissolved oxygen (DO) levels between 8.7 ppm and 9.6 ppm, total dissolved solids (TDS) from 153 ppm to 178 ppm, and total hardness between 96 ppm and 117 ppm in an old pond located on the campus of B.R.A. Bihar University, Muzaffarpur, Bihar.

Sarvesh (2020)<sup>15</sup> recorded temperatures between 18.5°C and 33.5°C and DO levels ranging from 4.6 mg/L to 10.0 mg/L in the Budhi Gandak River at Samastipur, Bihar. Niyoyitungiye (2019)<sup>16</sup> reported temperatures ranging from 27.1°C to 28.95°C, TDS between 440.86 mg/L and 453.59 mg/L, pH values from 8.5 to 8.88, DO between 7.162 mg/L and 7.71 mg/L, and phosphorus content ranging from 0.01 mg/L to 3.0 mg/L.

Chaturvedi and Pandey (2006)<sup>17</sup> observed temperature ranges from 30°C to 35°C, pH between 7.0 and 8.5, TDS from 1000 ppm to 1065 ppm, and total hardness between 500 mg/L and 600 mg/L in the Ganga River at Vindhyachal Ghat.

Mahendra (2015)<sup>18</sup> recorded water temperatures between 17.2°C and 32.4°C, turbidity from 21.5 NTU to 36.2 NTU, pH between 6.88 and 7.20, total hardness from 190 mg/L to 248.6 mg/L, DO levels between 5.54 mg/L and 7.40 mg/L, and TDS ranging from 402.6 mg/L to 432.4 mg/L in the Budhi Gandak River, Muzaffarpur District, Bihar.

Verma *et al.* (2012)<sup>19</sup> reported temperature ranges from 17°C to 30°C, electrical conductivity between 3.25 and 4.16  $\mu$ S/cm, turbidity from 19 NTU to 24 NTU, TDS from 828 ppm to 1014 ppm, pH values between 8.7 and 9.5, total hardness ranging from 320 ppm to 368 ppm, DO levels from 2.10 ppm to 4.12 ppm, chloride content between 116 ppm and 133 ppm, and phosphate ranging from 1.18 ppm to 2.12 ppm in Chandola Lake, Ahmedabad.

Shrivastava *et al.* (2015)<sup>20</sup> reported pH values between 7.0 and 7.5, TDS between 22 mg/L and 1128 mg/L, conductivity ranging from 33 to 1683  $\mu$ S/cm, phosphate

levels from 0.14 mg/L to 0.254 mg/L, and DO between 5.2 mg/L and 10.2 mg/L in the Patalganga River.

Singh *et al.* (2016)<sup>2</sup> observed pH ranging from 7.20 to 8.93, DO between 2.0 mg/L and 9.8 mg/L, electrical conductivity from 49  $\mu$ S/cm to 472  $\mu$ S/cm, total hardness between 134 mg/L and 368 mg/L, phosphate ranging from 0 mg/L to 0.2 mg/L, and chloride ions between 1.0 mg/L and 36.4 mg/L in Kanwar Lake, Begusarai, Bihar.

## CONCLUSION

The present investigation attempt to assess the Hydro biological characteristic of water of Gandak River near Sonpur with reference to its suitability for sustain the ecology and aquatic life in the river. Nevertheless, a total of 11 hydrobiological parameters have been analysed and the results of comparative analysis indicate that most of the important quantities such as turbidity, total dissolved solids, pH, hardness, TDS, ammonia, phosphate contents in Gandak River are under the upper threshold of the W.H.O., BIS guidelines. the river has a high potential for aquatic life as the most important of the water quality parameters were suitable to sustain the ecology and aquatic life in the river. Indeed, all parameters such as Temperature, pH, Total Dissolved Solids, phosphate, Dissolved Oxygen, etc were found within the permissible limit.

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