

Seasonal variation in water quality of river Ganga at Kangri village district Haridwar

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Abstract

The current investigation was conducted to determine the water quality of river Ganga with respect to physico-chemical parameter of river Ganga seasonally. Ganga is one of the holiest rivers of India. Due to its religious importance and multiple use of river water for human consumption, the water quality of river Ganga are deteriorating rapidly, therefore regular monitoring of river Ganga is essential. With this aim various studies have been conducted in the past on fresh water. The present study deals that the water quality monitoring of river Ganga at Haridwar was considered at different sampling sites during one year period divided in Winter (November-February), summer (March-June) and monsoon (July -October). Parameters studied were pH, Free CO₂, D.O., temperature at the spot and other parameters like as acidity, alkalinity, hardness, calcium, chlorides, B.O.D, etc. in the lab. TDS and TSS were recorded maximum in monsoon during our study. The value of dissolved oxygen observed maximum in winter season. During our study period it has been found that the water quality of river Ganga was quite good in all three seasons. However change in seasonal conditions had a great effect on physicochemical parameters.

Keywords: physicochemical parameter, river ganga, water quality, correlation

1. Introduction

Rivers are life line of human settlement but there are natural and anthropogenic factors which affect the hydrological parameters of river Ganga according to Gupta and Chakarpani, 2007. There are many rivers in our India. But Ganga is one of the holiest river of India. The River Ganges, largest river of the Indian sub-continent with a total length of about 2525 km, originates from ice-cave 'Gaumukh' (30°55' N / 70 ° 7' E) in the Garhwal Himalaya at an altitude of 4100 m and discharges into Bay of Bengal. In Kangri village, Ganga river passes through the Haridwar, at Shyampur and Gendi Khata villages. Kangri village is situated at the east bank of river Ganga, District Haridwar which is connected through Haridwar-Najibabad road. Due to anthropogenic activities, un proportional growth of population and industries, water quality of river Ganga is degrading at a faster rate day by day therefore, regular monitoring of river Ganga is essential. According to Khanna and Singh (2000) physicochemical parameter of water quality dispenses the running information about the concentration of various solutes at a given place and time. Various eminent limnologists have done the work on water quality parameters in India and Abroad. During the present investigation monitoring of River Ganga at Haridwar was done seasonally from different sampling sites for one year period divided in Winter (November-February), summer (March-June) and monsoon (July -October).

Materials and methods

Haridwar is one of the most holy cities of India. It lies in the foothills of Shivalik range. The position of city on the globe is on latitude 29°58'N and longitude 78 ° 13' E. Water samples were taken from upstream and downstream of Kangri village in Haridwar district. The selected sites of Upstream and downstream of Kangri village denoted as

Sampling site A and sampling site B. Monthly sampling was done from November-2009 to October 2010. The collection of sample was done in the morning hours (7.00 a.m. to 9.00 a.m.) in borosil glass bottles of 300 ml capacity and plastic containers from each sampling sites all the parameter were analysed by the methods of APHA (1998), Khanna & Bhutiani (2004)

Results and Discussion

The monitoring of the river Ganga is an important tool to notice the trend pattern of pollutants and their effect on living systems in today's developing life. On the basis of study average value of various physico-chemical parameters are given in table 1 at Kangri village.

Temperature is one of the most important factor, which determines the directly relation with the chemical reaction in water and biochemical reactions in the living organisms. During the current analysis, the higher temperature (19.02±1.93) was recorded in summer season while lower temperature (12.77±2.70) in winter season. According to Parashar *et al.* (2006) the fluctuation in water temperature may be noted due to collection of sample in different timings and impact of season. Similar results regarding to temperature was also observed by Khanna *et al.* (2011). Temperature found to have significant positive correlation with turbidity, conductivity, TDS, TSS, free CO₂, acidity, hardness, calcium, chloride, BOD, nitrate and had negative correlation with DO, phosphate, alkalinity and pH. Conductivity is an important factor which has an ability to measure the aqueous solution which carries an electric current. In Ganga river water conductivity varies from (137.37±11.94 to 220.72±39.54). The concentration of Conductivity was found to be maximum (220.72±39.54) in monsoon season while minimum (137.37±11.94) in winter season. It may be pretended that maximum value of

conductivity during monsoon season was possibly occurred as a result of higher quantity of salts and silt carried by the river. Bhardwaj *et al* (2010) spotlighted the similar trend on Chhoti Gandak river. Conductivity showed significant positive correlation with TDS, TSS, free CO₂, acidity, hardness, calcium, chloride, BOD, nitrate and had negative correlation with DO, phosphate, alkalinity and pH. Total dissolved solids or filterable residue are those solids, which left after evaporation of the filterable sample. TDS is a relevant factor which indicates the total amount of inorganic chemicals in the solution. In the present study the maximum (206.88±6.95) and minimum (118.6±4.20) concentration of TDS was observed in monsoon season and winter respectively. Khanna (1993) also observed similar trend for total dissolved solid and Venkatesharaju *et al* (2010) in Cauvery river. TDS has been positively correlated with TSS, free CO₂, acidity, hardness, calcium, chloride, BOD, nitrate and had negative correlation with DO, phosphate, alkalinity and pH. TSS is the amount of solid which does not get dissolved and remains in suspended form, which get settled down with decreasing turbulence and passage of time. The value of TSS was found to be maximum (311.97±94.92) in monsoon season while minimum (93.50±78.20) in winter season. Higher values were probably noted due to heavy rain causing soil erosion and more suspended or dissolved solids. The result shows resemblance with that of study conducted by Khanna (1993), Khanna and Chugh (2004) and Khanna *et al.* (2009). TSS has also been positively correlated with free CO₂, acidity, hardness, calcium, chloride, BOD, and had negative correlation with DO, phosphate, alkalinity, nitrate and pH. Turbidity is one of the most common forms of pollution in the river water. The value of turbidity was recorded maximum (120.37±56.89) during monsoon season and minimum (26.17±22.74) in winter season. Venkatesharaju *et al* (2010) reported the similar condition. Turbidity has been found significantly positive correlated with conductivity, TDS, TSS, free CO₂, acidity, hardness, calcium, chloride, BOD and had negative correlation with DO, phosphate, alkalinity, nitrate and pH. pH is an important factor which measure acidity or alkalinity in water. Aquatic organisms are sensitive for pH change due to any change in the pH cause change in the structure of aquatic system. In this study, pH observed maximum (8.03±0.17) in the winter season and minimum (7.38±0.16) in the monsoon season. It was observed that higher value of pH during winter season because of decreased decomposition rate owing to reduced microbial activity and increased algal productivity, photosynthetic activity of phytoplankton and other higher aquatic plants and lower value in monsoon due to increased decomposition rate, leading to acidification. Similar results regarding to pH was also reported by Yadav and Kumar (2011) in the river Kosi at Rampur district and Khanna and Bhutiani (2005) in river Ganga. pH found to have significantly negatively correlation with free CO₂, acidity, hardness, calcium, chloride, BOD, nitrate and had positive correlation with DO, phosphate, and alkalinity. Due to activity of aquatic organism, free CO₂ comes in water. During the present study free CO₂ varies from (1.61±0.21) minimum in the winter season to (2.99±0.46) maximum value in the monsoon season. This is similar findings of Khanna *et al* (2007) in river Ganga. Free CO₂ has been positively correlated with acidity, hardness, calcium, chloride, BOD, nitrate and had negative correlation with

DO, phosphate and alkalinity. Acidity of water indicates that it is quantitative capacity to react with a strong base to a designated pH. The concentration of acidity fluctuates between (13.89±1.38 to 19.50±1.08) during the study period. This maximum (19.50±1.08) and minimum (13.89±1.38) concentration of Acidity was observed in the monsoon season and winter season respectively Higher value of acidity may be due to high temperature, Carbon-dioxide and therefore, higher microbial activity was observed. This observation is confirmed by Singh (2010). Rai *et al* (2010) reported the identical trends in river Ganga at Varanasi. Acidity has also been positively correlated with hardness, calcium, chloride, BOD, nitrate and had negative correlation with DO, phosphate and alkalinity. Alkalinity is caused by the presence of Carbonate and Bicarbonate ions. It found to be maximum (80.33±7.70) in the winter season and minimum (53.55±7.47) in the monsoon. Maximum value were recorded in winter season may be due to decomposition of organic matter that has settled at the bottom. while, minimum value in monsoon season due to dilution of bicarbonates or increase in water level. Khanna *et al* (2007) also reported the similar trend on Song river at Dehradun and Sarkar *et al* (2007) observed similar trend for Alkalinity. Alkalinity found to have significantly negatively correlation with hardness, calcium, chloride, BOD, nitrate and had positive correlation with DO and phosphate. Hardness determines the contents of calcium and magnesium ions. It is governed by the presence of chloride, Nitrate, sulphate and bicarbonate of calcium and magnesium. (Kumar *et al.* 2010). The maximum (151.36±6.79) hardness of water observed in the monsoon while minimum (80.41±2.92) in winter. This might be due to discharge of sewage and lowering of water column. A similar finding was made by Mishra (2003) in river Ganga at Haridwar and Sarkar *et al* (2007) observed similar trend for hardness. Hardness showed a significantly positive correlation with calcium, chloride, BOD, nitrate and negative correlation with DO and phosphate. The concentration of Calcium was found to be maximum (18.14±2.09) in the monsoon while minimum (13.04±1.61) in the winter season. Similar findings were observed by Joshi *et al.* (2009) in the river Ganga. Calcium observed the significant positive correlation with chloride and BOD and negative correlation with DO, nitrate and phosphate. In river water sometimes chloride may be noted due to leaching of rocks. In the current investigation the concentration of chloride varies between (7.59±1.00 to 12.49±0.63). This maximum (12.49±0.63) and minimum (7.59±1.00) concentration of chloride was observed in the monsoon and winter respectively. Similar observation was also observed by Vishnoi *et al* (2008) in river Ganga at Kangri village and Kumar *et al.* (2011) also reported the similar trend on Yamuna river around Hamirpur. Chloride has been found positively correlated with BOD and nitrate and negatively with phosphate and DO. DO is an important tool, which depends on the factors as temperature, contents of dissolve solids physical and biological activities of all life. During the present study maximum (11.34±0.88) value of DO was recorded in the winter season while minimum (9.01±0.55) in the monsoon. Khanna *et al* (2010) observed the similar trend in river Ganga, Sangum and Sharma (1985) in river Yamuna. DO has been noted a significant positive correlation with phosphate and negative with BOD and Nitrate. The biochemical oxygen demand is the amount of

oxygen required to degrade the organic compound biologically. The concentration of BOD increases with the increase in chemical pollution of the water body. In the present investigation maximum (2.40±0.63) value of BOD was recorded in the monsoon while minimum (1.26±0.20) in the winter. The similar conclusion was supported by Khanna *et al.* (2007) in river Ganga and Venkatesharaju *et al.* (2010) in Cauvery river. BOD has been positively correlated with nitrate and negatively with phosphate. According to Dugan (1972) phosphate is an important factor to measure the water quality as it is an important plant nutrient and may play a role of a limiting factor among all other essential plant nutrients. Nitrate indicates that it is the

end product of oxidation of nitrogenous matters and its concentration depends upon the nitrification and denitrification activities of micro-organisms according to Sinha *et al.*(2000). In the present investigation maximum (0.138±0.026) value of phosphate was recorded in the winter season while minimum (0.060±0.006) in the monsoon. Similar observation was given by Yaqoob *et al.* (2004). This maximum (0.047±0.003) and minimum (0.027±0.002) concentration of Nitrate was observed in the summer and winter respectively. Similar trend was also observed Khanna (1993) and Joshi *et al.*(2009). Nitrate found to have significant negative correlation with phosphate.

Table 1: Average seasonal variation in physico-chemical parameters of river Ganga during year November 2009 to October 2010.

	Winter	Summer	Monsoon	Average
Temperature(°C)	12.77±2.70	19.02±1.93	18.43±0.67	16.74±3.45
Turbidity(JTU)	26.17±22.74	33.34±14.89	120.37±56.89	59.96±52.44
Conductivity(µmhos/Cm2)	137.37±11.94	168.52±12.01	220.72±39.54	175.53±42.11
T.D.S. (mg/l)	118.06±4.20	146.18±17.78	206.88±6.95	157.04±45.39
T.S.S. (mg/l)	93.50±78.20	98.33±34.61	311.97±94.92	167.93±124.76
pH	8.03±0.17	7.74±0.14	7.38±0.16	7.71±0.33
Free CO ₂ (mg/l)	1.61±0.21	2.07±0.28	2.99±0.46	2.22±0.70
Acidity (mg/l)	13.89±1.38	16.33±1.10	19.50±1.08	16.57±2.81
Alkalinity (mg/l)	80.33±7.70	70.40±4.64	53.55±7.47	68.09±13.54
Hardness (mg/l)	80.41±2.92	99.22±13.13	151.36±6.79	110.33±36.76
Calcium (mg/l)	13.04±1.61	13.63±1.26	18.14±2.09	14.93±2.79
Chloride (mg/l)	7.59±1.00	10.09±1.21	12.49±0.63	10.06±2.45
D.O. (mg/l)	11.34±0.88	9.27±1.04	9.01±0.55	9.87±1.27
B.O.D. (mg/l)	1.26±0.20	1.98±0.26	2.40±0.63	1.88±0.58
Nitrate (mg/l)	0.027±0.002	0.047±0.003	0.034±0.004	0.036±0.010
Phosphate (mg/l)	0.138±0.026	0.078±0.012	0.069±0.006	0.095±0.038

Table 2: showing correlation between physicochemical parameters of river Ganga for the year November 2009 to October 2010.

	Temperature	Turbidity	Conductivity	T.D.S.	T.S.S.	pH	Free CO ₂	Acidity	Alkalinity	Hardness	Calcium	Chloride	D.O.	B.O.D.	Nitrate	Phosphate
Temperature	1.00	0.49	0.73	0.68	0.44	-0.79	0.70	0.78	-0.73	0.64	0.52	0.83	-0.98	0.90	0.81	-0.98
Turbidity		1.00	0.95	0.97	1.00	-0.79	0.96	0.93	-0.95	0.98	1.00	0.89	-0.64	0.82	-0.12	-0.66
Conductivity			1.00	1.00	0.94	-1.00	1.00	1.00	-1.00	0.99	0.96	0.99	-0.84	0.96	0.19	-0.86
T.D.S.				1.00	0.96	-0.99	1.00	0.99	-1.00	1.00	0.98	0.98	-0.81	0.94	0.13	-0.82
T.S.S.					1.00	-0.90	0.95	0.91	-0.94	0.97	1.00	0.87	-0.60	0.79	-0.17	-0.62
pH						1.00	-0.99	-1.00	1.00	-0.98	-0.94	-1.00	0.89	-0.98	-0.28	0.90
Free CO ₂							1.00	0.99	-1.00	1.00	0.97	0.98	-0.82	0.94	0.15	-0.83
Acidity								1.00	-1.00	0.98	0.94	1.00	-0.88	0.97	0.26	-0.89
Alkalinity									1.00	-0.99	-0.96	-0.99	0.84	-0.95	-0.19	0.85
Hardness										1.00	0.99	0.96	-0.77	0.91	0.07	-0.79
Calcium											1.00	0.91	-0.67	0.84	-0.08	-0.68
Chloride												1.00	-0.92	0.99	0.34	-0.93
D.O.													1.00	-0.96	-0.69	1.00
B.O.D.														1.00	0.47	-0.97
Nitrate															1.00	-0.67
Phosphate																1.00

Conclusion

During the present investigation it was found that physico-chemical parameters of Ganga river at Kangri village was quite good in all seasons. However, during winter season the slight variations were reported due to runoff of organic matter in to river from foothills and River basin. The Fluctuation in the concentrations of various nutrients and physicochemical parameter recorded due to seasonal changes. Our study showed the slight variations in all the seasons. The problem of pollution was not a major concern in Ganga river at kangri village however conservation of river should be managed in Kangri village at Haridwar otherwise it will turn into state which affect its hydrological status and may not be fit for human consumption as well as growth and survival of aquatic life present in it.

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