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Monitoring of physico-chemical parameters of river Ramganga at Bareilly, Uttar Pradesh, India

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Abstract
Ramganga river is a the first tributary of the river Ganges and flows by Jim Corbett National Park near Ramanagar of Nainital district from where it descends upon the plains. The River Ganges being the utmost sacred river and salvation to millions of Indians in serving their water necessity is facing extreme hazards of pollution. Under the several river management and conservation strategies for its protection, the water quality assessment of its main tributary Ramganga river is inadequate. Bareilly city of Uttarpradesh is situated on the bank of river Ramganga. Present study was conducted to monitor the various physico-chemical parameters like temperature, electrical conductivity, pH, total hardness, dissolved oxygen (DO) and biological oxygen demand (BOD) of river Ramganga at Bareilly. River water samples were collected from two monitoring site (SI-Ramganga Bridge and SII-Chaubari Village) during February 2021. The results of present study showed that the values of DO and BOD were found beyond the permissible limit set by BIS and ICMR at SI indicated deteriorating water quality. Besides DO and BOD, the values of other physico-chemical parameters were found under the permissible limit. Therefore, it is recommended from the study that the government and the other local authorities should prevent the any kind of waste disposal in river as well as soil and crops cultivated in the vicinity of the monitoring sites need to be evaluated.

Keywords: Ramganga river, physico-chemical parameters, water pollution, permissible limit, ICMR/ BIS

Introduction

The Ramganga is an important river in Uttarpradesh which is the first tributary to join the Ganga at its left bank. It rises in lower Himalayas at an altitude of 3110m above the mean sea level near the village of Lobha in Garhwal district of Uttrakhand (Chandra *et al*., 2020). The total length of River is about 596km for first 200km the river flows in Uttrakhand state and remaining length falls in the state of Uttarpradesh. Before it decends into the plains, it is impounded by Kalagarh dam inside Jim Corbett National Park. In Uttarpradesh the river flows through Bijnor, Moradabad, Bareilly, Badaun, Shahjehanpur, and Hardoi cities before merging into Ganga. The geographical extent of the Ramganga subbasin lies between 78º14´ and 80º8´ east longitudes and 27º7´ to 30º6´ north latitudes. The catchment area of the subbasin is about 32493sq. km (Gangwar *et al*., 2013) [4].

Bareilly is situated at the bank of river Ramganga. Nearly all the sewage form the cities enters the Ramganga waterways partially treated or untreated domestic waste, industrial waste, primarily from agricultural fertilizers and pesticides (Markandya and Musty, 2004) [6]. In addition to these domestic and industrial pollutants, human corpse and animal carcasses are released to the river each day for spiritual birth. Population pressure, lack of proper investment in the water quality infrastructure, limited government initiative and a lack of empowerment of the people all continue to contribute the deterioration state of Ramganga River (Rai *et al*., 2010) [7]. Till date, there have been various studies on river water quality with reference to geochemistry pollution and suitability assessment of ground water for different uses.

The water from Ramganga is used for irrigation primarily and as source of drinking water and industrial application. It therefore, becomes necessary to assess the suitability of water for different uses. Thus, the present study has been undertaken to monitor various physico-chemical parametes of Ramganga water in Bareilly City. Different physico-chemical parameters analyzed from the study may help in tackling the problem of pollution by way of awareness to public for stopping them from further creation of such types of pollution. Recommendation measures and management program can be taken up by the people residing in the area. The result obtained will help the public precautions about the water they use for domestic purpose by way of water treatment, thereby improving the quality of human health.

Materials and Methods

Description of the monitoring sites

Water samples for the physico-chemical analysis were collected from 2 monitoring sites (Site I- Ramganga Bridge and SII-Chaubari Village) in Bareilly, Uttarpradesh. The description and geographical location of each monitoring sites are described below-

Table 1: Geographical location of monitoring sites

Monitoring Site	Geographical Description		
	Latitude	Longitude	Elevation
SI	27.99ºN	79.01ºE	175m above sea level
SII	28.30ºN	79.38ºE	168m above sea level

Analysis of Physico-chemical Parameters of water

From each monitoring sites one sample was collected weekly in the month of February 2021 in polyethylene plastic bottles rinsed three times with deionized water.

Water temperature was measured on the spot using water thermometer. Electrical conductivity and pH was measured by conductivity meter and pH meter respectively. Total hardness was determined titrimetrically by EDTA method. Dissolved oxygen (DO) was analyzed by Winkler's titrimetric method. BOD was estimated by Winkler's titrimetric method after 5 day incubation at 20ºC followed by subtracting the values of titration from the initial and final values of DO. All the analysis was done in triplicates following standard method prescribed by Trivedy *et al*., 1984 and APHA, 2005 [1].

Result and Discussion

Average concentration of all physico-chemical parameters are represented in table 2.

Water Temperature

The natural temperature plays a key role in the distribution of the species also by its extreme levels and its diurnal or seasonal variation. It is the important factor for its effect on chemical reaction, biological reaction and growth of microorganism of river estuary (Morhit *et al*., 2014) [8]. As shown in the table 1, the temperature was varied from 18.3 ºC to 23 ºC with mean values of 21.4 ºC±1.20 and 19.2±0.80 ºC at SI and SII respectively. Most aquatic organism lives in and optimal temperature 5-25 ºC. In general, atmosphere and water temperature depends on geographical location and meteorological condition such as rainfall, wind velocity, humidity, altitude etc. (Hussain *et al*., 2021) [9].

Electrical Conductivity (EC)

It is the ability of substance to conduct electric current in water and is a total parameter for dissolved and dissociated substance which also indicates the concentration of dissolved electrolytes (Meride and Ayenew, 2016) [19]. Lower conductivity value was recorded at SII (370 µS/cm) and higher at SI with a value of 663µS/cm. In present study mean value of electrical conductivity was recorded 582±59.94 and 405±24.75µS/cm at SI and SII respectively. The values of EC were found lower at both monitoring site when compared with the standard limit for drinking water given by ICMR which indicating good water quality. Similar result was also reported by Hussain *et al*., 2021 [9].

Table 2: Mean value of various physico-chemical parameters of water of River Ramganga at Bareilly

S. No.	Physico-chemical Parameters	Monitoring Site		Permissible Limit	
		SI	SII	BIS	ICMR
1.	Temperature (ºC)	21.4±1.20	19.2±0.80	-	-
2.	Electrical Conductivity (µS/cm)	582±59.94	405±24.75	-	750
3.	pH	7.05±0.03	7.4±0.29	6.5-8.5	6.5-8.5
4.	Total Hardness (mg/l)	224±23.70	205±18.79	300	-
5.	DO(mg/l)	5.8±0.90	4.5±0.69	5	5
6.	BOD(mg/l)	5.4±0.74	4.8±0.84	-	5

Potential Hydrogen (pH)

pH is the measure of intensity of acidity and alkalinity of a solution. More precisely, it is the measure of hydrogen ion activity. It also serves as important index of degree of pollution (Kulthanan *et al*., 2013) [18]. The factors like respiratory activity, exposure of air, temperature, and disposal of sewage etc. brings about changes in pH of water. In this study, pH was ranging from 7 to 7.8. The average value of pH was observed 7.05 at SI and 7.4 at SII which found within the safe limit prescribed by ICMR and BIS. The value of pH recorded in the present study was found lower than the values recorded by Singh *et al*., 2018 [10].

Total Hardness

Total hardness in river water is primarily regulated by carbonates, bicarbonates, chlorides, sulphates etc. of calcium and magnesium chiefly, whereas there are certain other chemical entities accounting for it (Tiwari and Bajpai 2012) [17]. The total hardness ranging from 179 to 253mg/l with the mean value of 224 and 205mg/l at SI and SII respectively.

The permissible limit of total hardness in potable water is 300 mg/l as given by BIS. As results showed that the average hardness values of both monitoring site were found below the permissible limit, study revealed that water of both sampling site is safe for domestic purpose. Although the values of hardness recorded in the present study were found higher when compared with studies done by Kibami *et al*., 2014 and Chandra *et al*., 2011 [3, 12].

Dissolved Oxygen (DO)

DO in water is an important parameter to monitor biological quality water and ascertain its designated best use. It support the aquatic life form and regulates the biological degradation of organic impurities (Naykki *et al*., 2013) [16]. Minimum DO value was recorded at SII (3.7mg/l) and maximum at SI (7mg/l). The mean value of DO was recorded 5.8 and 4.5mg/l at SI and SII respectively. Although, the values of DO were found under the permissible limit set by ICMR and BIS at SII but at SI it found higher than the permissible limit so indicates relatively mild organic pollution. However, water of SII can be used for fish culture as fishes needs at least 5 mg/l DO to survive. Higher values of DO at SI during the study period may be due to the addition of organic waste, surface runoff and removal of vegetation etc. Present study was found with the agreement of research done by Javed *et al*., 2020 [13].

Biological Oxygen Demand (BOD)

BOD is the measure of the amount of oxygen used in the respiratory processes of microorganism in oxidizing the organic matter in the sewage and for the further metabolism (oxidation) of cellular components synthesized from wastes (Jouanneau *et al*., 2014) [15]. Values of BOD approximate the amount of oxidisable organic matter present in the solution. The lowest concentration of BOD was found at SII with the value 3.6mg/l and the highest concentration at SI with the value 6.3mg/l. The mean value was observed 5.4mg/l at SI and 4.8mg/l at SII. The concentration of BOD was found higher at SII while lower at SI

when compared with the standard given by ICMR. The raised value of BOD at SI may indicate the extent of organic pollution which undergoes biotic decomposition (Jonnalagudda *et al*., 2001). Values of BOD was found low when compared with the work done by Javed *et al*., 2020 [13] and Singh *et al*., 2018 [10] while almost similar result was obtained by Gangwar *et al*., 2012 and 2013 [4].

Conclusion

During the study it was observed that the values of electrical comductivity, pH, total hardness were found under the permissible limit set by ICMR and BIS at both monitoring sites. The values of DO and BOD were found higher at Ramganga bridge when compared with the standard value of drinking water given by ICMR and BIS indicating the deterioration of water quality which is caused by industrial discharge. The main sources of organic pollution are non point sources like agriculture runoff, cattle-dropping etc. This study therefore recommended the government and other local authorities to ;1) prevent any kind of waste disposal into the river that supply domestic drinking water, 2) Soil and the crop cultivated in the vicinity of the areas need to be evaluated and lastly 3) Support for further study to investigate into biological parameters of significant health concern.

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