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Research article

Water Quality Assessment of the Subarnarekha River nearest to Dantan

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Abstract

The present study was carried out to assess the water quality status of the Subarnarekha River at the nearest area of Dantan, Paschim Medinipur during summer time. Water samples were collected from three sampling stations. The water samples were analyzed for 9 physicochemical parameters by standard methods followed by APHA 1985 [1] and the following results were: Temperature 31.2-33.4° C, pH 7.8-7.99, Electrical Conductivity 349-368 µ mho, Total dissolved solids 223.4-235.5 mg/l, Total Alkalinity 91-96.95 mg/l, Total Hardness 76.8-86.7 mg/l, Calcium 25.92- 27.84 mg/l, Magnesium 12.28-16.32mg/l, Chlorides 21.27-31.91 mg/l. The analyzed physicochemical parameters were below the maximum permissible limit of Indian standards (IS: 10500). So, from the physicochemical analysis, it is observed that the water quality of Subarnarekha River is satisfactory at the nearest area of Dantan and hence suitable for irrigation and human consumption with minimal treatment but after disinfection.

Keywords: Subarnarekha River, Dantan, Water Quality, Physicochemical Parameters

SUSTAINABLE DEVELOPMENT GOALS Clean Water and Sanitation

Introduction

Fresh surface water is an important habitat for many plant and animal species. It is used for different purposes such as drinking, irrigation for crop fields, different industrial activities, hydropower, and recreation. As river is one of the main sources of surface water, it is very important to collect reliable information on its quality [2]. Nowadays river water is contaminated by natural processes such as climate changes, natural disasters, and anthropogenic activities [3]. At present water quality of all major rivers in India is regularly monitored under the National Rivers Conservation Program [4].

The Subarnarekha is one of the longest east-flowing rivers in India. It originated near Nagri in Ranchi, the capital of Jharkhand [5] [6]. Then the river flows a long distance through Ranchi, [7] Seraikela,

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Kharsawan [8], and East Singhbhum [9] districts of Jharkhand. After that, the river enters the West Bengal on the northwest from Dhalbhum and passes through the Jhargram district intersecting the Gopiballavpur Police Station. Then it passes through the Dantan I block of Paschim Medinipur district enters Odisha through the Balasore district and finally falls into the Bay of Bengal. So, the river has largely flowed along the border of the Paschim Medinipur and Jhargram districts of West Bengal. The river traverses a vast area of copper and uranium mines in Jharkhand. As a result, the river is polluted due to these unplanned mining activities [10]. There are many tribal communities and fishing line communities residing on its bank. So, their livelihoods are greatly affected by the river's pollution. The major objective of this study is to determine different water quality parameters of the river for different stations of the nearest area of the Dantan to find whether it is fit for human consumption. Also, this analysis will provide information about the water body of Subarnarekha River in the nearest area of Dantan that will give solutions for improvement and maintenance of the same. Also, this study will benefit the local irrigation system a lot as crop growth is directly affected by the poor quality of irrigated river water [11, 12].

Materials and Methods

Sampling Locations

For this study, water samples were collected from three different stations nearest to Dantan. The sampling locations were Sonakania, Belmula, and Kotpada mentioned below (Table -1) in detail.

Sample Code	Name of the station	State	Latitude	Longitude
S_1	Sonakania	West Bengal	21.855265°	87.246083°
S_2	Kotpada	West Bengal	21.988775°	87.214727°
S_3	Belmula	West Bengal	21.954089°	87.238094°

Table 1: Sampling locations

Sampling Procedure

Three 500ml polythene bottles were washed well and rinsed with 2-3ml of 2% industrial HCl. Then the bottles were rinsed with the river water and the river water samples were collected from the sampling stations (with fast-moving river streams, from at least 15-20 cm deep). After that the bottles were sealed with proper labeling by writing the name of sampling locations, date, and time with a permanent marker. Then the water samples were carefully preserved in the laboratory for testing of various parameters throughout analysis.

Experimental Procedures

After the collection of water from different stations, the parameters (Temperature, pH, Total alkalinity, Conductivity, TDS, Chloride, Magnesium, Calcium, and Total Hardness) were analyzed.

Temperature

The temperature was measured during the time of sample collection with a good mercury-filled Celsius thermometer by placing it in the water near the sampling point.

pH

pH of the river water sample was determined within 3 hours of sample collection because the pH of the sample may have changed due to the dissolving of carbon dioxide in the sample water. At first pH meter was standardized by buffer solution. Then 50ml of water sample was taken in a 100ml beaker and the pH meter was immersed in it. After at least five minutes, the pH reading was collected.

Total alkalinity

The alkalinity in natural water is due to the presence of free hydroxyl ions formed by the hydrolysis of salts of weak acids and strong bases. The total alkalinity was determined by acid-base titration method using standard HCl as titrant and methyl orange as indicator.

Electrical conductivity (EC)

The electrical conductivity of the river samples was determined by the Systronics conductivity meter. For conductivity measurement of the sample, 0.01(M) KCl solution was used as the standard reference solution.

Total Dissolved Solids

Total Dissolved Solids (TDS) were measured from the electrical conductivity values of the water samples. As, Total dissolved solids = 0.64 x EC (µS/cm)

Total hardness

The total hardness of water was calculated from the sum of calcium and magnesium concentrations, both expressed in terms of calcium carbonate, in mg/L. The total hardness of water was measured by the EDTA titration method using EBT as an indicator. Both Ca^{2+} and Mg^{2+} form stable complexes with EDTA at pH =7-11. Standard 0.014 (M) EDTA was added as titrant with the 50ml sample solution in the presence of 5ml NH_4Cl-NH_3 buffer and 30-40mg EBT+ KNO_3 (used as an indicator) till the colour changed from wine red to blue.

Calcium

For the determination of the calcium concentration of the water samples, the river water was buffered to a pH of 12-12.5 with NaOH buffer. At a pH of 12.5, magnesium precipitated out as $Mg(OH)_2$, so that it did not interfere in the titration. Then 4-5 drops of diethylamine base calcon (0.4% solution in methanol) was added to the solution and standard 0.012 (M) EDTA was then added as a titrant. Generally, EDTA reacts with the free calcium ions present in the water sample and produces a stable EDTA–calcium complex. The mixture was titrated till the colour changed from pink to blue.

Magnesium

The concentration of Magnesium was determined from the difference between total calcium magnesium concentration and calcium concentration. Both Ca^{2+} and Mg^{2+} ions form stable complexes with EDTA at pH =10 in the presence of NH_4Cl-NH_3 buffer. So Total Ca^{2+} and Mg^{2+} ion content of the water samples was estimated by titration with standard 0.012 (M) EDTA solution in the presence of 5ml NH_4Cl-NH_3 buffer using 20-30 mg EBT indicator until the wine's red colour changed to blue.

Chloride

The Chloride concentration of the water sample was estimated by the argentometric titration method. Potassium chromate was used as an indicator. If the river water is titrated with standard silver nitrate solution, chloride ions present in the water are precipitated as silver chlorides. For chloride estimation,

1.0 ml of 5% potassium chromate solution was added to 20.0 ml of the sample and titrated with standard 0.011(N) $AgNO_3$ solution till the colour changed to reddish brown.

Results and Discussion

Physical Parameters

Temperature

As the temperature of the water increases, the rate of chemical reactions also increases which reduces the dissolved oxygen levels in the water. In the present study, the values of temperature ranged between 31.2°C to 33.4°C as the water samples were collected during the summer season.

Electrical Conductivity

Electrical Conductivity (EC) of water is dependent on the temperature of water, concentration, and mobility of ions in rivers. Significantly higher electrical conductivity value indicates that a higher number of impurities and pollutants are present in the river. Also, these values are used to calculate the TDS values and salinity concentrations in the water. In the present study, the values of Electrical conductivity ranged between 349 µ mho to 368 µ mho.

Parameters	Sample Code			Standard (IS:10500)
	S_1	S_2	S_3	
Temperature	32.7°C	31.2°C	33.4°C	-
Electrical Conductivity (µ mho)	349	355	368	-
TDS (mg/L)	223.4	227.2	235.5	500
pH	7.80	7.99	7.90	6.5-8.5
Total Alkalinity(mg/L)	96.95	93.6	91	200
Total Hardness(mg/L)	83.2	86.7	76.8	300
Ca (mg/L)	26.88	27.84	25.92	75
Mg (mg/L)	15.36	16.32	12.28	30
Chloride (mg/L)	31.91	24.82	21.27	250

Table 2: Analysis of different parameters of the Water sample

TDS

Though a slightly higher TDS level makes the water salty or bitter taste it does not have a drastic impact on human health. However, the TDS level above 1000 mg/l is considered harmful for the human body. The Total Dissolved Solids (TDS) values in the study area varied from 223.36 mg/l to 235.52 mg/l. So, all the TDS values of river water samples were within the permissible limit as per IS: 10500.

Chemical Parameters

pH

The pH value of the water helps in the determination of acidic or basic properties of water. Generally, most of the natural water have basic property due to the presence of sufficient carbonates [13]. But the water with excessive acidity or alkalinity is not suitable for human consumption. In the study, the pH values ranged from 7.8 to 7.99 which indicates the alkaline nature of river water. However, all the pH values were within the permissible limit as per IS: 10500.

Total Alkalinity

Generally, the alkalinity acts as a buffer to maintain the pH of the water. It measures the capacity of water to neutralize the acids [14]. In the present study, the Total Alkalinity values varied between 91 mg/l to 96.95 mg/l. So, the results indicate that the total alkalinity values of water samples in the study area were within the permissible limit as per IS: 10500.

Total Hardness

The Hardness of water is one of the most important chemical parameters for the determination of water quality. Generally, hardness is increased by the industrial (mining and chemical) and agricultural effluents and domestic discharges. Total hardness is expressed in terms of $CaCO_3$ concentration in mg/l. Hard water is not suitable for laundry purposes as it consumes excessive amounts of soap and detergents. Other disadvantages of using hard water are scaling of boilers, corrosion of pipes, and wastage of fuel. Based on the present study, total hardness values ranged from 76.8 to 86.7 mg/l. So, the results indicate that all the hardness values of river water samples in the study area were within the permissible limit as per IS: 10500.

Ca & Mg Concentration

Dissolved calcium and magnesium are the two main minerals that cause hardness in water. In the present study, the concentration of calcium and magnesium varied from 25.92 to 27.84 mg/l and 12.28 mg/l to 15.36 mg/l respectively. So all the concentration values were within the permissible limit i.e. mg/l for Calcium and 30 mg/l for Magnesium (IS: 10500).

Chlorides Concentration

In river water, chloride is present as highly soluble sodium, magnesium calcium, and iron salts. If the river water contains an excessive amount of chloride, it indicates pollution of water due to sewage, minerals, etc. In the present investigation, Chloride ranged from 21.27 mg/l to 31.9 mg/l in the study area. The prescribed limit of chloride for drinking water is 250 mg/l (IS: 10500). Hence all the Chloride values of river water samples were within the permissible limit.

Conclusion

This study indicates that the water quality of the Subarnarekha River is satisfactory in the nearest area of Dantan and hence suitable for irrigation and human consumption with minimal treatment but after disinfection. As the river passes through the mining, industrial, and urban areas of Jharkhand it is

expected that the river will be contaminated and polluted. However, the river has a considerable natural ability to self-purify through some chemical (oxidation, photochemical, hydrolysis, etc.) and physical (sedimentation, evaporation adsorption, etc.) processes. The author suggests that the concerned authority must monitor regularly the water quality of the river and the river basin needs more careful environmental management planning to protect its continued existence.

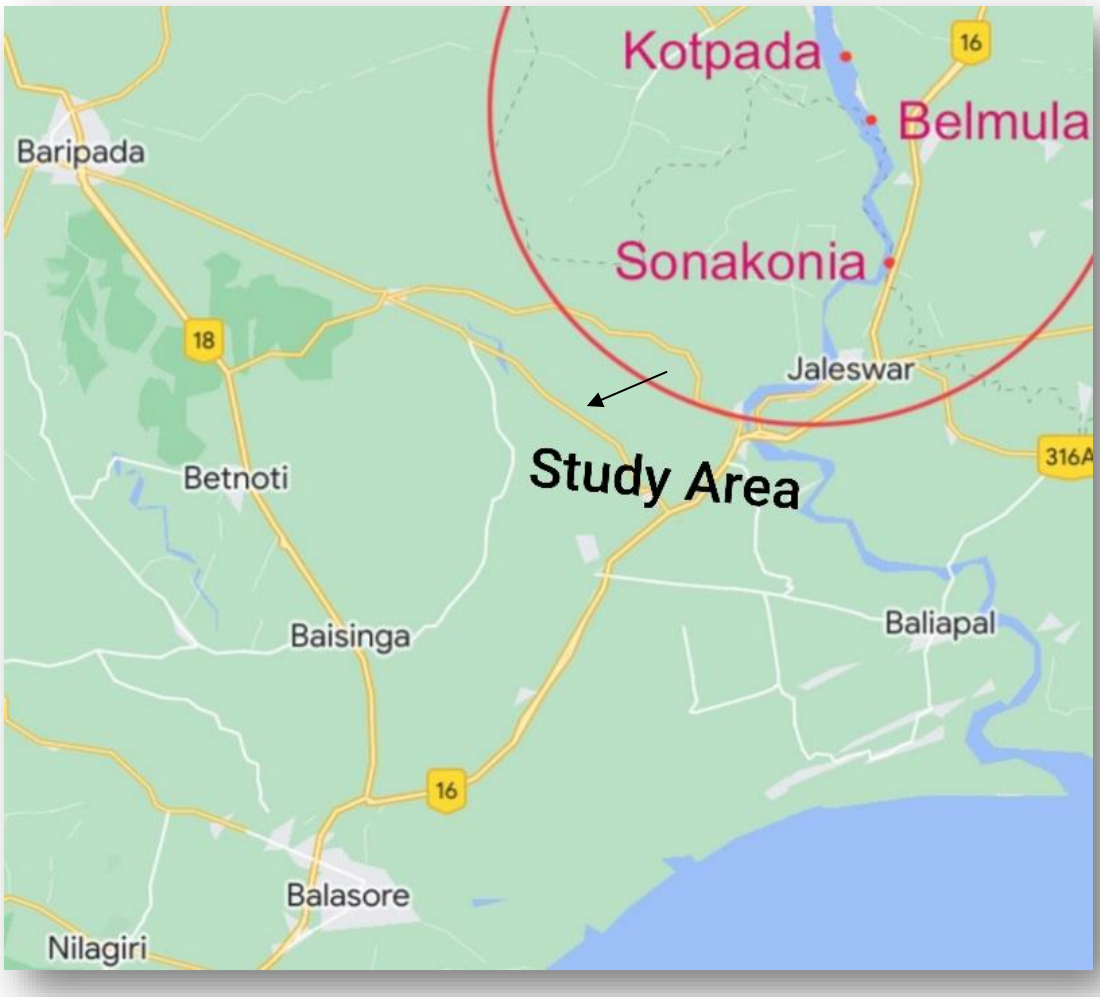

Figure 1: Map Showing Sampling Locations

(Source-Google Maps/Subarnarekha River)

Fig 2. Collection of water from Kapat Ghati (Kotpada)

Fig 3. Collection of water from Gabarghata (Sonakonia)

Fig4: Subarnarekha River at Belmula Ghat

Fig 5: Collection of water from Gabarghata (Sonakonia)

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Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

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