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Seasonal Variation in Water Quality at Chaubari Bridge, Ramganga River, Uttar Pradesh

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ABSTRACT
Analysis of water samples drawn each month of the experimental year 2015-16 from Ramganga river for various physico-chemical quality parameters were done by employing standard APHA guidelines. The range for demand parameters viz Dissolved Oxygen, Biochemical Oxygen Demand and Chemical Oxygen Demand were observed 5.8-7.8, 1.2-2.6 and 72-128 mg/l respectively. The values of calcium in analyzed samples were well within the BIS standard but that of magnesium breached the standard. The free CO_2 was found to be absent in pre-monsoon period for six consecutive months whereas in case of carbonates the absent status was found in post monsoon for six sequential months. The total hardness values ranged between 224-446mg/l with highest value in September. Strong positive and significant correlation was observed between chloride and DO as well as between BOD and carbonates present in the samples.Negative correlation was observed for free CO_2 with pH, DO, bicarbonate and chloride.

Key words: Water quality parameters, Physico-chemical environment, Dissolved Oxygen, BOD, COD

INTRODUCTION

Rivers had been a constant source of life for both animals and human beings, since time memorial. Increased human habitancy near river banks and development of towns and cities has been observed for the past thousand years. But the rapid pace of increased urbanization and industrialization has led in recent times to deterioration of river water quality. Consequently, consumption of such inferior water quality of river water has given a southern direction to human health.

Ramganga in north India have a holy and pious position among Indians and their lives. But in recent time's negligence of disposals from nearby inhabitants and industries have led to contamination of Ganga water. Ramganga is a major tributary of Ganga as it passes right from its origin in Himalayan ranges to the major cities in north Indian plains. District Bareilly is also one of the major cities developed near Ramganga.Several studies have been made on the physico-chemical parameters of different rivers in India and abroad (Kumar 1995, NIH 2001, Sinha et al 2006, Bhandari and Nayal 2008, Joshi et al 2009, Alam and Pathak 2010, IIT 2012, Kumar and Prabhakar 2012, Katyal et al 2012, Badaii et al 2013, Savita 2013, Bai and FenReji 2014, Santhi et al 2014, Kumari and Chaurasia 2015 and Rajendran et al. 2015). So, an experimental research attempt, on findings of water quality in river Ramganga held in 2015-16, was done. The necessity of monitoring the water quality is with a standpoint of health regarding to dwellers in Bareilly city and the farmers using the water for their irrigation and agricultural practices.

STUDY AREA

Ramganga is originally characterized as a spring fed river besides being a significant and a major tributary of Ganga, a pious and holy river well recognized in north India. It originates from middle Himalayan ranges and it enters the plains of north India at Kalagarh. Thereafter, it traverses downstream approximately 322 km before it meets Ganges again at Kannouj, U.P. Bedrock, boulders and gravel constitute the substratum of the up-streaming river while sand, silt and clay are major components downstream. Around 32500 km^2 of catchment area is found in the basin. Along its journey in plains, some major cities are established on its bank. The geographical coordinates of the study area in Bareilly catchment are located at latitude 28^0 20' N and longitude 79^0 25' E. Massive populations, cantonment premises and vast agricultural lands are found near the Ramganga River.

MATERIAL AND METHODS

Water samples were drawn from Ramganga River at a distance of 5 meters from the bank and from the mainstream in 2 liters precleaned polythene bottles, after thorough rinsing with river water. The bottles were closed immediately and removed from river gently. On spot measurements of air temperature (AT), water temperature (WT), pH and transparency were recorded. Thereafter, samples were brought to the laboratory in order to analyze the various demand and chemical parameters viz. dissolved oxygen (DO), free carbon dioxide (FCO_2), carbonate (CO_3^{--}), bicarbonate (HCO_3^-), chloride (Cl^-), calcium (Ca^{++}), magnesium (Mg^{++}), total hardness (TH), BOD and COD as per standard methods laid in APHA (2005). The data was collected in first week of each month during the entire experimental year.

RESULTS AND DISCUSSION

The assessed data with respect to chosen water quality parameters from the samples drawn from Ramganga river are shown in Tables1 and 2.

Physical parameters

Air and Water temperature

Water and air temperature plays a significant role in affecting physical, demand and chemical parameters present in the water bodies (ANZECC 1992). Temperature was known to influence in the determination of factors like pH, conductivity, dissolved gases and alkalinity. Another factor that affects Palar river water temperature is heat exchange on the earth surface under controlled radiation (Kumar and Prabhkar 2012). The range for air and water temperature recorded in relevant samples was from 19.0 to 38.0 ^{0}C and 20.0 to 35.0 ^{0}C, respectively. Higher water temperature enhances the rate of chemical reactions with effect to evaporation and volatilization of substances from water. Further solubility of oxygen gas decreases with the rise in water temperature. Moreover, warm water is responsible for greater consumption of oxygen and thereby increased rate of decomposition (Chapman and Kimstach 1992). Aquatic life gets destructed with abrupt change in temperature of water and its related air temperature which inturn gets affected on account of geographical locations, seasonality, and circulation of air, water depth and its flow rate. Generally, the range of surface water lies from 0 to 30^{0}C. Sharp increase in temperature arise from industrial effluents and sewage treatment plant discharges (Chapman and Kimstach 1992).

pH

The change in pH of water renders the changes in quality characteristics of water. Further the exposure of river water to atmosphere, biological activities and temperature changes are some of the reasons on which the variations in pH is noticed (Adebowale et.al., 2008). The value of pH recorded in all the months were ranged from 7.1 to 8.5 suggesting an alkaline nature of water.

Transparency

The clarity of water suggests the viewpoint on the primary stage of the pollution status. It is measured in the depth up to which the Secchi disc becomes invisible. Across the whole experimental year, the range of transparency found to be 10-50 cm. Surface run offs along with disposals of domestic and industrial wastes lead to decreased transparency (Agarwal and Rajwar 2010, Yisa and Tijani 2010).

Demand Parameters

Chemical oxygen demand

It is the measure of oxygen chemical compounds present in the water bodies as pollution causing components. The COD value varied between 72 and 128 mg/l throughout the experimental year. Srivastava and Patil (2002) in their experiment assessed the COD falling between 33.5 and 41.0 mg/l, which were helpful in indicating the extent of pollution in the related surface water.

Biochemical oxygen demand

It is a measure of the amount of biodegradable matter in water in which microorganisms requires the oxygen in stabilizing it under aerobic conditions. Henceforth, BOD test is employed to find the amount of biochemically oxidizable carbonaceous matter. The assessed value of BOD In water samples drawn in each month of the experimental year ranged to 2.6 from 1.2 mg/l, which might be assigned to a reason that organic matter gets entered in the river water at and before the sampling point downstream.

Dissoled oxygen

DO is a key demand parameter in determining water quality. This factor helps us in determining the biological changes in the water body taking place

Table 1. Physico-chemical parameters

S.N.	PARAMETERS	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE
1	Air Temperature (^{0}C)	36	35	37.5	31	30	19	29	26	32	34	37	38
2	Water Temperature (^{0}C)	34	33	35	26	24	20	21	24	26	28	30	32
3	Transparency (cm)	17	10	15	35	50	28	40	38.2	36	33	28	17
4	pH	8.4	7.3	7.1	7.3	7.5	8.0	8.2	8.2	8.3	8.3	8.4	8.5
5	Dissolved Oxygen (mg/l)	6.4	6.2	5.8	6.2	6.4	7	7.3	7.4	7.4	7.8	7.6	7.6
6	Free CO_2 (mg/l)	18	93	46	34	28	18	0	0	0	0	0	0
7	CO_3^{2-} (mg/l)	0	0	0	0	0	0	24	36	51	66	87	102
8	HCO_3^- (mg/l)	183	192.15	207.4	170.8	195.2	207.4	610	646.6	637.45	631.35	628.3	512.4
9	Cl^- (mg/l)	3.19	2.99	2.79	2.99	3.19	3.59	4.09	4.19	4.39	4.69	5.59	4.79
10	Ca^{2+} (mg/l)	40.1	72.18	37.69	39.29	40.1	42.91	45.31	48.52	51.33	56.14	56.14	52.13
11	Mg^{2+} (mg/l)	63.18	49.57	74.84	77.27	77.52	76.3	76.79	76.79	77.76	28.73	78.73	85.05
12	Total Hardness (mg/l)	260	204	446	318	319	314	316	316	320	324	324	350
13	BOD (mg/l)	1.8	1.6	1.6	1.4	1.2	1.2	1.4	1.7	2	2.2	2.4	2.6
14	COD (mg/l)	72	104	96	99.2	104.8	106.8	111.6	114.4	120.8	123.2	128	128

Table 2. Descriptive statistics

PARAMETERS	MIN.	MAX.	MEAN	MEDIAN	C.V.	S.D.
Air Temperature (^{0}C)	19	38	32.04	33	0.173	5.55
Water Temperature (^{0}C)	20	35	27.75	27	0.183	5.07
Transparency (cm)	10	50	28.93	30.5	0.416	12.04
pH	7.1	8.5	7.96	8.2	0.064	0.51
Dissolved Oxygen (mg/l)	5.8	7.8	6.93	7.15	0.099	0.68
Free CO_2 (mg/l)	0	93	19.75	9	1.422	28.08
CO_3^{2-} (mg/l)	0	102	30.50	12	1.236	37.71
HCO_3^- (mg/l)	170.8	646.6	401.84	359.9	0.551	221.25
Cl^- (mg/l)	2.79	5.59	3.87	3.84	0.229	0.89
Ca^{2+} (mg/l)	37.69	72.18	48.49	46.915	0.205	9.92
Mg^{2+} (mg/l)	28.73	85.05	70.21	76.79	0.227	15.94
Total Hardness (mg/l)	204	446	317.58	318.5	0.175	55.49
BOD (mg/l)	1.2	2.6	1.76	1.65	0.261	0.46
COD (mg/l)	72	128	109.07	109.2	0.146	15.90

either by aerobic or anaerobic organisms. It indicates well towards various physical and biological processes prevailing in the water. The presence of oxygen in the water is due to dissolution of it through atmosphere or through production by photosynthetic organisms (Kumar and Bahadur 2009). However, a reduction in oxygen content is noticed in water on account of respiration of biota, decomposition of organic matter, rise in temperature (Goldman and Horne 1983), oxygen demanding wastes and some inorganic reducing agents such as hydrogen sulphide, nitrites, ammonia, ferrous ions etc. (Sahu et al 2000, Saxena et al. 2008). The value of DO in the current study estimated was found in between 5.8 and 7.8 mg/l throughout the year, where maximum value was recorded in the month of April and minimum in September.

Chemical Parameters

Anions

Free carbon dioxide, carbonates, bicarbonates, were estimated in the river water of Ramganga, which showed minimum value of 0, 0 and 170.8 mg/l and maximum values of 93, 102 and 646.6 mg/l respectively. Collectively these three-water quality parameters show carbonate content variation. Free carbon dioxide was found to be nil in pre-monsoon periods from months of January to June 2016. Even maximum carbonate value was found up to 100 mg/l. After December carbonates increased in progressive trend from January to June 2016. Large value of bicarbonate beyond 500 mg/l was recorded in months from January to June 2016.

Chloride content present in large quantities impart saltiness to the taste of water hence renders it objectionable to consume for drinking by local communities. Besides this it is also responsible for accelerated corrosion of iron metal containers and tanks. The significance of less concentration of chloride in water is therefore an urgent need with regards to water treatment. The maximum value of chloride was 5.59 mg/l recorded in May 2016 and minimum in 2.79 mg/l in August 2015 which might be due to evaporation and decrease in water level of river and increased concentration of salt content and dilution of water due to rainfall in monsoon season in month of August, respectively.

Cations

Calcium and magnesium are the alkaline earth metal ions present in water making it hard in nature. 37.69 – 72.18 mg/l and 28.73 – 85.05 mg/l are the observed ranges for both calcium and magnesium and latter was found to be more than calcium across the experimental year. The value of magnesium was marginally higher than BIS standard limits prescribed.

Besides this, total hardness value ranged between 204 and 446 mg/l in each month of whole experimental year. However, the values assessed were within the BIS standard value of 500 mg/l. It is well known that hard water is resistant in respect to the usage of it domestically and industrially. It is measured in terms of $CaCO_3$ equivalent. A proposed classification of river water quality in respect to total hardness by Katyal et al. (2012) was excellent, acceptable, slightly polluted, polluted and heavily polluted bearing a scale value of 75, 150, 300, 500 and 750 mg/l (Wright 2010), respectively.

Correlation Output

Correlation among the studied parameters is given in Table 3. A positive correlation was noticed for pH with DO, Cl^-, bicarbonate and carbonate. Furthermore, DO also show positive correlation with carbonate, bicarbonate, chloride and COD. Both COD and BOD exhibited positive correlation with carbonate whereas a significant negative correlation was observed for the free carbon dioxide with pH, DO, bicarbonate and chloride.

CONCLUSIONS

The values of quality parameters assessed in water samples drawn in each month of the experimental year 2015-16 from river Ramganga banks near Bareilly showed that in most parameters the value ranged below the threshold benchmarks by BIS (2012) while in some parameters it has crossed the prescribed standard limits. This suggests that the quality of water in river Ramganga is slightly polluted. Eventually, this leads us to arrive a t a conclusion that still this river water can be consumed industrially and agriculturally but there is a need for this river water to be treated first before being used for domestic purposes. These assessed parameters

Table 3. Correlation matrix

*PARAMETERS	AT (^{0}C)	WT (^{0}C)	TRP. (cm)	pH	D.O. (mg/l)	F CO_2 (mg/l)	CO_3^{2-} (mg/l)	HCO_3^- (mg/l)	Cl^- (mg/l)	Ca^{2+} (mg/l)	Mg^{2+} (mg/l)	TH (mg/l)	BOD (mg/l)	COD (mg/l)
AT (^{0}C)	1.000													
WT (^{0}C)	0.875	1.000												
TRP (cm)	-0.509	-0.792	1.000											
pH	0.002	-0.145	0.108	1.000										
DO (mg/l)	-0.107	-0.345	0.297	0.852	1.000									
F CO_2 (mg/l)	0.157	0.403	-0.494	-0.809	-0.789	1.000								
CO_3^{2-} (mg/l)	0.380	0.124	-0.014	0.702	0.831	-0.621	1.000							
HCO_3^- (mg/l)	0.056	-0.234	0.319	0.707	0.890	-0.725	0.784	1.000						
Cl^- (mg/l)	0.144	-0.123	0.173	0.794	0.926	-0.726	0.925	0.867	1.000					
Ca^{2+} (mg/l)	0.266	0.245	-0.350	0.141	0.329	0.296	0.392	0.324	0.367	1.000				
Mg^{2+} (mg/l)	-0.181	-0.243	0.206	0.024	-0.053	-0.260	0.045	-0.014	0.044	-0.482	1.000			
TH (mg/l)	0.128	0.053	0.096	-0.127	-0.004	-0.333	0.188	0.134	0.086	-0.555	0.370	1.000		
BOD (mg/l)	0.647	0.496	-0.335	0.623	0.616	-0.418	0.907	0.600	0.763	0.438	-0.113	0.114	1.000	
COD (mg/l)	0.010	-0.263	0.260	0.403	0.786	-0.455	0.813	0.763	0.814	0.472	0.067	0.193	0.555	1.000

*AT= Air Temperature, WT= Water Temperature, TRP= Transparency, DO= Dissolved Oxygen, F CO_2= Free CO_2, TH= Total Hardness

contribute positively to the alterations of the quality of water. On this data outcome, government authorities and decision makers should design an optimal strategy in order to reduce experimental analysis costs, treatment costs for a healthy future of residents of Bareilly district, leading to safe and happy life of mankind before it's too late, even for aquatic life.

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