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Physico-chemical property of River Ganga at foot hills of Garhwal Himalayas

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Abstract

To assess the water quality of river Ganga at foot hills of Garhwal Himalaya five sampling station have been selected in a long stretch of 125 Km from Devprayag to Roorkee. The investigation was carried out for a one year (2010-2011). In the present study of river Ganga its physio-chemical characteristics*viz* temperature, turbidity, conductivity, total solid, BOD, COD, DO, Alkalinity, Acidity, Hardness, Chloride were done. A minor difference in all the physico-chemical parameters were observed in all the sampling station studied during the course of study.

Keywords:*BOD,Conductivity,Physico-chemical*

Introduction

The River Ganga (2,525 km long) is the largest river basin in India, covering 26.2 percent of India's total geographical area. The Bhagirathi River emerges at Gaumukh (30°92” N, 79°08” E, elevation 4100 m) from Gangotri glacier in Western Himalaya. Alaknanda River emerges from the Saptonath-Kharak group of glaciers, 8 km away from Badrinath(30°44" N, 79°32" E, elevation 3123 m). The stream formed after their merger at Devprayag is formally known as Ganga River.The country is blessed with so many river systems that have a history of sustaining civilizations as old as Harappa and Indus Valley civilizations. That is why rivers are held in awe and revered in our country. But we have taken an unfair advantage of these lifelines of our country by polluting them. Water resources are national assets and holds key of the economy of the country. This vital resource is becoming a scarce commodity and as such required to be planned, developed and managed with most care.

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But due to growing population and industrialization, maintains and safe guarding of this precious resources is however, neglected (Anchal*et al*., 2007).The maintenance of healthy aquatic ecosystem is depended on the physico-chemical properties and biological diversity. A regular monitoring of water bodies with required number of parameters with reference to the quality of water not only prevents the outbreak of diseases and occurrence of hazards but checks the water from further deterioration. A number of investigations have been conducted to study the physicochemical properties of water in different Rivers. The River Ganga is a part and parcel of everyday life in the city and thousands of people bath daily in the River Ganga. Pressure on the river increasing is enormously due to ever increasing population, industrial and urban growth in the river basins. The Ganga has been worshipped by Indians from time immemorial and the practice still continues. The water of the Ganga was considered to be holy, having powers to rid us from all our sins. But now the water has become contaminated to such an extent that it has the potential to cause many life threatening diseases. At Haridwar domestic sewage and untreated industrial effluents along with the excreta of various warm blooded animals are directly or indirectly discharged into

river Ganga which had adversely affected physicochemical property of River Ganga. In the present paper an attempt has been made to assess the impact of changes on the physiochemical properties of water of river Ganga at foot hills of Garhwal Himalaya.

Materials and method

The investigation was performed at five different sampling sites for a period of one year i.e. March 2010-March 2011in a long stretch of about 125 km. Sampling station A (Devprayag), Sampling station B (Rishikesh), Sampling station C (Haridwar) Sampling station D (PulJatwara) and Sampling station E (Roork**e**e).

Water samples were collected at monthly interval for a period of one year between 8.00AM to 10.00 AM in clean borosil glass bottles of 300 ml capacity and plastic containers from five selected sampling sites. Standard method for the examination of water and waste water was used APHA–AWWA–WPCF (1998), Trivedy and Goel (1986) and Khanna and Bhutiani (2008) for analysis work.The temperature was recorded at the sites with the help of mercury thermometer. DO in water samples were fixed with the help of mangnoussulphate and alkali-iodide-azide solution (2ml each) at the sites and analyzed in the laboratory using wrinkler´smodified iodide- azide method.

Results and discussion

On the basis of analysis result of various physico-chemical parameter are given in table 1 while correlation coefficient between different parameter are given in table 2. Temperature is the important factor which influences the chemical, biochemical and biological characteristic of the aquatic system. In the present investigation minimum water temperature was recorded 15.54±3.32 at sampling site A while maximum was recorded 17.04±4.54 at sampling site E. The average value of temperature was observed as 16.47±0.61 during the study period.The water temperature showed an upward trend from January to April followed by a downward from May onwards. A more or less similar trend has been observed in the River Yamuna by Chakrabarty*et al*. (1959). Badola and Singh (1981) also reported similar trend in the river Alaknanda. Same study was made by Khanna*et al.* (2011) in river Ganga at Haridwar, and Kulshrestha and Sharma (2006) in Ganga river at Haridwar. Same trend of temperature was observed by A. Mohan*et al*. (2007) in river Ganga at Moradabad. The electrical conductivity has always been used as a valuable method to estimate the degree of salt contents and total dissolved solids in water.Minimum Conductivity was recorded 124.23±21.75 at sampling site A while maximum was recorded 152.02±49.18 at sampling site E. The average value of conductivity was observed as 16.47±0.61 during the study period. It can be said that the present higher conductivity values in July to October month due to the input of large amount of salts and silt carried by the river.EC showed significant positive correlation with TS, chlorides, alkalinity, free CO_2, Acidity, DO and hardness and had negative correlation with Turbidity, BOD and COD. Identical results were observed byAbida and Harkrishna(2008)Dobriyal, *et al*., (1983) and Kudesiaand Verma (1985) from various Indian rivers. Singh, *et al*. (2006) also observed similar trend of conductivity in Ganga river at Bulandshahar.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. The water of the river Ganga becomes start turbid from June month onward and in July to September the water was highly turbid. Minimum turbidity was recorded 111.42±132.63at sampling site B while maximum was recorded 182.32±192.32at sampling site A.The average value of turbidity was observed as 131.47±29.69 during the study period. Significant positive correlation was found withBOD, COD and free CO_2 and had negative correlation with DO, TS, acidity, alkalinity, hardness and chloride. Similar pattern was also reported by Badola and Singh (1981), Khanna*et al*. (2010) in the hill streams of the Garhwal Himalaya, Malik*et al*. (1995) in river Ganga, and Ray*et al*. (1966) in the river Yamuna and Ganga. In the present investigation it was noted that the minimum total solid was recorded 336.02±317.89 at sampling site C while maximum was recorded 627.77±753.39 at sampling site E.The average value of Total Solid was observed as 434.57±115.87during the study period. Total solids cause ecological imbalance in the aquatic ecosystem by mechanical abrasive action.

Table 1: Physico-chemical characteristics of Ganga River at different sampling stations during 2010-11

Parameter	Sampling site A	Sampling site B	Sampling site C	Sampling site D	Sampling site E	Average
Temp.(°C)	15.54±3.32	16.79±3.40	16.16±3.82	16.83±3.73	17.04±4.54	16.47±0.61
Cond. (µmhos/Cm^2)	124.23±21.75	128.69±20.74	135.81±23.76	140.35±19.18	152.02±49.18	136.22±10.80
Turbidity (JTU)	182.32±192.32	111.42±132.63	115.24±123.05	114.99±116.87	133.39±147.11	131.47±29.69
Total Solid (mg/l)	365.91±411.18	393.11±420.35	336.02±317.89	627.77±753.39	450.02±585.91	434.57±115.87
BOD (mg/l)	2.72±0.67	1.78±0.54	0.89±0.79	0.95±0.48	1.85±0.46	1.63±0.18
COD (mg/l)	8.86±2.30	8.89±2.06	6.88±1.33	6.22±0.86	9.00±1.34	7.97±1.31
DO (mg/l)	6.84±2.62	6.98±2.20	9.26±1.18	9.09±1.31	6.47±1.16	7.73±1.33
Free CO_2 (mg/l)	1.42±0.70	0.98±0.31	1.08±0.20	1.14±0.21	1.85±0.57	1.29±0.35
Acidity (mg/l)	52.19±11.60	50.00±11.91	48.56±19.67	49.55±11.84	51.25±10.68	50.30±1.98
Alkalinity (mg/l)	36.87±7.74	43.28±9.83	43.42±9.91	73.39±16.31	74.60±17.78	54.31±18.16
Hardness (mg/l)	54.65±9.44	52.88±9.76	56.65±10.58	60.98±9.74	74.02±14.78	59.84±8.48
Chloride (mg/l)	4.65±0.57	4.67±1.12	4.98±0.91	5.40±0.69	4.79±1.82	4.90±0.30

All values are mean values ,± = Standard Deviation

Higher values of total solids may cause deterioration of the surviving condition of aquatic organisms by mechanical abrasive action and enhance the turbidity of the river. Same conditions were shown by Khanna (1993), Kudesia&Verma(1985) in their studies. Sah*et al*. (2000), and Shraddha*et al*. (2011) studied that most of the Indian rivers show similar tendency with respect to fluctuations of total solids. Khanna*et al*. (2001) and Dwivedi*et al*. (2002) also made out the same study. Similar trends were shown by Bilgramiand Duttamunshi (1985).Biological oxygen demand has been used as a measure of the amount of organic material in an aquatic solution which supports the growth of microorganism. Minimum biological oxygen demand was recorded 2.39±0.46 at sampling site E while maximum was recorded 2.83±0.79 at sampling site E. The average value of biological oxygen demand was observed as 2.61±0.18 during the study period. Highest annual average value of bio-chemical oxygen demand at sampling station E may be due to drainage of several small sewage drains into the river and runoff of sludgy, silted sewage during months of rainy season. A negative relationship has been observed between BOD and COD contents. A similar pattern has been reported by Khanna&Chugh (2004) and Singh, (1999). BOD determination is a most useful technique to assess the level of organic pollution in river system. BOD levels were probably influenced by heavy metals with regard to seasonal fluctuation. Meenakshi*et al*. (2002) reported similar trends in river Yamuna and Singh, (1999) for the river Ganga. Singh*et al*. (2009) noticed peak values during summer in Irilriver and Singh &Rai (1999) observed peak values in monsoon season in river Ganga.COD determines the amount of oxygen required for chemical oxidation of organic matter using a strong chemical oxidant such as potassium dichromate under reflux conditions. Minimum Chemical oxygen demand temperature was recorded 6.22±0.86 at sampling site Dwhile maximum was recorded 9.00±1.34 at sampling site E. The average value of COD was observed as 7.97±1.31 during the study period. Similar trends of COD have shown by Khanna&Bhutiani (2003) in the river Ganga and Khanna&Chugh (2004) inGangaRiver.Temperature plays an important role in determining DO in an aquatic body. Dissolved

oxygen data are valuable in determining the water quality criteria of an aquatic system. In the system where rate of respiration and organic decomposition are high,the DO values remain lower than those of system where the rate of photosynthesis is high.A high pollution load may also decrease the DO values to considerable level.Minimum Dissolved oxygen was recorded 6.47±1.16 at sampling site E while maximum was recorded 9.26±1.18 at sampling site D. The average value of dissolved oxygen was observed as 7.73±1.33 during the study period. The cause of maximum dissolved oxygen in November to February is due to reduced rate of decomposition by decreased microbial activity at low temperature Swarnali*etal*. (2009). Meenakshi*etal*. (2002),Abowei, (2010)and Singh and Rai(1999) also have got the same result and have opined that low temperature in November to February increases the oxygen retaining capacity of water and solubility of O_2 in water. This trend was also observed by Badola and Singh (1981) in the river Alaknanda. Khanna (1993) has also reported the same trends in the river Ganga at Haridwar. Same study is also made by Joshi*et al*. (2009a) in Ganga canal at Hardwar. Concentration of dissolved oxygen is one of the most important parameter to indicate water purityand to determine thedistribution and abundance of various algal groups. It has been recommended that a minimum of 4 mg/l of dissolved oxygen should be maintained in water for healthy growth of fish and other microbial population. Different workers have pointed out various influencing factors on oxygen level that include discharges from industries, water current, velocity and biota.Minimum Free CO_2 was recorded 0.98±0.31 at sampling site B while maximum was recorded 1.85±0.57 at sampling site E. The average value of Free CO_2 was observed as 1.29±0.35during the study period.Singh*et al*. (2006) and Seth *et al*. (2000) have also reported the same trends in the river Ganga.A direct relationship was established between the water temperature and free carbon dioxide.The dissolved oxygen and free carbon dioxide usually inversely related to one another because of photosynthetic and respiratory activity of the biota (Hynes, 1970). The fluctuations in the dissolved oxygen content were mainly influenced by the factors like TOC, plankton and microbial activity.

Minimum Acidity was recorded52.19±11.60 at sampling site A while maximum was recorded 56.81833±19.67 at sampling site C. The average value of acidity was observed as 53.88±1.98 during the study period. Similar trend was found by Khanna and Bhutiani (2003).

Table 2: Correlation between physico-chemical parameter of Ganga River at different sampling stations during 2010-11

Parameter	Temp.	Cond.	Turbidity	TS	BOD	COD	DO	CO_2	Acidity	Alkalinity	Hardness	Chloride
Temp.												
Cond.	0.72											
Turbidity	-0.73	-0.38										
Total Solid	0.55	0.44	-0.30									
BOD	-0.72	-0.74	0.14	-0.77								
COD	-0.07	-0.14	0.48	-0.51	-0.01							
DO	-0.03	0.59	-0.50	0.29	-0.84	-0.96						
Free CO_2	0.12	0.59	0.47	0.02	-0.56	0.48	-0.59					
Acidity	0.10	0.48	-0.37	-0.35	0.21	-0.25	0.36	0.13				
Alkalinity	0.77	0.88	-0.35	0.79	-0.92	-0.27	0.07	0.46	-0.05			
Hardness	0.57	0.93	-0.06	0.35	-0.78	0.11	-0.25	0.83	0.34	0.82		
Chloride	0.32	0.36	-0.47	0.79	-0.36	-0.92	0.80	-0.26	0.09	0.58	0.15	

Alkalinity constitutes an important parameter in determining the quality of water. Minimum Alkalinity was recorded 36.87±7.74 at sampling site A while maximum was recorded 74.60±17.78 at sampling site E. The average value of alkalinity was observed as 54.31±18.1 during the study period.This result was supported by the finding of Kumar *et al.*(2010) Galy and Lanord (1999). The decomposition of the organic matter leads to the high alkalinity of the waters. (Maiti, 2004).Minimum Hardness was recorded 52.88±9.76 at sampling site B while maximum was recorded 74.02±14.78 at sampling site E. The average value of hardness was observed as 59.84±8.48 during the study period. Calcium and Magnesium are the two component of Total hardness. It is present in form of carbonate and bicarbonate. Calcium In is one of the most abundant substances of natural waters. Being present in high quantities in the rocks, it is leached from there to contaminate the water. Calcium is essential for metabolic processes in all-living organisms. Khanna*et al*. (2001) and Joshi *et al.* (2009a) observed hardness in river Ganga at Haridwar and found more or less similar trends in their study.Minimum Chloride was recorded 4.65±0.57 at sampling site A while maximum was recorded 5.40±0.69 at sampling site D. The average value of Chloride was observed as 4.90±0.30 during the study period. Chlorides are present in sewage, sewage effluents and farm drainage. Chloride showed positive correlation with temperature, EC, TS, DO, acidity and alkalinity and had significant negative correlation with turbidity, BOD,COD and free CO_2.Significant levels of chloride were shown by many rivers like Yamuna (Meenakshi*et al*., 2002), Harshley*et al*.(1982). Khanna and Chugh (2004)also reported chloride in Ganga river at Hardwar.

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