



**ORIGINAL ARTICLE**

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## **Physico-Chemical Characteristics of Water of Budhi Gandak River In Muzaffarpur District of Bihar (India)**

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### **ABSTRACT**

*Budhi Gandak river is one of the most important rivers of north Bihar. It originated at West Champaran district of North Bihar, near Ramnagar and Bagha. This river flows through East Champaran, Muzaffarpur, Samastipur, Begusarai and finally flows in to the Ganga near Khagaria district. During present investigations physico-chemical characteristics of water of Budhi Gandak river in Muzaffarpur district of Bihar was analysed in three stations - Site- I (Akharaghat, Muzaffarpur city), Site II (Kanti) and Site III (Motipur). The selected physico-chemical parameters analysed during investigation were temperature, turbidity, pH, total hardness, total dissolved solids, total alkalinity, BOD, COD, free CO<sub>2</sub>, dissolved oxygen, sulphate and chloride. Findings of present investigation reflected that water temperature was maximum during summer, turbidity was maximum during rainy season, pH value of water was maximum (more than 7) during winter, total hardness of water was maximum during winter season, total dissolved solids was maximum during winter season, maximum alkalinity was observed during summer, BOD and COD recorded maximum during summer, free CO<sub>2</sub> was maximum during summer, dissolved O<sub>2</sub> was highest during summer months, sulphate concentration was highest during winter while chloride concentration was highest during summer months.*

**Keywords :** Physico-chemical, Parameters, Budhi Gandak, River, Muzaffarpur

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### **INTRODUCTION**

Bihar in general and North Bihar particularly is very rich in water resources. It has a number of water bodies like rivers, streams, ponds, lakes and ditches. Water has always been an important and life sustaining drink to humans and it is essential for the survival of all organisms. North Bihar has various rivers like the Budhi Gandak, Gandak, Bagmati, Lakhandei, Kamla Bagan, Koshi etc. Budhi Gandak river is one of the major and significant tributary of the Ganga in North Bihar. The origin of Budhi Gandak is at the West Champaran near Ramnagar and Bagha. This river flows through East Champaran, Muzaffarpur, Samastipur, Begusarai and finally flows in to the Ganga near Khagaria district. Budhi Gandak river shows very high sinuosity in its entire flow and has characteristically low silt content than other Himalayan rivers. Many researchers have worked in Physico-chemical characteristics of rivers in India [1, 2]. Some reports are available on the limnological study of Budhi Gandak River [3, 4]. The present investigation was carried out to evaluate the physico-chemical characteristics of water of river Budhi Gandak in Muzaffarpur district of Bihar.

### **MATERIALS AND METHODS**

Three sampling sites - Site - I (Akharaghat, Muzaffarpur city), Site - II (Kanti) and Site III (Motipur) were selected for monthly sampling. Samples were collected for a period of one year (March, 2013 to February 2014). The sampling period was divided in three seasons - summer (March to June), Rainy (July to October) and winter (November to February). The sampling was done during morning (9-10 am). The water samples for physico-chemical analysis were collected in five litre plastic jars from each site. The selected physico-chemical parameters analyzed during investigation were - temperature, turbidity, pH, total hardness, total dissolved solids, total alkalinity, B.O.D., C.O.D., free CO<sub>2</sub>, dissolved oxygen, sulphate and chloride. Selected physico-chemical parameters were analysed with the help of standard analytical

methods [5]. Instruments and methods employed in analyzing physico-chemical factors of water is listed in Table-1.

**Table - 1: Instruments / methods used for physico-chemical analysis of water samples**

Parameter	Instrument / method used
Temperature	Thermometer
Turbidity	Turbiditymeter
pH	pH meter
Total hardness	EDTA Titration
Total dissolved solids	Conductivity / TDS meter
Total Alkalinity	Neutralising with standard HCl (Titration)
B.O.D.	B.O.D. Analyser
C.O.D.	C.O.D. Analyser
Free CO <sub>2</sub>	Carbon dioxide meter
Dissolved oxygen	Dissolved oxygen meter
Chloride	Titration by AgNO <sub>3</sub>

## RESULTS AND DISCUSSION

Results of the monthly observations of present investigation was averaged for different seasons viz. summer, rainy and winter and summarized in Table-2. The parameter wise results are discussed below:-

**Table - 2 Physico-chemical characteristics of water of Budhi Gandak river in Muzaffarpur district (March 2013 - February 2014)**

Physico-chemical parameters	Summer			Rainy			Winter		
	Site I	Site II	Site III	Site I	Site II	Site III	Site I	Site II	Site III
Water Temperature (°C)	30.2	31.4	32.4	27.6	28.4	29.6	17.2	18.4	18.8
Turbidity (JTU)	22.56	23.90	28.85	32.6	34.8	36.2	21.50	19.6	27.76
pH	6.88	6.92	6.90	6.88	6.94	6.90	7.15	7.10	7.20
Total Hardness (mg/l)	190	194	210	235	200	214	242.2	248.6	238.6
Total dissolved solids (mg/l)	412.5	402.6	403.4	422.4	408.6	412.6	428.4	432.4	424.4
Total Alkalinity (mg/l)	51.25	52.64	50.1	38.4	35.2	35.4	33.6	32.4	32.2
B.O.D. (mg/l)	8.4	9.0	8.2	8.2	8.8	7.8	7.4	8.26	6.4
C.O.D. (ml/l)	18.6	20.8	18.2	16.4	18.4	15.8	13.4	14.80	12.4
Free CO <sub>2</sub> (ml/l)	8.6	8.4	8.8	7.8	7.9	8.0	6.6	7.4	7.6
Dissolved oxygen (ml/l)	5.54	5.68	5.30	6.20	6.30	6.32	7.40	7.20	7.30
Sulphate (ml/l)	140.50	142.56	144.85	145.60	148.20	150.35	185.5	188.8	190.2
Chloride (ml/l)	19.54	17.63	18.45	12.24	13.35	13.58	6.24	6.28	5.86

**Water Temperature:**

The water temperature ranged between 17.2 – 30.2 °C for Site-I, 18.4 – 31.4 °C for Site II and 18.8 – 32.4 °C for Site III. The maximum temperature was recorded during summer followed by rainy season while the minimum temperature was observed during winter months. It was observed that water temperature is influenced by air temperature. Water temperature influences the level of oxygen of water body. In summer months water temperature is generally higher as compared to winter months [6].

**Turbidity :**

The maximum value of turbidity was during rainy season and minimum during winter. It ranged between 21.50 to 32.60 for Site I, 19.60 to 34.80 for Site II and 27.76 to 36.2 for Site III. The seasonal variation in turbidity value was very similar to findings of Varunprasath and Danie [7]. Higher turbidity in river water might be due to growth of phytoplankton, human activities etc.

**pH :**

pH is one of the most important parameters in water chemistry. It also suggests that whether the water is suitable for drinking or not. The pH ranged between 6.88 – 7.15 for Site I, 6.92 – 7.10 for Site II and 6.90 – 7.20 for Site III. The data of the present study reflected highest pH value during winter when the water is slightly alkaline. These findings are also accordance with Mishra et al [8]. The pH value of water during summer and rainy season is very close but a little less than 7. The microbiological integrity of water also depends upon its pH value [9].

**Total Hardness :**

The total hardness of water is caused by carbonates, bicarbonates, sulphate, chlorides and nitrates of calcium and magnesium ions. In present investigation maximum value of total hardness was observed during winter season, followed by rainy season. The total hardness of water ranged between 190–242.2 for Site I, 194 – 248.6 for Site II and 210 – 238.6 for Site III. Present investigation suggests that water of every site in all seasons is hard. Water with a hardness upto 75 mg/l is treated as soft, from 75 – 150 mg/l moderately hard, 150–300 mg/l as hard and above that very hard [10]. Total hardness values of river water at all the three sites in different seasons were found to be well within the BIS permissible limit of 500 mg/l.

**Total dissolved solids :**

Dissolved solid substances influence the taste, hardness and corrosive property of water. Dissolved solids in water include organic salts and small amount of organic matter. In present investigation, the amount of dissolved solids ranged between 412.5 – 428.4 for Site I, 402.6 – 432.4 for Site II and 403.4 – 424.4 for Site III.

The high amount of suspended, dissolved and total solids adversely affects the quality of water and unsuitable for any purpose including irrigation [11].

**Total Alkalinity :**

Total alkalinity of water is due to the presence of mineral salts. It is due to carbonate and bicarbonate ions. Total alkalinity of water ranged between 33.6 – 51.25 for Site I, 32.4 – 52.64 for Site II and 32.2 – 50.1 for Site III. The maximum alkalinity was observed during summer and minimum during winter season. The low alkalinity during winter is due to dilution [12]. Alkalinity is directly related to the productivity of water bodies because it regulates the pH and free CO<sub>2</sub> of the water bodies.

**BOD :**

Biochemical oxygen demand (BOD) is one of the most important parameters as it reflects status of aquatic pollution. BOD is the oxidisable organic matter found in water and its value may be used as a measure of waste strength. BOD ranged between 7.4 – 8.4 for Site I, 8.26 – 9.0 for Site II and 6.4 – 8.2 for Site III. BOD was recorded maximum during summer while minimum during winter. The data of BOD suggests that all selected sites of river were moderately polluted since water having BOD less than 1.0 mg/l is unpolluted between 2.0 – 9.0 mg/l is moderately polluted and above 9.0 mg / l is heavily polluted.

**COD :**

COD or Chemical Oxygen Demand is the total measurement of all chemicals (organic & inorganic) in the water. COD is a measure of the total quantity of oxygen required to oxidize all organic material in to CO<sub>2</sub> and water. COD values are always greater than BOD values. COD ranged between 13.4 – 18.6 for Site I, 14.8 – 20.8 for Site II and 12.4 – 18.2 for Site III. It is evident from the findings that COD value is maximum during summer and minimum during winter season. The BOD and COD was recorded maximum at Site II in all seasons due to the fact that the water of river at Kanti was receiving many pollutants of Kanti factory and sewage of municipal area.

**Free CO<sub>2</sub> :**

Free CO<sub>2</sub> in water body is generally derived from the atmospheric sources, biotic respiration, decomposition of organic matter etc. According to the present findings free CO<sub>2</sub> ranged between 6.6 – 8.6 for Site I, 7.4 – 8.4 for Site II and 7.6 – 8.8 for Site III. It is evident that free CO<sub>2</sub> was maximum during

summer and minimum during winter. The higher value of CO<sub>2</sub> in summer months might be due to decomposition of organic matter by microbes in the bottom. The present findings is very close to that of other workers [13].

#### **Dissolved Oxygen :**

Dissolved oxygen is an important parameter for water quality. It also serves as an indicator of the physical, chemical and biological activities of the water body. During investigation the minimum value of DO<sub>2</sub> of water was recorded during summer months while maximum during winter. DO<sub>2</sub> ranged between 5.54 – 7.40 for Site I, 5.68 – 7.20 for Site II, while 5.30 – 7.30 for Site III. The highest dissolved oxygen during winter months might be due to high photosynthetic activity during these months [14].

#### **Sulphate :**

The maximum concentration of sulphate was recorded during winter while minimum during summer months. It ranged between 140.50 – 185.50 for Site I, 142.56 – 188.80 for Site II and 144.85 – 190.2 for Site III.

#### **Chloride :**

The level of chloride ranged between 6.24 – 19.52 for Site I, 6.28 – 17.63 for Site II and 5.86 – 18.45 for Site III. It is evident here that chloride was minimum during winter and maximum during summer season. The major anthropogenic sources of chloride in surface waters include deicing salt, urban and agricultural run off, municipal discharges etc. chloride is an index of pollution of human origin [15].

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