

## Physico-chemical Characteristics of Water of Burhi Gandak River at Samastipur, North Bihar

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### ABSTRACT

Life on earth is linked to water and rivers are the natural source of water. The physico-chemical analyses of river water provide good informations of the physical as well as chemical state of the river ecosystem. A physico-chemical analysis of Burhi Gandak river water, were done for a year from November 2017 to October 2018 in three seasons *i.e.*, winter season (November to February), summer season (March to June) and Rainy seasons (July to October) at 5 selected sites. Study showed that Burhi Gandak river water was characterized by air temperature range with 17.3–32.5°C, water temperature range with 17.0–32.1°C, transparency range with 09.0– 36.6 cm, pH range with 7.1– 8.8, conductivity with 327–665  $\mu\text{S}/\text{cm}$ , dissolve oxygen range with 2.12–8.54mg/l, total dissolved solid range with 192–490mg/l, dissolved organic material range with 2.54–6.23mg/l, free CO<sub>2</sub> range with 0.0–6.4mg/l, carbonate alkalinity range with 1.24–7.31mg/l, and total hardness range with 165–290mg/l. Most of the physico-chemical parameters of this river water were found within the prescribed limits except in few cases.

**Keywords:** *Burhi Gandak River, Samastipur, Physico-chemical parameters.*

### INTRODUCTION

The Burhi Gandak river is one of the important tributaries of the Ganga river. It is flooded in rainy season. It originates from Chautarwa Chaur near Bisambharpur in the district of West Champaran in Bihar. It courses through east and west Chhamparan, Muzaffarpur, Samastipur and joins into the Ganga in Khagaria district near Sitakund. The total length of the river is 320 kilometers (about 199 mile). The river flows in very zig-zag pattern. Important towns *i.e.*, Mainatar, Pakridyal, Chhakiya, Kanti, Muzaffarpur, Dholi, Pusa, Samastipur, Rosera, Khagaria etc., are located on the bank of this river.

Life on earth is linked to water. Rivers are the natural source of water and ideally considered as one of the important natural resource for the development of human civilization. The river water quality has considerate importance as they sustain urbanization, industrialization, agriculture, transportation and tourism purposes. But at present there has been continuous degradation of river water quality due to human activities.

Availability of fresh water is important for the human life and also for the economic wealth. The physico-chemical analyses of river water provide a good indicator of the physical as well as chemical state of the river ecosystem. Therefore, qualitative and quantitative analyses of different types of water quality parameters can be used to assess the pollution status.

## MATERIALS AND METHODS

Total 5 sites were selected on the bank of Burhi Gandak river at Samastipur town keeping in mind pollution point of view. The location was taken about 1.2 km far from Samastipur railway station at the north direction. The river flows from the north-west to the south-east direction (Table 1, Fig. 1). The selected sites were as follows:

**Site.1 Dharampur Ghat-** Upstream Site -It is surrounded by settlement and fields. It is the place of human bathing, washing and other activities.

**Site.2 Pakkisdhi Ghat-** It is about 400 m far from site 1. It is also the place of human bathing, washing and other activities. It is the place of dumping of garbage.

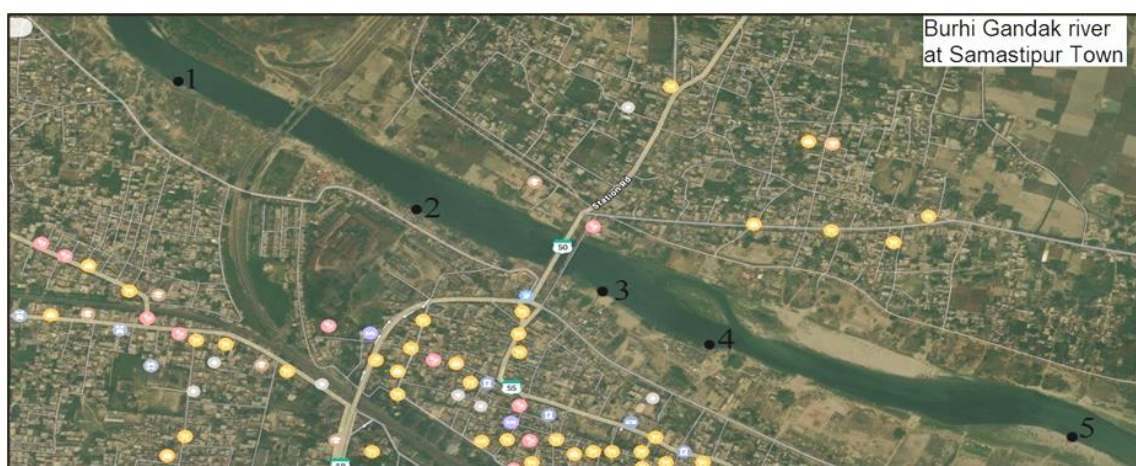
**Site.3 Magardahi Ghat-** It is about 125 m far from site 2. It is the outlet of the channel of Samastipur city sewage which falls into the river. Dumping of garbage, open defecation, plastic bottles, polythene, old clothes, paper etc occurs here.

**Site.4 Asnan Ghat-**It is about 130 m far from site 3. It is surrounded by settlement and fields. It is the place of human bathing, washing immersing of idols and other activities.

**Site.5 Mandir Ghat-** Downstream Site It is about 250 m far from Site 4. It is surrounded by settlement and fields. It is used by many kinds of human activities.

**Table 1**  
**Details of GPS Co-ordination and Soil substratum of selected sites**

Site	Name	Latitude	Longitude	Altitude	Soil Substratum
1	Dharampur Ghat	25°52'16" N	85°46'40" E	164 ft	Sandy and Silt
2	Pakkisdhi Ghat	25°52'00" N	85°47'04" E	163 ft	Silt and Clay
3	Magardahi Ghat	25°51'58" N	85°47'08" E	163 ft	Silt and Clay
4	Asnan Ghat	25°51'57" N	85°47'11" E	162 ft	Sandy and Silt
5	Mandir Ghat	25°51'45" N	85°47'30" E	162 ft	Sandy and Silt



**Fig.1. Satellite picture of the Burhi Gandak river at Samastipur town.**

For the study of physico-chemical parameters of Burhi Gandak river, water samples were taken from surface at the distance of 1.0-2.0m from the bank selecting three seasons *i.e.*, winter season (from November to February), summer season (from March to June), and rainy

season (from July to October) between 9-11a.m. for one year from November-2017 to October-2018. The physico-chemical analysis of the Burhi Gandak river water were made with references to temperature, transparency, pH, conductivity, dissolve oxygen, total dissolved solid, dissolved organic material, free CO<sub>2</sub>, carbonated alkalinity, and total hardness. Determination of temperature, transparency, pH, was done on the site and rest of the parameters were determined in the laboratory of taken water sample. The physico-chemical analysis of samples were done according to standard methods (APHA, 1995).

### **RESULTS AND DISCUSSION**

Study showed that the Burhi Gandak river is characterized by an air temperature range with 17.3–32.5<sup>0</sup>C, water temperature range with 17.0–32.1<sup>0</sup>C, transparency range with 09.0– 36.6 cm, pH range with 7.1– 8.8, conductivity with 327-665 μS/cm, dissolve oxygen range with 2.12–8.54mg/l, total dissolved solid range with 192–490mg/l, dissolved organic material range with 2.54–6.23mg/l, free CO<sub>2</sub> range with 0.0–6.4mg/l, carbonate alkalinity range with 1.24–7.31mg/l, and total hardness range with 165–290mg/l. Most of the physico-chemical parameters of the river water were found within the prescribed limits except in few cases (Table 2).

Temperature is an important parameter because of its influence on water chemistry. The rate of chemical reactions generally increases at higher temperature. Warm water holds less dissolved oxygen than cool water, and may not contain enough dissolved oxygen for the survival of different species of aquatic life. The Burhi Gandak river water is characterized by air temperature range with 17.3–32.5<sup>0</sup>C and water temperature ranged with 17.0-32.1<sup>0</sup>C. Maximum water temperature was found 32.1<sup>0</sup>C at site-5 in summer season while minimum water temperature was found 17.3<sup>0</sup>C at site-2 in winter season. Transparency of this river water was found between 09.4cm to 36.6cm. Transparency was found very low in the rainy seasons due to overloading and high speed of water. The maximum transparency in summer season is probably due to low stream speed and low flow of effluents into the river (Nandan and Aher, 2005). The maximum and the minimum transparency were found at site-1 Dharampurghat and site-3 Magardahighat respectively. Transparency of Burhi Gandak river was found averagely 18.37±5.49 in whole of the investigations. pH in one the most important parameters in water chemistry. It also suggests that whether the water is suitable for drinking, fish culture or not (Gupta, *et al.*, 2008). The pH was found 7.1-8.8 in whole of the investigations. The pH result shows that the Burhi Gandak river water is slightly alkaline. Maximum pH value was found 8.8 at site-3 in summer season while minimum pH value was found 7.1 at site-1 in winter season. pH of Burhi Gandak river was found averagely 7.83±0.50 in whole of the investigations. Conductivity is the measure of the capacity of a solution to conduct electric current. It is a rapid measure of the total dissolved solids present in ionic form. Conductivity of this river water was found between 327 to 665μS/cm which was under potable water upper limit 1055μS/cm. Maximum conductivity was found 665μS/cm at site-3 in summer season while minimum conductivity was found 327μS/cm at site-1 in winter season. Conductivity of Burhi Gandak river was found averagely 496.07±89.31 μS/cm in whole of the investigations. Dissolved oxygen is the amount of oxygen available to living aquatic organisms. It serves as an indicator of the physical, chemical and biological activities in the water body. Microorganisms such as bacteria decompose organic wastes in water taking dissolved oxygen. The fall of dissolved oxygen level directly influences the composition, abundance and distribution of the benthic macro-

invertebrates and other aquatic organisms and photosynthetic activity of aquatic plants (Islam and Sinha, 2012). Dissolved oxygen of water of river Burhi Gandak ranged from 2.12–8.54mg/l during the observation period. Maximum dissolved oxygen was found 2.12mg/l at site-3 in summer season while minimum dissolved oxygen was found 8.54mg/l at site-1 in winter season. Due to high temperature in summer oxygen concentration was found low in comparison with winter seasons (Kumar, A., 2000). Healthy water should generally have dissolved oxygen concentrations above 6.5-8.0 mg/L and between about 80-120 % (WHO, 1984)

**Table 2**  
**Physico-chemical analysis of water of Burhi Gandak river at Samastipur**

Physico-chemical parameters		Air temp(°C)	Water temp(°C)	Transparency (cm)	pH	Conductivity (µs/cm)	Dissolved O <sub>2</sub> (mg/l)
Seasons	Sites	1	2	3	4	5	6
Winter Season	Site-1	17.4	17.3	18.5	7.1	327	8.54
	Site-2	17.3	17.0	15.4	7.4	354	7.79
	Site-3	17.6	17.4	13.6	8.0	456	5.23
	Site-4	17.4	17.1	14.8	7.6	390	6.59
	Site-5	17.8	17.6	17.5	7.3	351	7.00
Summer Season	Site-1	31.2	30.5	36.6	7.5	503	5.53
	Site-2	30.8	30.0	27.3	8.2	527	4.79
	Site-3	31.1	31.0	19.2	8.8	665	2.12
	Site-4	31.9	31.5	23.4	8.5	605	4.43
	Site-5	32.5	32.1	33.5	7.9	512	4.60
Rainy Season	Site-1	28.6	28.2	13.3	7.4	523	4.53
	Site-2	28.6	28.1	10.3	7.6	534	3.50
	Site-3	27.6	27.5	09.4	8.5	590	3.32
	Site-4	28.4	28.2	11.8	8.1	564	5.03
	Site-5	27.8	27.5	11.0	7.6	540	5.23
<i>Mean</i>		25.73	25.40	18.37	7.83	496.07	5.21
<i>Average Deviation</i>		±5.49	±5.41	±6.43	±0.42	±89.31	±1.25
<i>Standard Deviation</i>		±6.20	±6.12	±8.37	±0.50	±100.66	±1.70

Continues.....

Physico-chemical parameters		Total dissolved solid TDS (mg/l)	Organic material (mg/l)	Free CO <sub>2</sub> (mg/l)	Carbonate alkalinity	Total hardness (mg/l)
Seasons	Sites	7	8	9	10	11
Winter Season	Site-1	377	2.54	0.0	6.23	214
	Site-2	349	3.02	2.0	6.40	245
	Site-3	344	4.23	4.8	7.31	290
	Site-4	356	3.34	3.3	5.90	225
	Site-5	312	2.89	1.2	4.53	180
Summer Season	Site-1	192	5.98	1.0	1.24	165
	Site-2	201	4.60	5.2	4.05	180
	Site-3	240	6.23	6.4	5.60	198
	Site-4	212	5.02	5.7	4.85	192
	Site-5	223	4.37	3.1	3.25	170
Rainy Season	Site-1	460	3.01	0.5	3.35	272
	Site-2	443	2.59	1.5	3.56	226
	Site-3	490	3.23	3.7	4.89	280
	Site-4	412	2.81	3.5	2.90	261
	Site-5	423	2.80	2.3	2.25	241
<i>Mean</i>		335.6	3.78	2.95	4.42	222.6
<i>Average Deviation</i>		±84.48	±1.06	±1.62	±1.38	±34.56
<i>Standard Deviation</i>		±101.1	±1.22	±1.96	±1.67	±41.35

Total dissolved solid or TDS value increases with increasing pollutants. Increase of TDS value directly influenced the composition, abundance and distribution of the aquatic organisms. Total dissolved solid present in the water of Burhi Gandak river was found with the range 192–490mg/l. Maximum TDS was found 490mg/l at site-3 in rainy season while minimum TDS was found 192mg/l at site-1 in summer season. Dissolved organic material present in water was found with the range 2.54–6.23mg/l. The high dissolved organic material in summer season is probably due to low amount of water and high amount of dissolved solutes per unit volume of water. Free Carbon dioxide present in water was found with the range 0–6.4mg/l. The presence of carbon dioxide in water explains how its content controls the concentration of carbonate and bicarbonate. It is to be noted that at sites-3 has been observed nearly or above 6.0 ppm which is ISI tolerance limit of free CO<sub>2</sub>. This indicates unfavorable condition for fish production (Islam and Sinha, 2013). Carbonate alkalinity, also called carbonate hardness, describes the amount of carbonate and bicarbonate anions measured in a solution. Anions contribute to the alkalinity of a substance, like water, because of their basic, or alkaline tendencies to neutralize acids. Carbonate alkalinity of Burhi Gandak river was found with the range 1.24–7.31mg/l. Maximum carbonate alkalinity was found 7.31mg/l at site-3 in winter season while minimum carbonate alkalinity was found 1.24mg/l at site-1 in summer season. Carbonate alkalinity was found maximum in the winter season than in the summer season in all observed sites probably due to more flow of sewage and others effluents into river water (Sharma, 1986). TDS and hardness values of river water were also found within the permissible standard limits set by W.H.O. The pH values were also found within the desirable limits prescribed by W.H.O and ISI (Mumtazuddin, *et al.*, 2009). Hardness of water is generally caused by the presence of calcium and magnesium ions. Total hardness of the Burhi Gandak river water ranged 165–290mg/l throughout the observation. The high prescribed limit for drinking water is 500mg/l which is far above than the observed level of total hardness. Maximum hardness was found 290mg/l at site-3 in winter season while minimum hardness was found 165mg/l at site-1 in summer season.

### **CONCLUSION**

Study showed that Burhi Gandak river water was slightly alkaline. Most of the physico-chemical parameters of this river water were found within the prescribed limits except in few cases. At sites-3 Magardahi Ghat, free CO<sub>2</sub> in river water has been observed nearly or above 6.0 ppm which is ISI tolerance limit. This indicates unfavorable condition for fish surviving and propagation. Other selected sites of Burhi Gandak river are suitable for the diversity, density and abundance of aquatic flora and fauna.

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