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Research Article

QUALITY ASSESSMENT OF GANGA RIVER AT HARIDWAR WITH REFERENCE TO VARIOUS PHYSICO-CHEMICAL PARAMETERS

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ABSTRACT

The present investigation deals with the monthly variations in the physico-chemical parameters of river Ganga in the Haridwar region during January 2014 to June 2014. Various physico-chemical parameters analysed during the study period included temperature, pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), alkalinity, acidity, total hardness (TH), calcium, magnesium, total dissolve solids (TDS), total solids (TS), free CO_2 and chlorides. During the study period, only minor differences in physico-chemical parameters were observed and found within the range except calcium at site 1 and 2 whereas at site 3 calcium was found within the limit.

Keywords: River Ganga, Physico-chemical properties, Monthly variations etc.

INTRODUCTION

Water has played an important role not only in the history of countries, but in religion, mythology, and art. Water in many religions cleanses the soul through holy water. India is a country having various land forms and rivers. There are 14 major rivers in India water, the universal solvent because of high dielectric constant has the property of dissolving most of the substances but the access of these substances leads to water pollution (Gautam, 1990). In many developed countries, water pollution is a major pollution and many river basins have been found to show high organic matter concentration. In rapidly industrialization countries like India, China and Brazil, untreated sewage and industrial waste create substantial pressure on water quality. Rivers are of immense importance geologically, biologically, historically and culturally. Although they contain only

about 0.0001% of the total amount of water in the world at any given time, rivers are vital carriers of water and nutrients to areas all around the earth. They are critical components of the hydrological cycle, acting as channels for surface water – the world's rivers drain nearly 75% of the earth's land surface. They provide habitat, nourishment and means of transport to countless organisms (http://www.Eo earth.org/article/River). Rivers are water ways of strategic importance across the world, providing main water resources for domestic, industrial and agricultural purposes. River pollution in India has now reached to a point of crisis due to unplanned urbanization and rapid growth of industrialization. The entire array of life in water is affected due to pollution in water. The problem of water quality deterioration is mainly due to human activities such as disposal of dead bodies, discharge of industrial and sewage wastes and agricultural runoff which are major cause of ecological damage and pose serious health hazards (http://irjs.info/index.php/irjs/article/viewFile/8506/4367) It is estimated that community waste from human activities accounts for four times as much wastewater as industrial effluents, most of which is discharged untreated/partially treated into the water courses in India.Increasing problem of deterioration of river water quality, it is necessary to monitoring of water quality to evaluate the production capacity (Kesharwani *et al.*, 2004).Various aspects related to water quality of different Riversin India and its tributaries have been studied by various researchers (Khanna *et al.*, 2006; Khanna *et al.*, 2007a; Khanna *et al.*, 2007b; Khanna *et al.*, 2012; Singh *et al.*, 2012; Yadav *et al.*, (2013); Khanna *et al.*, 2013a; Bhutiani *et al.*, 2015; Pandey *et al.*, 2014, Bhutiani and Khanna, 2015; Bhutiani and Khanna, 2016).

MATERIAL AND METHODS

Analysis of water was done according to standard methods as prescribed by APHA (1998) and Khanna and Bhutiani (2007). In the present study the samples were collected twice in a month in morning hours (7 am-10 am) from January 2014 to June 2014 from Ganga River near Devpura Jagjeetpur, Haridwar, Ganga River near Sewage treatment plant, Jagjeetpur, Haridwar and Ganga River near Misharpur, Haridwar (Fig. 1 to 3). Grab water samples from sites were collected in plastic jerry cans from about 15 cm below the surface water by keeping and opening Jerri cans below the surface water. Caps of cans were removed after dipping the can and also closed in the water after filling up of can. Care was taken to avoid bubbling and entry of leaves, twigs or debris into the sampling bottle. The water samples were directly taken to the lab and analyzed for various physico-chemical parameters while some of the parameters were analyzed in the field immediately after collection of samples.

Figure 1. Sampling Site of Ganga River near Devpura Jagjeetpur, Haridwar

Figure 2. Sampling Site of Ganga River near Sewage treatment plant, Jagjeetpur, Haridwar

Figure 3. Sampling Site of Ganga River near Misharpur, Haridwar

RESULTS AND DISCUSSION

The physico-chemical characteristic that were considered in the study were water temperature, pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), alkalinity, acidity, total hardness (TH), calcium, magnesium, total dissolve solids (TDS), total solids (TS), free CO_2 and chlorides. Site wise observations for various physico-chemical parameters are given in tables from 1-6. pH is measure of the intensity of acidity or alkalinity and the concentration of hydrogen ion in water. Most rivers have a neutral to slightly basic pH of 7.00 to 8.00.

Table 1. Monthly variation in different physical parameters at site-1

Month/Parameters	pH	Temperature(^{0}C)	Total solid (mg/l)	Total dissolved solid (mg/l)
January	7.67	10.0	435	365
February	7.74	11.9	445	375
March	7.32	12.1	452	363
April	7.43	12.8	465	371
May	7.43	14.1	457	389
June	7.44	17.4	469	403
Average ± SD	7.51±0.16	13.05±2.52	453.83±12.66	377.67±15.48

Table 2. Monthly variation in different physical parameters at site-2

Month/Parameters	pH	Temperature(^{0}C)	Total solid (mg/l)	Total dissolved solid (mg/l)
January	7.45	9.8	430	370
February	7.74	10.7	454	362
March	7.53	11.0	456	369
April	7.05	11.5	470	366
May	7.54	12.7	462	374
June	7.49	14.2	472	384
Average ± SD	7.47±0.23	11.65±1.57	457.33±15.21	370.83±7.60

Table 3. Monthly variation in different physical parameters at site-3

Month/Parameters	pH	Temperature(^{0}C)	Total solid (mg/l)	Total dissolved solid (mg/l)
January	7.50	10.2	433	330
February	7.50	9.6	450	308
March	7.15	10.7	456	353
April	7.75	12.4	477	365
May	7.30	14.0	471	373
June	7.70	15.1	479	391
Average ± SD	7.48±0.23	12.0±2.21	461±17.94	353.33±30.14

The monthly average value of pH was observed 7.51±0.16 at site-1, 7.47±0.23 at site-2 and 7.48±0.23 at site-3.The pH was recorded to be minimum of 7.05 in the month of April at site-2 and maximum of 7.74 in the month of February at site-1. Gupta *et al.,* (2008) observed pH in Mothronwala swamp and found more or less similar trends in their study. The water temperature plays an important factor which influences the chemical, bio-chemical characteristics of water body. In the present study, an average fluctuation of water temperature was observed 13.05^{0}C±2.52 at site-1, 11.650C ±1.57 at site-2 and 12.0^{0}C ±2.21 at site-3. The temperature was recorded to be minimum (9.6^{0}C) in the month of February at site-3 and maximum (17.4^{0}C) in the month of June at site-1. A more or less trend has been observed in Mothronwala swamp, by Gupta (2008), Preety (2014) who also reported similar trend in river Gomti (UP) of India. Total solids cause ecological imbalance in the aquatic ecosystem by technical abrasive action. In the present study, the monthly average value of total solids was observed 453.83 mg/l ±12.66 at site-1, 457.33 mg/l ±15.21 at site-2 and 461 mg/l ±17.94 at site-3. The monthly average value of total solid was found minimum (430mg/l) in the month of January at site-2 and maximum (479mg/l) in the month of June at site-3. Same trend were also reported by Yadav *et al.,* (2013) and Bhutiani *et al.,* (2015b) in River Ganga. Total dissolved solids indicate the salinity behavior of water. The monthly average fluctuation of total dissolved solid was observed 377.67 mg/l ±15.48 at site-1, 370.83 mg/l ±7.60 at site-2 and 353.33 mg/l ±30.14 at site-3. The total dissolved solids was recorded to be minimum (308mg/l) in the month of February at site-3 and maximum (403mg/l) was recorded in the month of June at site-1. Similar trend was observed by Khanna *et al.,* (2011) in the analysis of Ganga river water. Dissolved oxygen reflects the physical and biological processes prevailing in the water. The DO values indicate the degree of pollution in water bodies. Dissolved oxygen (DO) is an important water quality parameter for various purposes. DO levels in surface water body indicate the ability to support aquatic life. The monthly average value of DO was observed 8.0 mg/l ±0.32 at site-1, 6.9mg/l ±0.38 at site-2 and 9.4 mg/l ±0.47 at site-3. The DO was recorded to be minimum (6.5 mg/l) in the month of June at site-2 and maximum (9.9 mg/l) in the month of January at site-3. Same trend is also reported Khanna and Bhutiani, (2005) in the Ganga river system. BOD value is indication for entry of organic waste in the river. In the present study, BOD value was recorded maximum (2.7 mg/l) in the month of June at site-2 and the minimum (1.1mg/l) value of BOD was recorded in the month of April at site-1. The total monthly average value of BOD was observed 1.4 mg/l ±0.32 at site-1, 2.3 mg/l ±0.25 at site-2 and 1.3 mg/l ±0.13 at site-3. Similar trends were observed by Khanna and Bhutiani (2003) in Ganga River at Haridwar and Bhutiani and Khanna, (2007) in River Suswa. The COD test is commonly used to indirectly measure the amount of organic compounds in water. The monthly average value of

COD was observed 36.5±0.50 at site-1, 5.87±0.96 at site-2 and 3.68±0.51 at site-3. The COD was recorded to be minimum (3.1mg/l) in the month of May at site-3 and maximum (6.4 mg/l) in the month of February at site-2. Similar trend was observed by Pandey *et al.*, (2014) in the study of river Ganga at Allahabad. In the present study, free CO_2 value was recorded maximum (3.8 mg/l) in the month of June at site-2 and the minimum (1.5mg/l) value of BOD was recorded in the month of February at site-3. The total monthly average value of CO_2 was observed 2.6±0.28 at site-1, 3.3±0.46 at site-2 and 2.4±0.92 at site-3. Bhutiani *et al.*, (2015) reported similar trend alkalinity denotes the acid neutralizing capacity of water. Alkalinity may also increase due to decomposition of organic matter that has settled at the bottom. The monthly average value of alkalinity was observed 109.7±13.4site-1, 128.1±5.05 at site-2 and 104.6±4.64 at site-3. The alkalinity was recorded to be minimum (93.0mg/l) in the month of January at site-1 and maximum (133.5 mg/l) in the month of March at site-2. Same trend is also reported by Khanna *et al.,* (2013) in the Ganga river system in foothills, of Garhwal Himalaya and Pandey *et al,* (2014). The total average value of acidity was recorded 13.4±0.52 at site-1, 16.7±3.28 at site-2 and 11.7±0.91whereas maximum average value (20.0 mg/l) was found in the month of April at site-2 and the minimum average value (10.5 mg/l) was found in the month of June at site-3. Similar trend was found by Khanna and Bhutiani (2003). The chlorides occur naturally in all types of water. High concentration of chloride is considered to be the indicators of pollution due to organic wastes of animal or industrial origin. The monthly average value of chloride was observed 29.3±7.24 at site-1, 42.2±3.38 at site-2 and 37.3±2.41 at site-3. The chloride was recorded to be minimum (26.4 mg/l) in the month of April at site-1 and maximum (45.9mg/l) in the month of March at site-2. Similar results were found by Preety (2014) in their study on Physico-chemical parameters of the river Gomti (U.P.) India. Gupta *et al.*, (2008) observed pH in Mothronwala swamp, and found more or less similar trends in their study. Hardness is the property of water which prevents the lather formation with soap and increases the boiling points of water. Hardness of water mainly depends upon the amount of calcium or magnesium salts or both. In the present study, the value of Total Hardness was recorded maximum (189.4mg/l) in the month of March at site-2 and the minimum (120.2mg/l) value of Total Hardness was recorded in the month of June at site-3. The total monthly average value of Total Hardness was observed 173.9±6.14 at site-1, 182.9±4.49 at site-2 and 121.9±4.53 at site-3. Similar trend was observed by Singh *et al.,* (2012) in the study of River Ram Ganga at Bareilly. The monthly average value of Calcium was observed 75.4±3.46 at site-1, 79.6±4.94 at site-2 and 63.5±1.26 at site-3. The Calcium was recorded to be minimum (61.3 mg/l) in the month of June at site-3 and maximum (85.4mg/l) in the month of February at site-2. Similar results were observed by Arya and Gupta (2013). The principal source of Mg in natural waters is various kinds of rocks, sewage and industrial wastes are also important contributors of Mg. The monthly average value of Magnesium was observed 24.0±1.43 at site-1, 25.2±0.65 at site-2 and 14.2±1.11 at site-3. The Magnesium was recorded to be minimum (12.5 mg/l) in the month of February at site-3 and maximum (26.3mg/l) in the month of June at site-1.Similar results were reported by Singh *et al.*, (2015).

Table 4: Showing monthly variation in different chemical parameters at site-1

Month/ Parameters	DO	BOD	COD	Free CO_2	Alkalinity	Acidity	Cl	Total Hardness	Ca	Mg
January	8.4	1.2	3.8	2.4	93	13.4	24.4	168.6	74.7	22.9
February	8.2	1.3	4.5	2.2	104	12.7	24.0	169.5	71.6	23.9
March	7.9	1.5	3.4	2.6	100.5	13.2	24.0	172.8	72.3	24.5
April	8.2	1.1	3.1	2.7	119	13.6	26.4	171.9	80.8	22.2
May	7.7	1.7	3.3	2.7	111.5	13.0	40.4	175.0	74.9	24.4
June	7.6	1.6	3.8	3.0	130	14.2	36.4	185.5	77.8	26.3
Average ±SD	8.0± 0.32	1.4± 0.24	3.65± 0.50	2.6± 0.28	109.7± 13.4	13.4± 0.52	29.3± 7.24	173.9± 6.14	75.4± 3.46	24.0± 1.43

Table 5: Showing monthly variation in different chemical parameters at site-2

Month/ Parameters	DO	BOD	COD	Free CO_2	Alkalinity	Acidity	Cl	Total Hardness	Ca	Mg
January	7.4	2.1	5.7	3.3	122.0	13.0	36.1	181.8	79.2	25.1
February	7.2	2.3	6.4	2.6	125.0	13.4	41.6	186.2	85.4	24.6
March	7.1	2.0	6.3	3.0	130.5	15.0	45.9	189.4	82.9	26.0
April	6.9	2.4	5.8	3.6	133.5	20.0	43.2	176.4	73.1	25.2
May	6.5	2.3	5.8	3.7	124.0	19.9	44.4	183.0	82.4	24.5
June	6.5	2.7	5.2	3.8	133.5	19.0	42.1	180.9	74.4	26.0
Average ±SD	6.9±0 .37	2.3±0. 25	5.87±0 .96	3.3±0 .44	128.1± 5.05	16.7± 3.28	42.2± 3.38	182.9± 4.49	79.6± 4.94	25.2± 0.65

Table 6: Showing monthly variation indifferent chemical parameters at site-3

Month/ Parameters	DO	BOD	COD	Free CO_2	Alkalinity	Acidity	Cl	Total Hardness	Ca	Mg
January	9.9	1.5	4.4	1.6	111.0	12.5	33.6	126.8	64.0	15.3
February	9.5	1.2	3.1	1.5	110.0	12.6	37.1	115.1	64.0	12.5
March	9.9	1.4	3.9	2.0	102.8	11.1	35.9	121.1	65.1	13.6
April	9.3	1.2	3.9	2.4	100.3	12.4	40.0	121.1	63.2	14.1
May	9.1	1.2	3.1	2.7	102.0	11.1	37.1	127.2	63.6	15.5
June	8.7	1.4	3.7	4.0	101.6	10.5	39.8	120.2	61.3	14.4
Average ±SD	9.4± 0.47	1.3± 0.13	3.68± 0.51	2.4± 0.92	104.6± 4.64	11.7± 0.91	37.3± 2.41	121.9± 4.53	63.5± 1.26	14.2± 1.11

CONCLUSION

Direct discharge of human and animal waste not only imparts the quality of water but also affects the health of the people where the same water is used for washing, bathing and sometimes for drinking purposes. The urban runoff and continuous dumping of waste materials especially sanitary waste are affecting the water quality of river Ganga. Although in the present study all the parameters are found within the prescribed limits. But it is an alarming situation of increasing pollution load as most of the parameters studied are found nearby to the permissible limits. Therefore, it has been suggested to regularly monitor the water quality of river so as to take an immediate action for better management of river water.

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