



## Research paper

### Assessment of physicochemical characteristics of Ramganga River, Bareilly, Uttar Pradesh, India.

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**Abstract:** The water samples for physicochemical parameters were collected from holy river Ramganga, Bareilly, UP India for two years from the three study sites during 2020-21 and 2021-22. The observations were done on different physicochemical characteristics like air temperature, water temperature, pH, transparency, total dissolved solids, total suspended solids, dissolved oxygen, free CO<sub>2</sub>, carbonate, bicarbonate, chloride, calcium, magnesium and total hardness. The value of pH was highest in summer while total dissolved solids and total suspended solids of river water reported maximum during September. However, in winter the dissolved oxygen and free carbon dioxide have their highest values. A positive correlation was observed between air and water temperature (0.833), total dissolved solids and total suspended solids (0.947), dissolved oxygen and bicarbonate (0.925) and dissolved oxygen and magnesium (0.912). Positive correlations were expressed between bicarbonate and magnesium (0.881). The correlation between dissolved oxygen and calcium (0.972) and dissolved and chloride (0.915) were also reported during the study

period. The results indicated that the mean of most physicochemical parameters were within the permissible limit of WHO and BIS standards while some parameters like dissolved oxygen, calcium and magnesium were found to be higher.

**Keywords:** Physicochemical characteristics, Dissolved oxygen, Ramganga River, Total hardness and Chloride.

#### Introduction:

India is rich in water resources, being endowed with a network of rivers and blessed with snow cover in the Himalayan range that can meet a variety of water requirements of the country. Importance of rivers in maintaining health as well as a prosperous nation in a healthy environment is amply recognized from the very existence of civilization (Welch, 1952). In the ecosystem, water is one of the most important and abundant compounds for survival and growth of all living organisms on the earth. It is noticed that 70% earth's surface is covered with water having less than 3% of freshwater (Wetzel, 1983). The dam, river, reservoir

etc. are the main source of water for agricultural purposes in India (Thiatme 2010). The water resources available in many parts of the country are getting depleted and deteriorated due to the rapid increase in the population and to fulfill the increasing demands of human, irrigation and industrial consumption. According to Commoner (1976) the environment in the past was almost pure and unused but today most of the rivers have become polluted to a great extent by domestic and industrial wastes (Shukla *et al.*, 1989 and Sinha *et al.*, 1989). Hasty industrialization, fast urbanization and other constructional activities pollute rivers (Bhutani *et al.*, 2018 and Sinha *et al.*, 2016) but it causes a lot of harm to aquatic life. Therefore it is necessary that the quality of drinking water should be checked at regular time intervals, because due to use of contaminated drinking water, the human population suffers from a variety of waterborne diseases. It is difficult to understand the biological phenomenon fully because the chemistry of water reveals much about the metabolism of the ecosystem and explains the general hydro-biological relationship (Basavaraja *et al.*, 2011). The interactions of the physical and chemical properties of water play a significant role in composition, distribution, and abundance of aquatic organisms (Pal and Chakraborty, 2014 and Heinrics *et al.*, 2020). Several studies have been made on riverine limnology in India and abroad (Chacko and Ganapati 1949, Chacko and Srinivasan 1955, Bolani and Sarkar 1965, Aggarwal *et al.*, 1976, Badola and Singh 1981, Bist *et al.* 1989, Jindal and Vashisht 1981, Kumar 1995, Chopra and Rehman 1995, Abbasi *et al.*, 1996, NIH 2001, Sinha *et al.*, 2006, Dalal *et al.*, 2008, 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,

Rajendran *et al.*, 2015 and Kumar and Jain 2022). Therefore, experimental attempts were made to monitor the water quality of the river for the adjacent dwellers and farmers.

### Materials and Methods:

Ramganga basin is the first major tributary of the River Ganga and its length from the source to the confluence with the Ganga is 596 km. The river flows entirely in the states of Uttaranchal and Uttar Pradesh. The study sites namely village Gautra, village Sujanpur ghat (Bhatt Gautiya) and Chaubari Bridge are selected for experimental work. The proposed work had been considered to study the physico-chemical characteristics of river Ramganga at Bareilly. The samples of water were collected carefully from three study sites in morning hours of the fourth week of each month. The samples were analyzed as per procedures given in APHA (1998). For collecting the samples 2.0 litre size wide-mouthed precleaned plastic bottles were used.

Immediately, after collection of the samples, some parameters are analyzed at the study site like air temperature (AT) and water temperature (WT), pH and transparency (TR). While other titrimetric analysis done in laboratory to measure dissolved oxygen (DO), free carbon dioxide (FCO<sub>2</sub>), carbonate, bicarbonate, chloride, calcium, magnesium and total hardness (TH). The data are collected from three study sites and presented in table as mean and further it was subjected to statistical analysis employing various statistical techniques.

### Results and Discussion

Water samples from the three study sites were analyzed and the result of mean monthly values of each of the parameters are presented in the Table 1 to 8 and figures 1-14 for physical and chemical parameters.

Physical parameters-  
 Air temperature mean ranges from 19.00°C (Dec.,20) to 41.00°C (Jun.,20) in the first year and 19.33°C (Dec.,21) to 40.67°C (Jun.,21) in the consecutive year while water temperature mean ranges from 21.30°C (Nov.,20) to 31.30°C (Jul.,20) in

the first year and from 20.67°C (Dec.,21) to 33.33°C (Sep.,21) in successive year . The variation in the temperature is mainly related to atmospheric conditions and higher values of temperature during the summer are mainly due to high influx of heating.

**Table: 1 Monthly Mean Variations in Physical Parameters of RamGanga River**

Months	*Apr.	May	Jun.	Jul.	Aug.	Sep	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
	2020	2020	2020	2020	2020	2020	2020	2020	2020	2021	2021	2021
Parameters												
AT(°C)	Covid	39.30	41.00	35.00	36.00	38.30	33.70	31.00	19.00	22.30	24.00	29.30
WT(°C)	Covid	30.20	31.00	31.30	30.30	29.70	24.00	21.30	23.00	24.00	25.30	27.30
pH	Covid	8.33	8.40	8.13	7.70	7.50	7.53	7.67	7.83	8.00	8.10	8.33
TR(cm)	Covid	36.33	33.33	27.00	24.33	16.33	27.00	37.33	50.67	47.33	45.00	42.70
TDS (mg/L)	Covid	176.67	187.67	234.67	310.00	351.33	278.00	270.00	235.33	244.33	228.33	225.00
TSS (mg/L)	Covid	106.00	116.67	143.67	277.67	308.00	317.00	292.67	168.67	118.67	115.67	95.70

\*Due to severe covid pandemic condition data could not be collected in April 2020

pH is a term that is universally used to express the intensity of the acid or alkaline state of a solution. The observed value of pH mean ranges from 7.50 (Sep.,20) to 8.40 (Jun.,20) in the first year and 7.06 (Sep.,21) to 8.37 (Jun.,21) in the following year (Table 1 and 3). Higher values of pH can be an indicator of industrial pollutants, influx of sewage, effluents disposal, photosynthesis or large algae respiration which is feeding on the pollutants. The higher pH values observed also suggests that carbon dioxide, carbonate, bicarbonate equilibrium is affected more due to change

in physicochemical conditions (Karanth 1987). There is a high negative correlation reported between pH and TSS (-0.929) in the first year.

Transparency is a characteristic of water which varies with the combined effect of color and turbidity and measures the light penetrating intensity through the water body. The transparency values in water samples varied from 16.33cm (Sep., 20) to 50.67cm (Dec., 20) in the first year and from 15.33cm (Aug., 21) to 47.33cm (Nov., 21) in the second year.

**Table: 2 Correlation matrix for 2020-21**

	<i>AT</i>	<i>WT</i>	<i>pH</i>	<i>TRC</i>	<i>TDS</i>	<i>TSS</i>
<i>AT</i>	1.000					
<i>WT</i>	0.740	1.000				
<i>pH</i>	0.081	0.400	1.000			
<i>TR</i>	-0.799	-0.578	0.430	1.000		
<i>TDS</i>	0.066	-0.092	-0.883	-0.600	1.000	
<i>TSS</i>	0.241	-0.218	-0.929	-0.635	0.841	1.000

TDS content of the river water mean value ranged from 176.67 mg/L (May,20) to 351.33 mg/L(Sep.,20) in the first year and from 221.00 mg/L (Apr.,21) to 349.33 mg/L (Sep.,21) in the consecutive year. Higher TDS in the water system increases the demand for chemical and oxygen and also reduces the dissolved oxygen level in the water. Total suspended solids determined in this study mean ranged from 95.70 mg/L (Mar., 21) to 317 mg/L (Oct.,

20) in the first year and from 98.33 mg/L (Mar., 22) to 358 mg/L (Sep., 21) in the successive year. Total suspended solids analysis has a great effect on the control of biological and physical wastewater treatment processes. There is a positive correlation exhibited between TDS and TSS (0.841) in the first year and (0.947) in the second year

**Table: 3 Monthly Mean Variations in Physical Parameters of RamGanga River**

Months	Apr.	May	Jun.	Jul.	Aug.	Sep	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
	2021	2021	2021	2021	2021	2021	2021	2021	2021	2022	2022	2022
Parameters												
AT(°C)	36.30	38.30	40.67	36.67	36.83	36.50	32.50	30.33	19.33	20.00	22.16	26.67
WT(°C)	28.33	29.67	30.50	31.67	31.33	33.33	24.33	23.33	20.67	23.33	25.33	25.50
p H	8.19	8.28	8.37	8.06	7.43	7.06	7.10	7.26	7.63	7.83	8.00	8.16
TR (cm)	38.00	39.33	30.00	21.33	15.33	23.67	37.33	47.33	41.67	44.26	42.06	41.67
TDS (mg/L )	221.00	233.33	265.67	310.00	333.33	349.33	285.33	269.67	258.67	245.67	231.33	225.67
TSS (mg/L)	123.33	143.33	154.00	326.00	349.33	358.00	297.67	267.33	194.67	170.67	153.33	98.33

**Table 4: Correlation matrix for 2021-22**

	<i>AT</i>	<i>WT</i>	<i>p H</i>	<i>TRC</i>	<i>TDS</i>	<i>TSS</i>
<i>AT</i>	1.000					
<i>WT</i>	0.833	1.000				
<i>p H</i>	0.104	0.130	1.000			
<i>TR</i>	-0.630	-0.824	0.137	1.000		
<i>TDS</i>	0.401	0.547	-0.652	-0.798	1.000	
<i>TSS</i>	0.313	0.387	-0.758	-0.665	0.947	1.000

**Chemical parameters:**

Dissolved oxygen varied from 6.20 mg/L(Aug.,20) to 8.70 mg/L(Mar.,21) in the first year and from 6.10mg/L (Sep.,21) to 8.60mg/L (Apr.,21) in the following year (Table 5 and 7). Dissolved Oxygen indicates the physical and biological processes occurring in water and an

important factor to determine whether the biological changes are brought about by aerobic or anaerobic organisms (Gangwar *et al.*, 2012). The oxygen present in water can be dissolved from the air or produced by photosynthetic organisms (Kumar and Bahadur 2009).

**Table: 5 Monthly Mean Variations in Chemical Parameters of RamGanga River**

Months	*Apr.	May	Jun.	Jul.	Aug.	Sep	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
	2020	2020	2020	2020	2020	2020	2020	2020	2020	2021	2021	2021
Parameters												
DO (mg/L )	Covid	7.90	7.50	6.60	6.20	6.50	6.80	7.00	7.50	7.90	8.40	8.70
Free CO <sub>2</sub> (mg/L )	Covid	0.00	0.00	13.33	55.33	40.67	25.00	24.67	20.67	17.00	16.33	12.33
Carbonates (mg/L)	Covid	77.33	89.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bicarbonates (mg/L )	Covid	325.33	307.03	298.90	209.43	215.53	236.88	258.23	303.98	333.47	361.93	359.90
Chloride (mg/L )	Covid	5.05	5.48	6.69	3.26	3.22	3.26	3.49	3.82	4.09	4.39	4.62
Calcium (mg/L)	Covid	49.85	53.60	30.74	37.82	38.76	39.56	41.03	42.38	44.51	45.71	47.19
Magnesium (mg/L)	Covid	39.04	37.99	26.57	22.36	23.98	26.81	31.18	34.26	35.88	36.77	38.49
T. Hardness (mg/L)	Covid	284.67	290.00	186.00	187.33	195.33	209.00	230.67	272.33	258.67	265.00	276.00

\*Due to severe covid pandemic condition data could not be collected in April 2020

**Table 6: Correlation matrix for 2020-21**

	DO	FCO <sub>2</sub>	Carbonates	Bicarbonates	Chloride	Calcium	Magnesium	TH
DO	1.000							
FCO <sub>2</sub>	-0.653	1.000						
Carbonates	0.174	-0.621	1.000					
Bicarbonates	0.925	-0.773	0.214	1.000				
Chloride	0.236	-0.701	0.438	0.546	1.000			
Calcium	0.686	-0.595	0.706	0.537	0.073	1.000		
Magnesium	0.912	-0.831	0.505	0.881	0.363	0.835	1.000	
TH	0.846	-0.745	0.560	0.769	0.225	0.903	0.967	1.000

**Table: 7 Monthly Mean Variations in Chemical Parameters of RamGanga River**

Months	Apr.	May	Jun.	Jul.	Aug.	Sep	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
	2021	2021	2021	2021	2021	2021	2021	2021	2021	2022	2022	2022
Parameters												
DO (mg/L)	8.60	8.33	7.73	6.63	6.50	6.10	6.37	6.53	6.90	7.36	8.03	8.53
FCO <sub>2</sub> (mg/L)	0.00	0.00	0.00	15.00	71.67	45.00	37.00	32.33	26.67	22.33	21.33	20.00
Carbonates (mg/L)	61.67	76.00	87.00	0.00	0.00	0.00	0.00	0.00	0.00	9.00	15.00	24.00
Bicarbonates (mg/L)	361.93	345.67	310.08	181.98	193.17	203.33	188.08	204.35	284.67	370.06	401.58	389.38
Chloride (mg/L)	4.72	4.92	5.12	2.89	2.76	2.52	2.86	3.29	3.72	4.02	4.29	4.52
Calcium (mg/L)	52.66	53.46	45.44	35.42	40.23	34.35	35.69	37.29	38.76	43.17	47.99	50.66
Magnesium (mg/L)	39.44	39.93	46.08	34.02	26.24	37.90	42.21	44.31	43.90	42.76	42.22	40.41
Total Hardness (mg/L)	293.67	271.00	303.00	228.33	208.33	241.67	261.67	274.00	277.33	283.67	289.33	295.33

**Table 8: Correlation matrix for 2021-22**

	DO	FCO <sub>2</sub>	Carbonates	Bicarbonates	Chloride	Calcium	Magnesium	TH
DO	1.000							
FCO <sub>2</sub>	-0.717	1.000						
Carbonates	0.720	-0.746	1.000					
Bicarbonates	0.898	-0.594	0.516	1.000				
Chloride	0.915	-0.804	0.850	0.847	1.000			
Calcium	0.972	-0.614	0.748	0.859	0.887	1.000		
Magnesium	0.273	-0.578	0.294	0.413	0.500	0.164	1.000	
TH	0.703	-0.714	0.544	0.772	0.816	0.604	0.849	1.000

Dissolved oxygen appears to be caused by its biggest solubility, reduces the microbial decomposition of low organic matter and low organisms at low temperatures, reduces respiratory demand and increases the progressive growth of immersed macrophytes. DO is an important physicochemical parameter, its correlation with water bodies gives direct and indirect information e.g. availability of nutrients, bacterial activity, photosynthesis, stratification etc. (Premlata, 2009). In the

progress of summer, due to increasing temperature, dissolved oxygen decreased and microbial activity increased (Moss 1972, Morrissette and Mavinic 1978 and Kataria *et al* 1996). The high DO in summer is due to increase in temperature and duration of bright sunlight has influence on the percentage of soluble gasses (O<sub>2</sub> & CO<sub>2</sub>). During summer the intense sunlight and long days seem to accelerate photosynthesis by

phytoplankton, giving off oxygen by utilizing CO<sub>2</sub>.

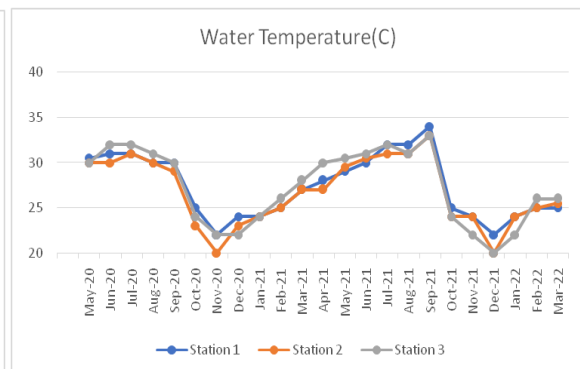
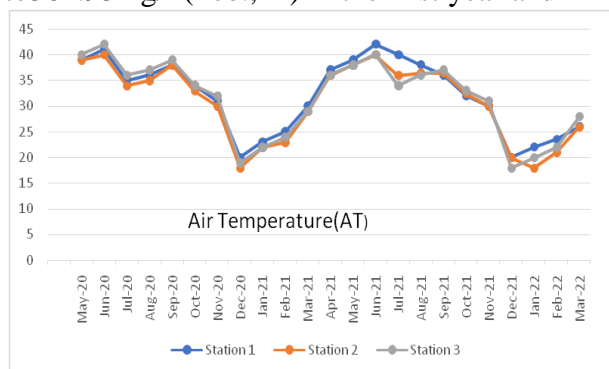
Free CO<sub>2</sub> is a test that is used to measure and quantify valuable information about industrial effluents and domestic sewage pollution. In the present study, the values of CO<sub>2</sub> were varied from 0.00 to 55.33 mg/L (Aug., 20) in the first year and 0.00 to 71.67 mg/L (Aug., 21) in the second year. Highest values of CO<sub>2</sub> indicated that most of the pollution in the study zone in the Ramganga River is caused by domestic sewage discharge by nearby villages and Bareilly city. Carbon dioxide is the end product of organic carbon degradation in almost all aquatic environments and its variation is often a measure of net ecosystem metabolism (Smith 1993, 1997 and Hopkinson 1985).

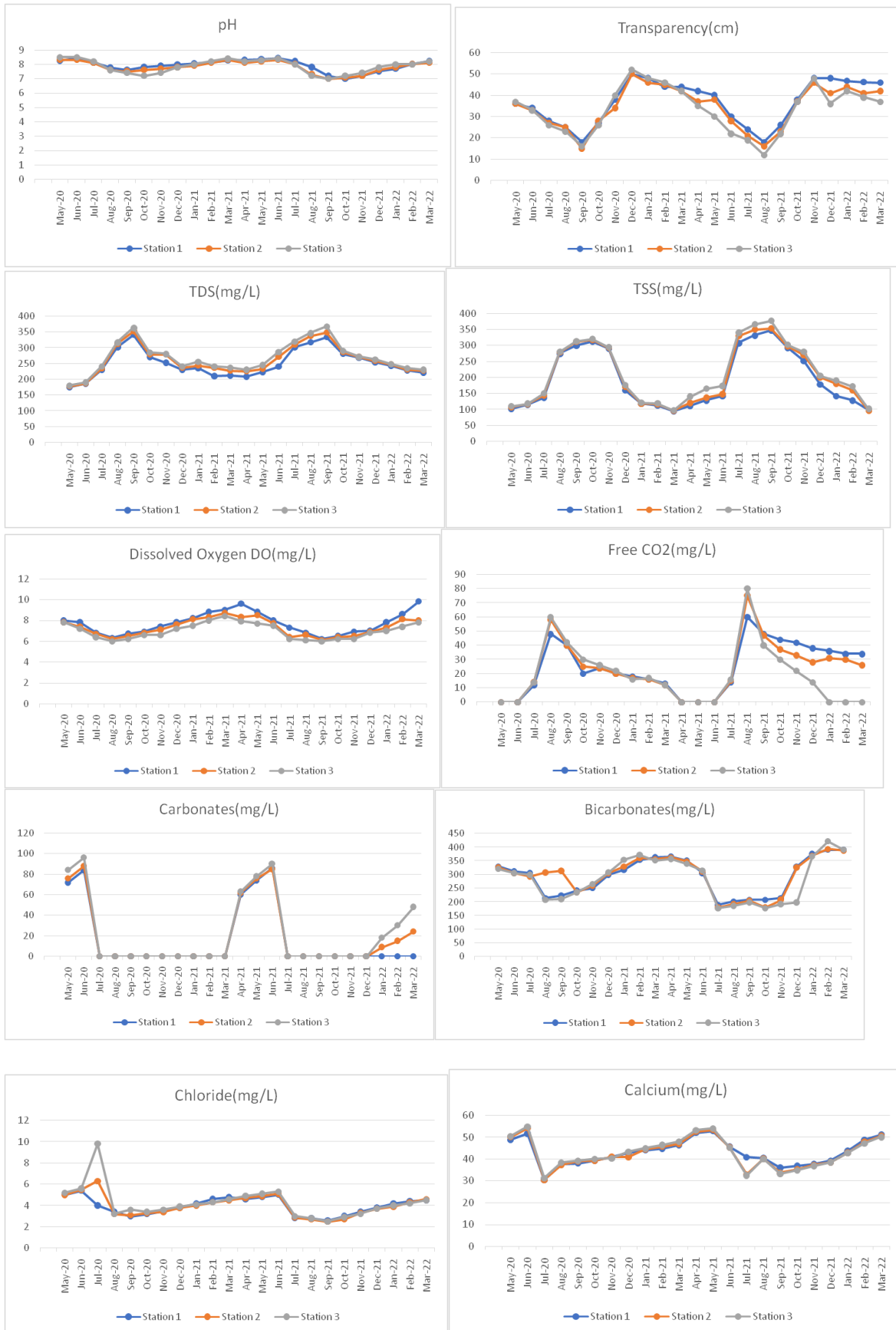
Carbonate mean values ranged from 0 mg/l (Jul.-Mar., 20) to 89.33 mg/l (Jun., 20) in the first year of my work. And from 0 mg/l (Jul.-Dec., 21) to 87 mg/l (Jun., 21) in the second year. These values of carbonate were due to the high rate of decomposition of organic matter on the high temperature, turbidity, and low water current. The mean values of bicarbonate varied from 209.43 mg/l (Aug.,20) to 361.93mg/l (Feb.,21) in the first year and

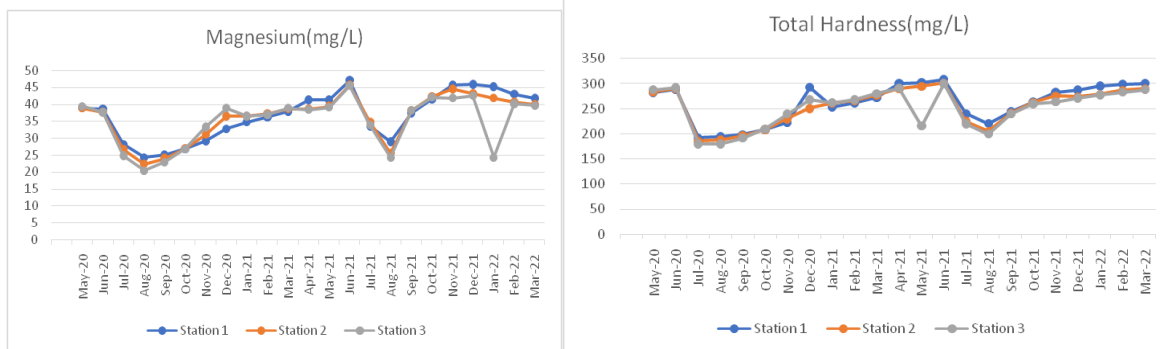
from 188.00mg/l (Aug.,21) to 401.58 mg/l (Feb.,22) in the following year.

The mean value of chloride ranged from 3.22 mg/l(Sep.20) to 5.48mg/l (Jun.,20) in the first year and from 2.52 mg/l(Sep.,21) to 5.12mg/l(Jun.,21) in the consecutive year. Calcium is an important determinant of water hardness and gives a better taste to water. Due to its buffering properties it also acts as pH stabilizer. Calcium of water samples was in the values range from 30.74 mg/l (Jul.,20) to 53.60 mg/l (Jun,20) in the first year and from 34.35mg/l(Sep.,21) to 53.46mg/l(May,21) in the following year. Water containing low calcium levels is usually oligotrophic and can support sparse plants and animal life. Calcium levels are typically higher in eutrophic water.

The Magnesium mean values observed from 22.36 mg/l(Aug.,20) to 39.04 mg/l(May,20) in the first year and from 26.24 mg/l(Aug.,21) to 46.08 mg/l(Jun.,21) in the second year. Total hardness mean value ranged from 186 mg/l(Jul.,20) to 290 mg/l(Jun.,20) in the first year and from 208.3 mg/l (Aug.,21) to 303.00 mg/l (Jun.,21) in the consecutive year.







### Conclusion:

Continuous and regular analysis of physicochemical parameters clearly indicated that some sampling sites of the Ramganga River are known as the continuously polluting zone. The source of pollution can be direct discharge through drainage outlets, untreated pollution discharge, agricultural runoff, domestic activities etc. The heavy discharge of pollutants accumulates in the river. Therefore, it was necessary that the present aquatic system of the river is being treated properly. Day to day increase in pollution causes a lot of harm to aquatic biota. Oxygen content is decreasing due to increase in carbon dioxide concentration. Necessary actions are required to check the balance of the natural ecosystem with the diversity of flora and fauna in river Ramganga.

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