



# Assessment of River Water Quality during Summer Season in Prayangraj, Uttar Pradesh, India

**Alfa Omega Minz<sup>a++\*</sup> and Satyendra Nath<sup>a#</sup>**

<sup>a</sup> Department of Environmental Sciences and NRM, SHUATS, Prayagraj, 211007, India.

## **Authors' contributions**

*This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.*

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## **ABSTRACT**

The present study is focused on assessment of river water quality during summer season in Prayagraj, Uttar Pradesh was experimentally investigated. The purpose of this study was to analyzed the physio-chemical properties of the river Ganga and Yamuna in Prayagraj. Water parameters such as pH, EC, DO, BOD, Alkalinity, Chloride, TDS and Hardness were analyzed. The results reveals that water was suitable for irrigation on purpose as the values were found to be within the permissible limit except DO whose values were found to be slightly less than the permissible limit.

**Keywords:** Water quality; Ganga river; Yamuna river; pollution.

<sup>++</sup> M.sc Environmental Science;

<sup>#</sup> Associate Professor and Head;

<sup>\*</sup>Corresponding author: E-mail: omegaminz709@gmail.com;

## 1. INTRODUCTION

Water is precious and essential for human survival fresh water is in danger less than 1% of world's water is readily available fresh water, which is found in rivers, lakes, wetlands and aquifers. This freshwater is also in danger [1,2]. 29 cities, 70 towns and thousands of villages extend along the Ganga banks. All of their sewage over 1.3 billion liters per day goes directly to the river [3].

The need for water increase along with the growth of human population worldwide. Freshwater ecosystem are under stress due to the disruption of natural water cycle brought on by human activities and climate change. The determinant effects on our freshwater system are further exacerbated by poor water management, pollution, the construction of infrastructure, and resource extraction [4,5].

Industrial effluents discharge into river bodies contain toxic chemicals, hazardous compounds, metallic waste, ketones etc. The biological purification mechanism of sewage treatment is altered or poisoned when these effluents are discharged through sewage system [6]. Moreover, only 70 % of the sewage treatment plants (STP) are functional in the NCR which treat only 50 % of the effluent, thereby adding onto the domestic sewage treatment burden (DPCC 2011). Additionally, the river is also vitiated by the 23 major drains (19 major drains fall directly into river and 4 through Agra and Gurgaon canal) carrying vast quantity of domestic and industrial sewage discharge directly into the river without treatment and thus form the point sources of contamination (CPCB 2013)

## 2. MATERIALS AND METHODS

Prayagraj formerly known as Allahabad, is a city in the Indian state of Uttar Pradesh. It is the administrative headquarters of Allahabad district- the most populous district in the state and 13<sup>th</sup> most populous district in India. The present region of Allahabad district is situated with latitudes of 25°27'N 81°51'E, which lies close to Triveni Sangam, " three river confluence ",

Original name Prayag, " Place of Sacrifice and offering " - which lies at the Sangam (confluence) of the Ganga, Yamuna and Saraswati rivers, a propitious place to conduct sacrifices. It plays a central role in Hindu scripture. Allahabad is in the southern part Uttar Pradesh, at the confluence of Ganga and Yamuna. The region was known in the antiquity first as the Kuru, then as the Vats country. To the southwest in Baghelkhand, to the east and southeast is Baghelkhand, to the north and Northeast is Awad and to the west is the lower doab (of which Allahabad is part) Allahabad is well placed geographically and culturally.

Geographically part of the Ganga-- Yamuna Doab (at the mouth of the Yamuna), culturally it is the terminus of the Indian west. According to United National Development Programme report, Allahabad is in a " low damage risk " wind and cyclone zone. In common with rest of doab, its soil and water are primarily alluvial.

**Climate of Prayagraj (Allahabad):** Prayagraj has a humid subtropical climate common to its cities in the plain of North India. The annual mean Temperature is 26.1°C (79.0°F); monthly mean temperature are 18-19°C(64-84°F). Prayagraj has three seasons: a hot, a dry summer, a cool, dry winter and a hot, humid monsoon.

**Sampling and Analytical procedures:** In the study, the representative 10 sampling sites were chosen to cover various anthropogenic activities like pollution, disposal of untreated waste water into river etc. The collected background data provides suitable details on those aspects.

**Collection and Preservation of Samples:** Water samples were collected during February to April 2023, in triplicate (with the interval of 10 days water was collected) from ten different sites in the morning hours 6am to 11 am, in a clean polythene bottles without any air bubbles and closed tightly after collection and labeled in the field and preserved for physio-chemical analysis in laboratory as per standard methods as per the procedure laid down in Standard Methods [7]. The physio-chemical parameters such as temperature of water was determined in the field.

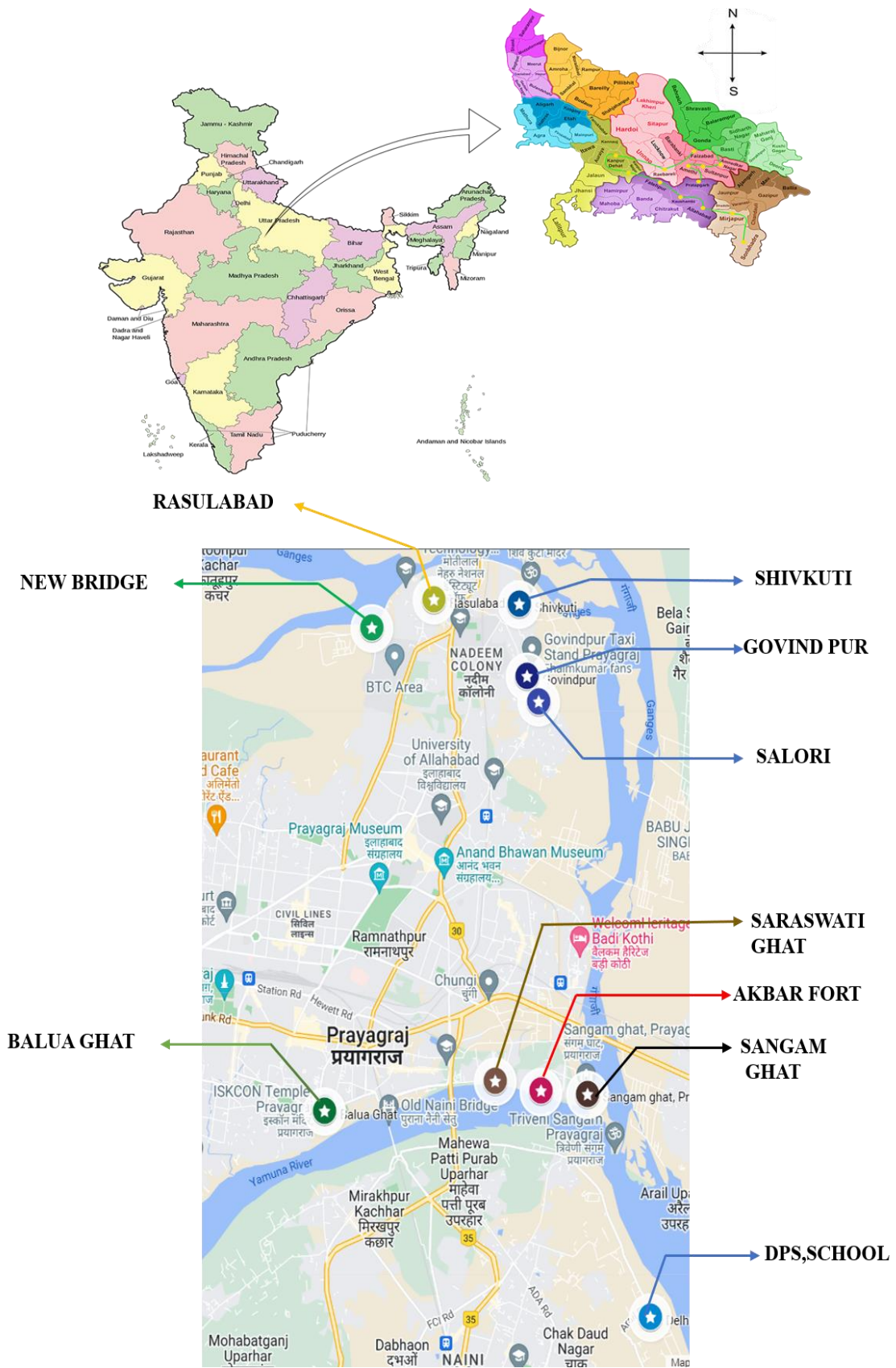


Fig. 1. Map of Study area

**Analysis of the collected Samples:** The water samples were immediately brought into Laboratory for the estimation of various Physio-chemical parameters like PH, EC, TDS etc. Total 150 samples have been collected from ten different stations. And analyzed for different parameters. The samples were analyzed for different physio chemical parameters as per Bureau of Indian Standards (BIS) [1].

### 3. RESULTS AND DISCUSSION

The physio-chemical characteristics provide a fair knowledge of the water quality in any water body. The results were based on the data collected during experimental investigation of the study and are presented through subjective analysis and graph. Discussion are made for explaining the interpretation of the results.

#### Variability of Physio-chemical characteristics of River Ganga and Yamuna at sampling sites:

**pH:** pH is a measure of the hydrogen ion concentration, a measure of the acidity or alkalinity of a solution. It is necessary to check the pH because a little change in pH affects the solubility and availability of nutrients presents in water for aquatic organisms.

Minimum pH value was 6.5 at Balua Ghat in the month of February and the maximum was 9.3 at Sangam respectively during summer season as represented in Fig. 2.

The maximum values of pH during summer days may increase due to influence of untreated waste water discharge from drain near the sampling sites. Photosynthesis of the algal bloom resulting in the precipitation of carbonates of calcium and magnesium from bicarbonates. Almost similar results were observed by [8,5,9].

**Electrical Conductivity:** “The electrical conductivity is a measurement of capability of water to transmit electric current in water bodies [10]. It is generally used for indicating the total concentration of ionized constituents of water. The electrical conductivity of water is more or less linear function of the concentration of dissolved ions. It can serve as an indicator of other water quality problems. If the conductivity of the stream suddenly increases, it indicates that there is a source of dissolved ions in the vicinity. Therefore, the conductivity measurements can be used as a quick way to locate potential water quality problems” [11].

From the Fig. 3 EC varies from 0.65 mmhos/cm to 0.80mmhos/cm in all the sites during summer season. Electrical Conductivity value falls under the permissible range prescribed by BIS.

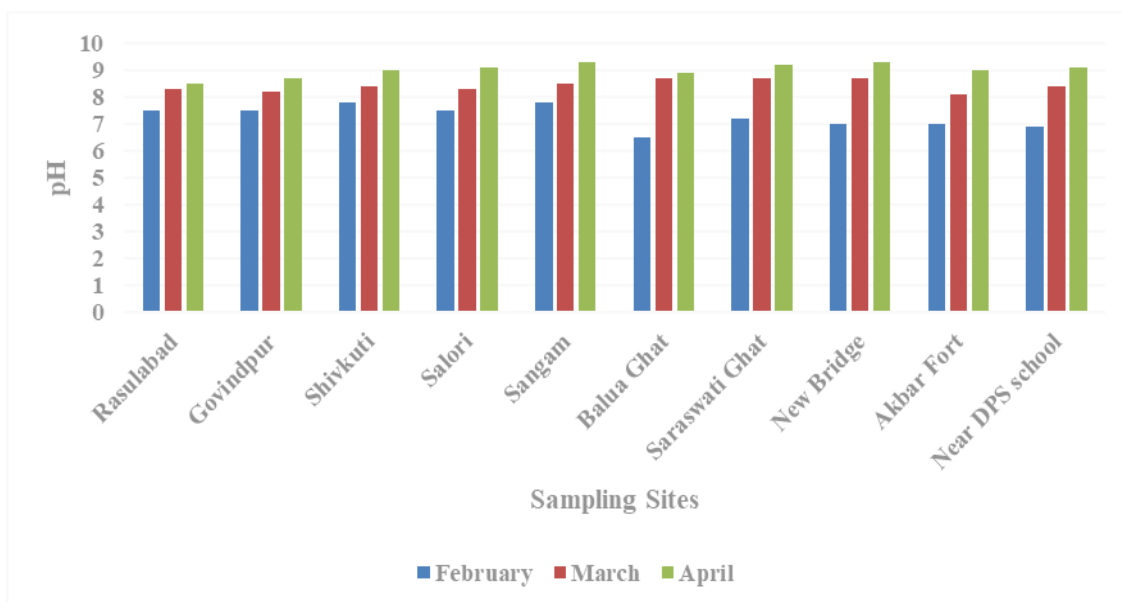


Fig. 2. Variation of pH in river Ganga & Yamuna during summer season

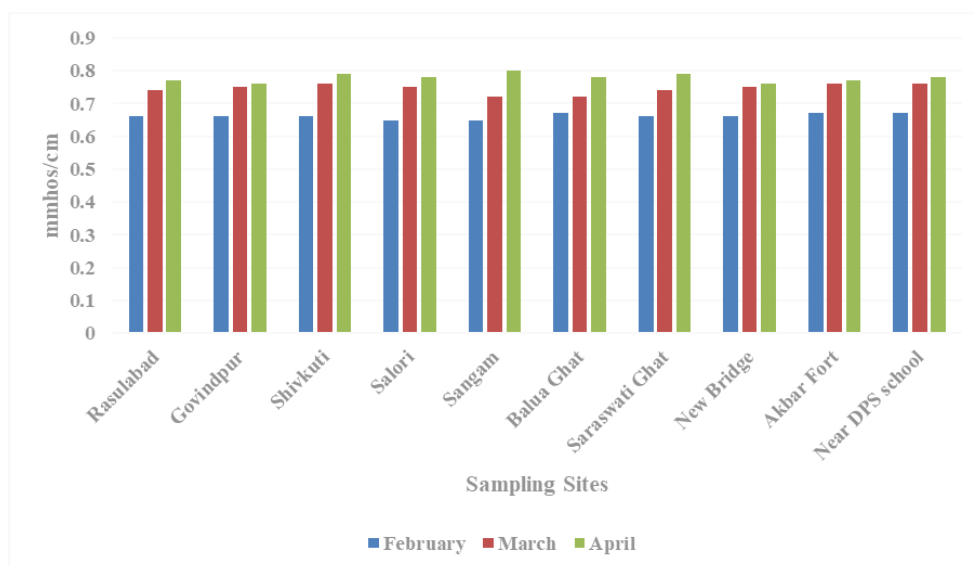


Fig. 3. Variation of EC in river Ganga & Yamuna during summer season

**Dissolved Oxygen:** “Dissolved Oxygen (DO) is a measure of the amount of oxygen available to all living aquatic organisms. The amount of DO in a river or lake can tell us a lot about its water quality. Deficiency of DO directly affects the ecosystem of river due to bio-accumulation & bio- magnifications. It is the most important pollution assessment parameter of the receiving water bodies. Stabilization of organic matter, when discharged untreated or partially treated in receiving water, leads to depletion of their DO. Nutrients (nitrogen and phosphorus) addition due to discharge of untreated sewage may lead to algal growth in streams as a result depletion of DO in water [12]. Thus, it is observed that all the

polluting constituents of sewage have their direct or in direct effects on DO of water. The impact of an effluent or wastewater discharge on the receiving water is predicted by its oxygen demand. This is because the removal of oxygen from the nature water reduces its ability to sustain aquatic life” [13,14]. Fig. 4 the maximum value of DO observed summer season was found to be 8.3 mg/l at Akbar Fort in the month of April 2023 and minimum DO value was found 5.5 mg/l in Govindpur in the month of February 2023. The average DO value of Ganga and Yamuna falls in the range of 6.3 to 7.7 mg/l which is under the permissible limit of BIS.

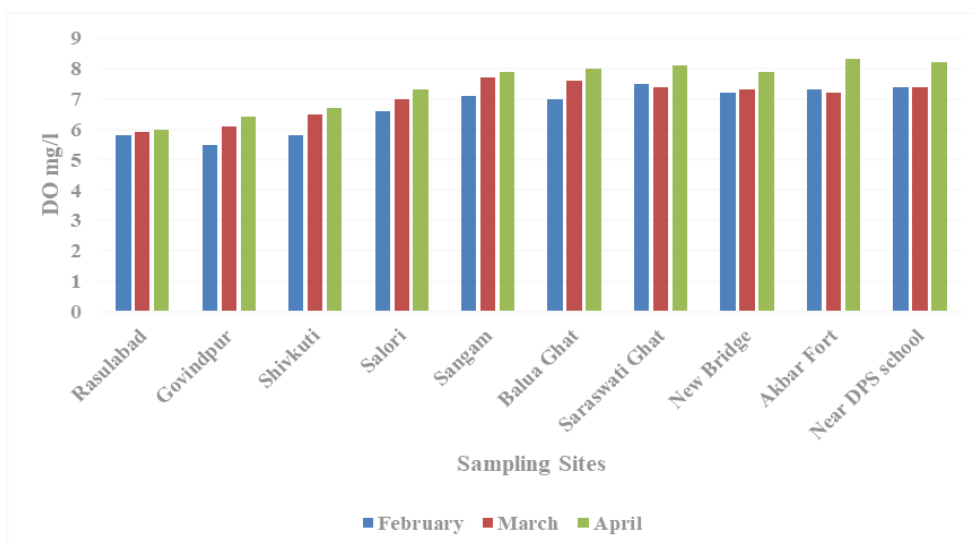


Fig. 4. Variation of DO in river Ganga & Yamuna during summer season

**Biological Oxygen Demand (BOD<sub>3</sub>):** Biological Oxygen Demand (BOD<sub>3</sub>) is measured of the oxygen in water that is required by the aerobic organisms. The bio degradation of organic materials exerts oxygen tension in water and increases the biochemical oxygen demand [15].

“BOD<sub>3</sub> is a measure a measure of amount of oxygen that bacteria will consume while decomposing organic matter under aerobic conditions. The main focus of wastewater treatment plants is to reduce BOD<sub>3</sub> in the effluent discharge to natural waters. Wastewater treatment plants are designed to function as bacteria farms, where bacteria are fed oxygen and organic waste. The excess bacteria growth in the system are removed as sludge. If effluent with high BOD<sub>3</sub> levels is discharged into a stream or river, it will accelerate bacterial growth in the river and consume the oxygen level in the river. The oxygen may diminish to levels that are lethal for most fishes and many aquatic insects” [4,16,17,18,8,5].

In Fig. 5 maximum value of BOD<sub>3</sub> in Summer was found 5.4 mg/l at Sangam in March 2023 and minimum 3.6 mg/l in Balua ghat in February 2023. The average BOD<sub>3</sub> of river Ganga and Yamuna was reported to range between 1.9 mg/lto 5.4 mg/l which was under the permissible

limit of BIS. The higher values were recorded due to organic waste discharge from various source.

**Total Hardness:** Total hardness of water means the water that contain high levels of dissolved calcium, magnesium and other mineral salts such as iron. High amount of dissolved minerals in the water causes more hardness in water. In Fig. 6, it was found that the maximum range of Total Hardness in summer was 166.5 mg/l at Saraswati Ghat in the month of March 2023 and minimum range of total hardness was 95.6 mg/l at Salori in the month of January 2023. Intermediate value of total hardness lies in between the range of 66.8 mg/lto 166.5 mg/l at all the sites. Hard water is safe for drinking, cooking and household uses. But it can cause effect on digestive system and forming of calcium oxalate in urinary bladder.

**Chloride (Cl<sup>-</sup>):** Chloride is one of the major anions found in water and are generally combined with calcium, magnesium or sodium. Chlorides are leached from various rocks into soil and groundwater by weathering. The main source of chloride in the surface water and ground water is due to atmospheric precipitation, animal feeds, septic tanks, use of inorganic fertilizers and landfill leachate.

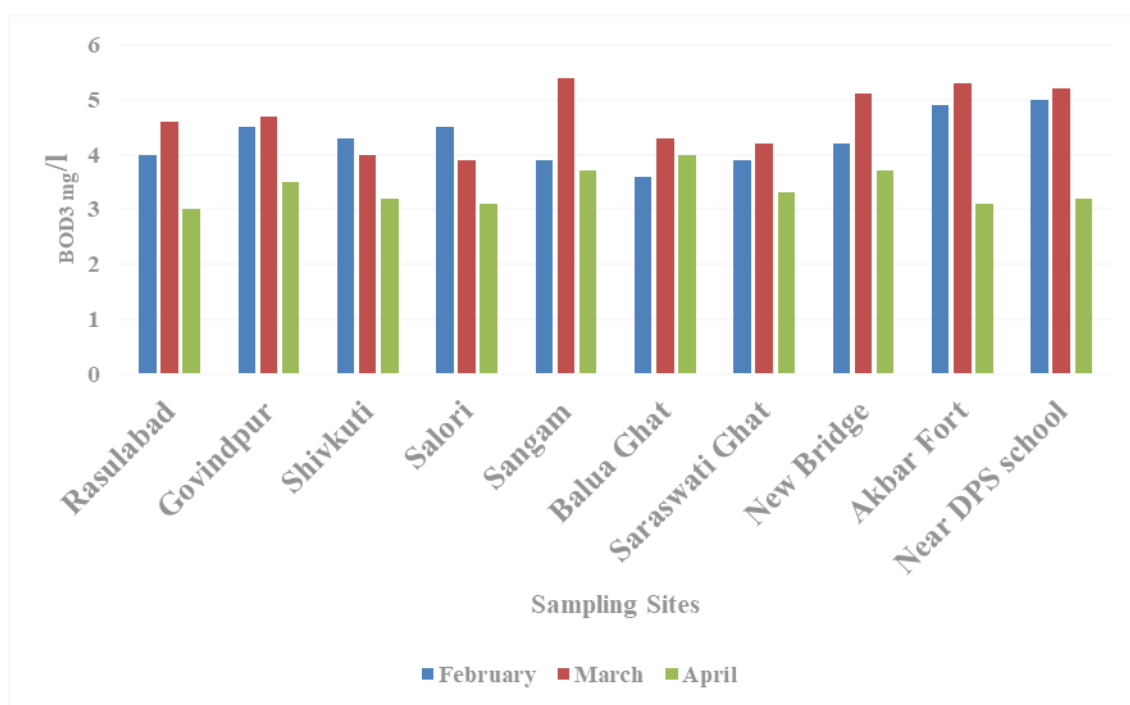
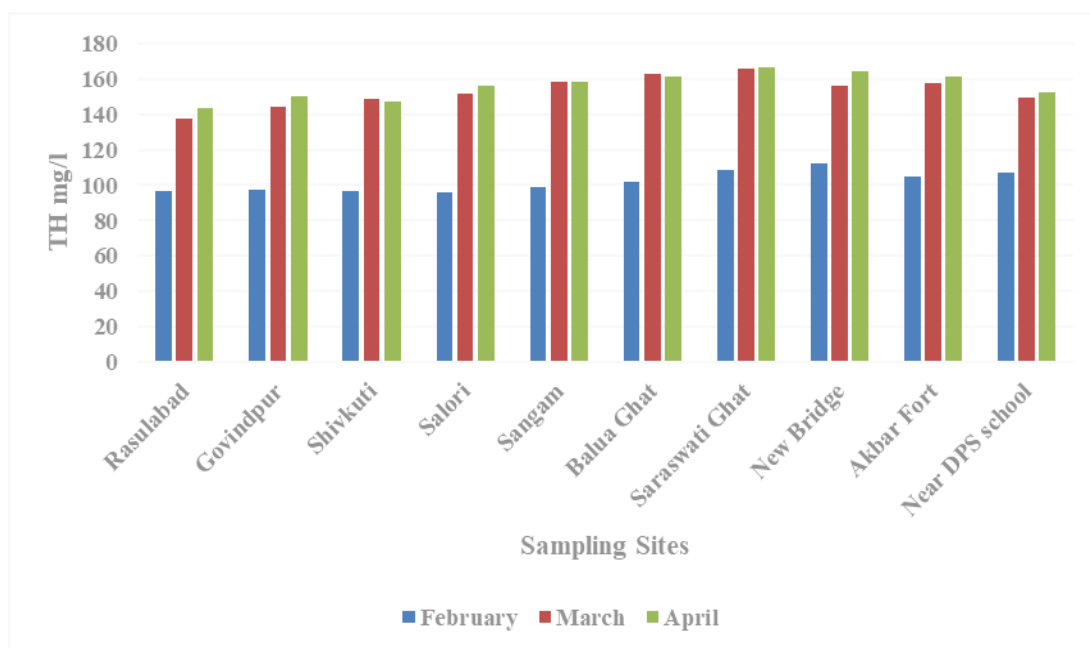


Fig. 5. Variation of BOD in river Ganga & Yamuna during summer season

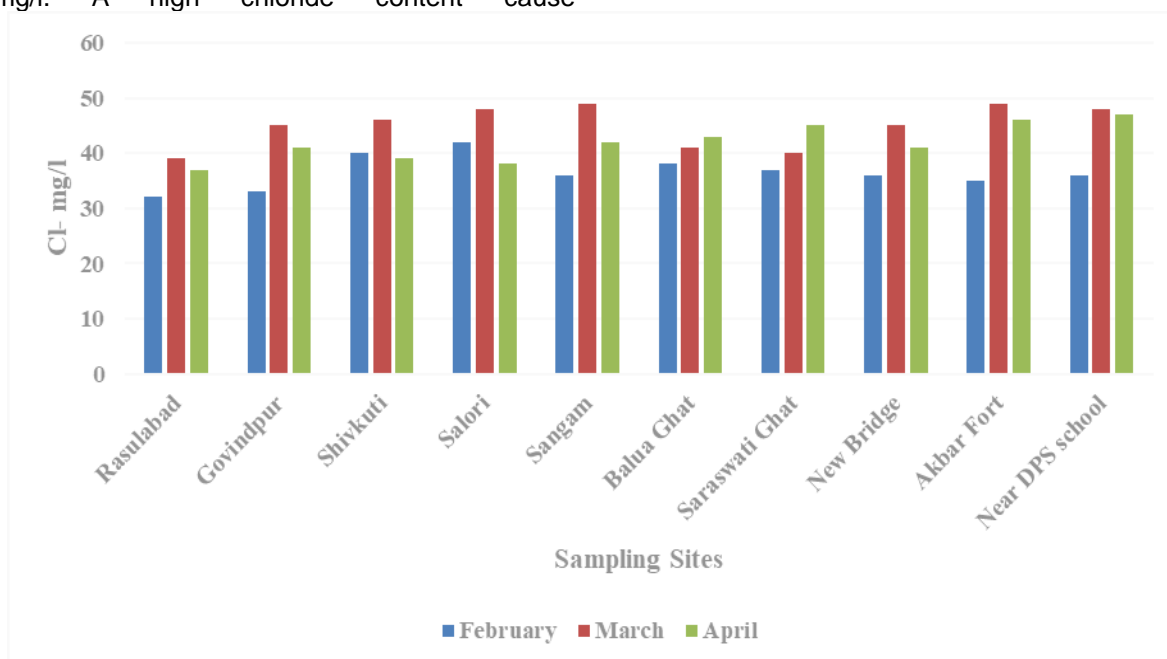


**Fig. 6. Variation of Total Hardness in river Ganga & Yamuna during summer season**

In Fig. 7 the observation of chloride reveals that the maximum value of chloride in summer season was found 49 mg/l at Akbar Fort and Sangam in the month of March 2023 and minimum value was reported 32 mg/l Rasulabad in the month 2022. The average chloride value of all the sites of river Ganga and Yamuna 24 to 45 mg/l. A high chloride content cause

cardiovascular problem and give a bitter taste. It also give an undesirable taste of drinking water. Similar results were found by [8,5,9,19]

**Alkalinity:** Alkalinity is measured of water's ability to neutralize acidity. An alkalinity test measures the level of bicarbonates, carbonates, and hydroxides in water.



**Fig. 7. Variation of Chloride in river Ganga & Yamuna during summer season**

In Fig. 8 the maximum alkalinity value was found 77mg/l at Saraswati ghat in March and minimum value was found 20 mg/l at Rasulabad in the month of February 2023. The average alkalinity of all the sites of River Ganga and Yamuna during summer season was found in the range of 25.5 to 67.2 mg/l. Increase concentration of CO<sub>2</sub> in water causes increase in alkalinity which raise the pH level which in turn kills aquatic organisms.

**Total Dissolved Solid (TDS):** Total dissolved solids describe the amount of inorganic salts of calcium, magnesium, sodium etc. And small proportion of organic matter present in the water. Perusal of Fig. 9 TDS value in Summer season was found maximum in 325 mg/l at Sangam in the month of March 2023 and minimum 302 mg/l at Salori in February 2023 [20-22].

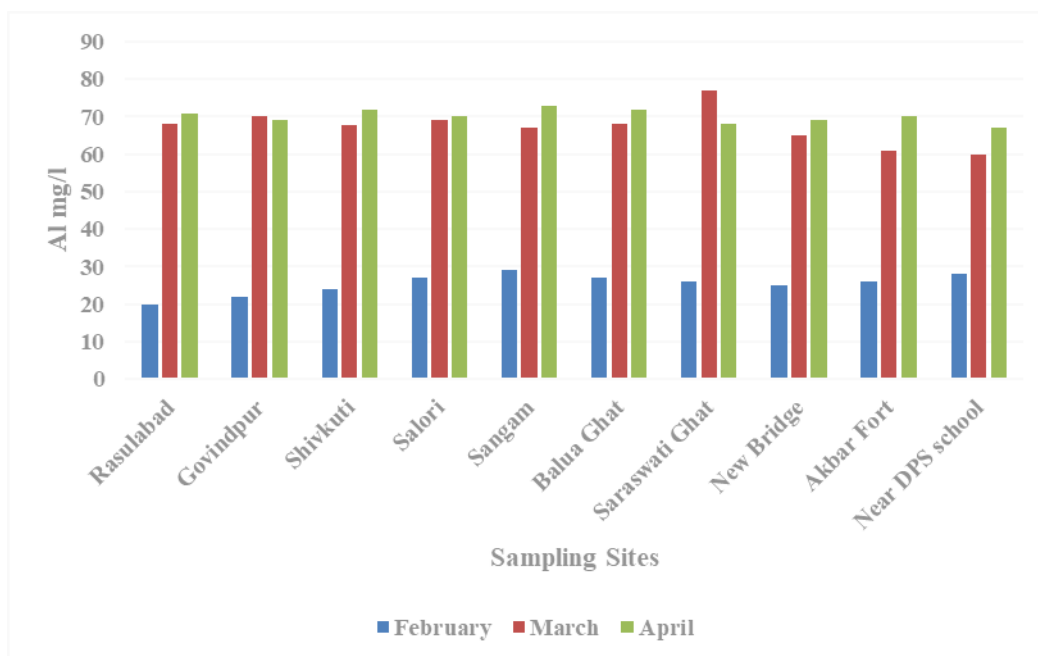


Fig. 8. Variation of Alkalinity in river Ganga & Yamuna during summer season

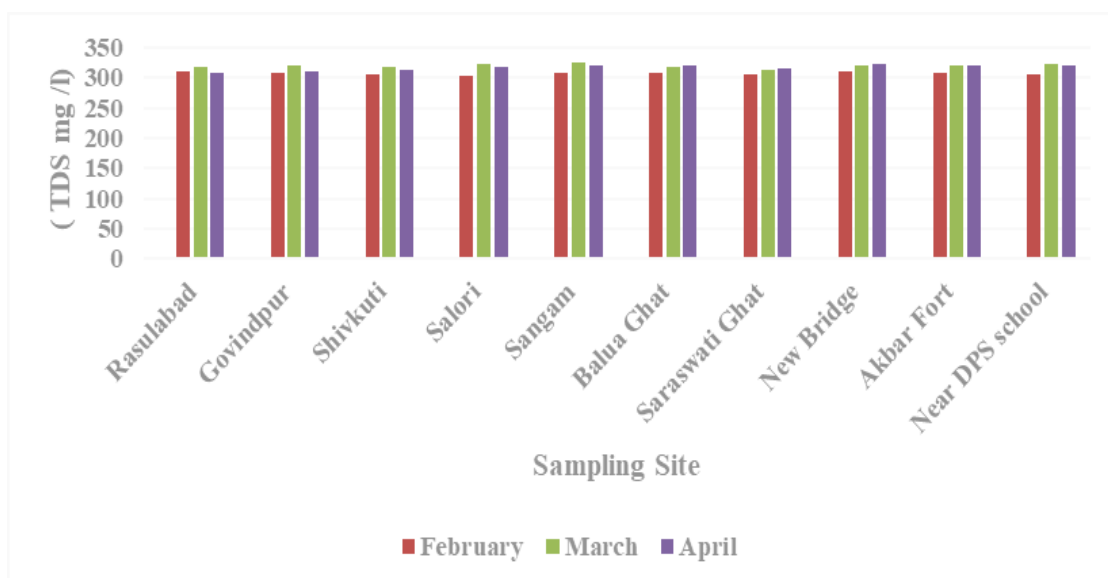


Fig. 9. Variation of TDS in river Ganga & Yamuna during summer season



**Table 1. Comparison of water quality parameters with BIS standards for river Ganga during summer season**

<b>Sites</b> Parameters	Rasulabad	Govindpur	Shivkuti	Salori	Sangam	BIS Standards	CPCB
pH	7	8.1	8.4	8.3	8.3	6.5-8.5	6.5-7.5
EC	0.72	0.72	0.73	0.72	0.72	300 mmhos/cm	
DO	5.9	6	6.3	6.9	7.5	5 (mg/l)	>6.0mg/l
BOD	3.8	4.2	3.8	3.8	4.3	3 (mg/l)	<2.0 mg/l
Total Hardness	125.7	130.6	130.9	134.5	138.5	200(mg/l)	300-600
Chloride	36	39.6	41.6	42.6	42.3	250(mg/l)	250-1000
Alkalinity	53	53.6	54.6	55.3	56.3	200(mg/l)	
TDS	313	313.6	312.3	314.6	318.6	500(mg/l)	500-1500

**Table 2. Comparison of water quality parameters with BIS standards for river Yamuna during summer season**

<b>Sites</b> Parameters	Balua Ghat	Saraswati Ghat	New Bridge	Akbar Fort	Near DPS School	BIS Standards	CPCB
pH	8	8.3	8.3	8	8.1	6.5-8.5	6.5-7.5
EC	0.72	0.73	0.72	0.73	0.73	300 mmhos/cm	
DO	7.5	7.6	7.4	7.6	7.6	5 (mg/l)	>6.0mg/l
BOD	3.9	3.8	4.3	4.4	4.4	3 (mg/l)	<2.0 mg/l
Total Hardness	141.7	146.9	144.3	141.1	136.4	200(mg/l)	300-600
Chloride	40.6	40.6	40.6	43.3	43.6	250(mg/l)	250-1000
Alkalinity	55.6	57	53	52.3	51.6	200(mg/l)	
TDS	315	311.3	317.6	316.3	316	500(mg/l)	500-1500

#### 4. CONCLUSION

The results of the experiment are concluded that water quality parameters during summer season pH and DO values are slightly high. All the parameters fall under the permissible limits prescribed by BIS except BOD<sub>3</sub>. Continuous monitoring of river water quality and awareness program among the people of concerned areas to decrease the level of pollution in the river.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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