

# The Water Quality of Gangan River in Moradabad (Uttar Pradesh), India

Harendra Kumar\*, Nitin Kumar Agrawal and Animesh Agarwal

*Department of Applied Sciences & Humanities, Moradabad Institute of Technology,  
Ram Ganga Vihar Phase – 2, Moradabad-244001 (U.P.), India.*

## Abstract

Gangan river water were collected at six different sites and analysed for three seasons winter, summer and rainy seasons. Gangan river water found to be highly contaminated with reference to water parameters at all the sites in every season. The present study shows that the river found to be alkaline at every site as the value of both pH and alkalinity is very high as compared to WHO standards. The range of turbidity at all the sites found to be approximately 40-50 NTU and is very high as compared with WHO standards. High value of turbidity indicates that the percentage of organic matter and other chemicals is very high in river water and it is unfit for the agricultural and other purposes. It is also found by the study that B.O.D. and C.O.D. values are very high and D.O. value is low and this clearly shows that water is highly contaminated. The fluctuated values of physico chemical water parameters are only due to various activities like cattle bathing, mixing of discharge from small scale industries and other mankind activities noticed at these sites.

**Keywords:** Physico chemical water parameters, Gangan River, WHO standards, Different seasons.

## 1. INTRODUCTION

Water is the universal solvent [1]. In the recent few decades, India has seen the large-scale urbanization, industrialisation and technological development. The rapid growing population and improved living standards, the pressure on the present water resources is increasing day by day [2, 3]. The industrial revolution resulted in an improving lifestyle, raising the standard of living of people, but also resulted in an indiscriminate exploitation of natural resources. Human activities have put a considerable pressure on the availability of basic human necessities such as clean water and air. Waste water from various industries, municipal corporations, urban and rural runoff, coupled with the increasing use of various chemicals, surfactants, fertilizers, pesticides and herbicides in agriculture and the decomposition of vegetable and animal matter discharge varying amounts of these and other chemicals into ground and surface water, making it unfit for human and animal consumption. Studies have shown many industries are discharging their waste into the rivers. Water sources were polluted by domestic wastage in rural areas whereas industrial wastages discharged into natural water sources in urban areas [4-6]. This is attaining hazardous conditions, especially in big cities where the population is large, the demand for water is very high, and industries are

developing at a faster rate. But due to industrial and agriculture revolution water which is collected in the various water resources highly polluted in various ways [7-9]. Some of the organic and inorganic compounds, when present in water are toxic, carcinogenic and mutagenic, and cause several ailments in humans. Among the inorganic contaminants of the river water, heavy metals are getting importance for their non-degradable nature and often accumulate through tropic level causing a deleterious biological effect. One of the major reasons of river water pollution in India is unplanned urban development without adequate attention to sewage and waste disposals [10-15].

Moradabad is a city of Uttar Pradesh, India, famous for Brass Metal Handicrafts not only in India but also in abroad since ancient times. This city is situated in western U.P. between 28°-21' to 28°-16' Latitude North and 78°- 4' to 79 Longitude East. Ram Ganga River flows in the north east and Gangan River is there in south west of the city. Gangan river rises in the north of the district Bijnor and enters in the district Moradabad near village of Kalmukhia, district Amroha and forms the boundary of the district in the north for a short distance. It then flows in a winding course in a south-easterly direction for about 5 Kms and then goes on towards the south west about two Kms. Near the village of Isapur it makes a bend and again flows on in a south easterly direction. Proceeding in the same direction it forms the natural boundary between Amroha and Moradabad for about 2 Kms and again further on between Moradabad and Bilari. It leaves the district near the village of Turtipur (In Bilari). It has well defined banks which are generally high and firm on the east and low and sandy towards the west. In the upper course the character of the bed is clayish sand which gradually becomes clayish in the south. The river is crossed by Girder bridge near the villages of Lakri Fazalpur and Pandit Nagla in Moradabad on the Delhi –Lucknow and the Moradabad –Chandausi road respectively.

The brass industry in Moradabad is regularly discharging the effluents into the river Gangan. River Gangan receives almost all the domestic and industrial effluents of Moradabad city. The water of river Gangan is highly polluted by direct contamination of sewage and industrial effluents. Quality of river water is degrading day by day hence there is an acute need of measuring physico chemical parameters of rivers at a regular basis. In present study, an attempt is made to monitor the physico chemical water parameters of river Gangan and assess the extent of pollution by comparing the results with WHO standards.

## 2. MATERIALS AND METHODS

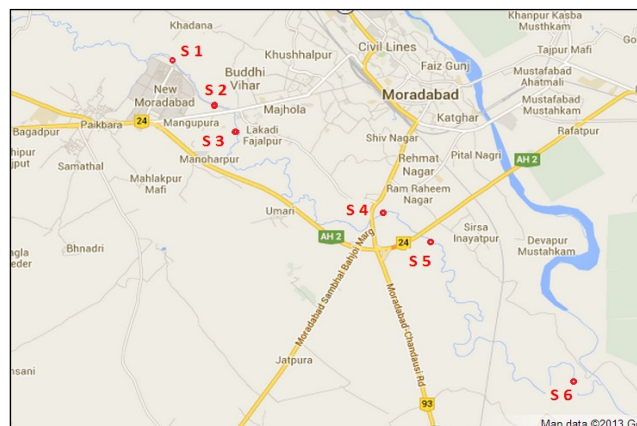
### 2.1 Sampling Sites

For the collection of water samples six sites (fig-1) were selected in Gangan river near district Moradabad keeping in view the physical accessibility of the river. The sampling sites of river Gangan are summarised in table – 1.

### 2.2 Collection of water samples

Water samples were collected in 3 seasons winter, summer and rainy for a period of one year (i.e., from June 2017 to May 2018). The samples were collected in wide mouthed polythene bottles and stored in ice box for analysis of various physicochemical parameters.

The analysis of various physicochemical and biological characteristics namely temperature, pH, total hardness, turbidity, alkalinity, biological oxygen demand, chemical oxygen demand, dissolved oxygen, and total dissolved solids are done by using standard methods[16]. Each sample was analyzed in duplicate and the average of the results was taken for analysis.



**Figure 1:** Sampling sites of Gangan River

Site wise values of physico chemical parameters of river Gangan in Moradabad in winter, summer and rainy seasons are shown in table-2.

**Table 1:** Sampling sites

S.No.	Name of the Site	Noticed activities
1.	S-1 -- Near new Moradabad	Undeveloped colony of MDA and cattle bathing activities noticed here.
2.	S-2 -- Before Gangan flyover Delhi road	Metal and Glass industries situated here.
3.	S-3 -- Lakri Fazalpur	It is a rural area and activities related with villagers noticed here.
4.	S-4 -- Moradabad Chandausi road crossing	Small scale industries situated.
5.	S-5 -- Zero point bypass	Animal activities noticed.
6.	S-6 -- Near village Alirajapur	Cattle bathing activity noticed.

**Table 2:** Physico-Chemical Parameters of River Gangan

Physico-chemical parameters	SITE-1			SITE-2			SITE-3		
	Winter	Summer	Rainy	Winter	Summer	Rainy	Winter	Summer	Rainy
Temperature	21.3	34.2	33.5	21.5	34.2	33.9	22.1	34.3	33.8
pH	7.8	7.4	7.9	8.2	7.8	8.3	7.8	7.4	7.9
TH	279	285	248	310	315	280	261	320	230
Turbidity	35	37	45	41	45	57	45	38	47
Alkalinity	223	221	201	279	265	243	230	221	198
B.O.D.	13.5	12.8	13.2	15.3	13.7	14.1	17.2	15.3	16.6
C.O.D.	36.3	35	36	37	36	36.5	31.9	31.2	31.8
D.O.	3.5	3.4	3.7	4.1	3.9	4.4	3.9	3.8	4.3
T.S.	1510	1545	1423	1663	1687	1533	986	1001	1080

Table-2—continued.....

Physico-chemical parameters	SITE-4			SITE-5			SITE-6			W.H.O. Standard
	Winter	Summer	Rainy	Winter	Summer	Rainy	Winter	Summer	Rainy	
Temperature	23.6	34.5	34.1	22.8	34.6	34.2	22.7	34.5	34.2	--
pH	8.3	7.7	7.8	8.6	7.7	8.2	8.4	7.5	7.9	7.0-8.5(8.0)
*TH	391	395	302	423	432	397	407	415	385	100
Turbidity	49	54	69	53	55	73	47	51	68	5.0
Alkalinity	301	276	253	351	343	329	326	310	280	100
*B.O.D.	17.4	15.7	16.9	20.1	18.3	19.0	18.5	16.6	17.9	6.0
*C.O.D.	48.9	48.5	49	63	65	64	57.6	58	57	10.0
*D.O.	3.1	3.0	4.3	2.3	2.2	3.3	2.7	2.6	3.5	5.0
*T.S.	2018	2065	2037	3146	3189	2687	3965	3960	2763	500

\*T.H.(Total hardness), B.O.D.(Biological oxygen demand), C.O.D.(Chemical oxygen demand), D.O.(Dissolved oxygen), T.S.(Total solids)

### 3. RESULTS AND DISCUSSION

Site-wise and parameter wise seasonal variations for river Gangan in Moradabad are shown in figure- 2 to figure- 10. A critical analysis of the results presented in table-2 showing seasonal variations reveals many interesting features regarding the status of Gangan River water pollution at six different sites during the course of study for winter, summer and rainy seasons.

#### 3.1 Temperature

Temperature was recorded to  $\pm 0.1^{\circ}\text{C}$  accuracy using a mercury thermometer, in the river immediately after collecting the samples. Figure 2 shows average winter, summer and rainy season temperatures of the Gangan river water, which vary from  $21.3^{\circ}\text{C}$  to  $22.8^{\circ}\text{C}$ ,  $34.2^{\circ}\text{C}$  to  $34.6^{\circ}\text{C}$  and  $33.5^{\circ}\text{C}$  to  $34.2^{\circ}\text{C}$  respectively. The variation are mainly related with the temperature of atmosphere and weather conditions. Higher temperature during summer was due to greater heating.

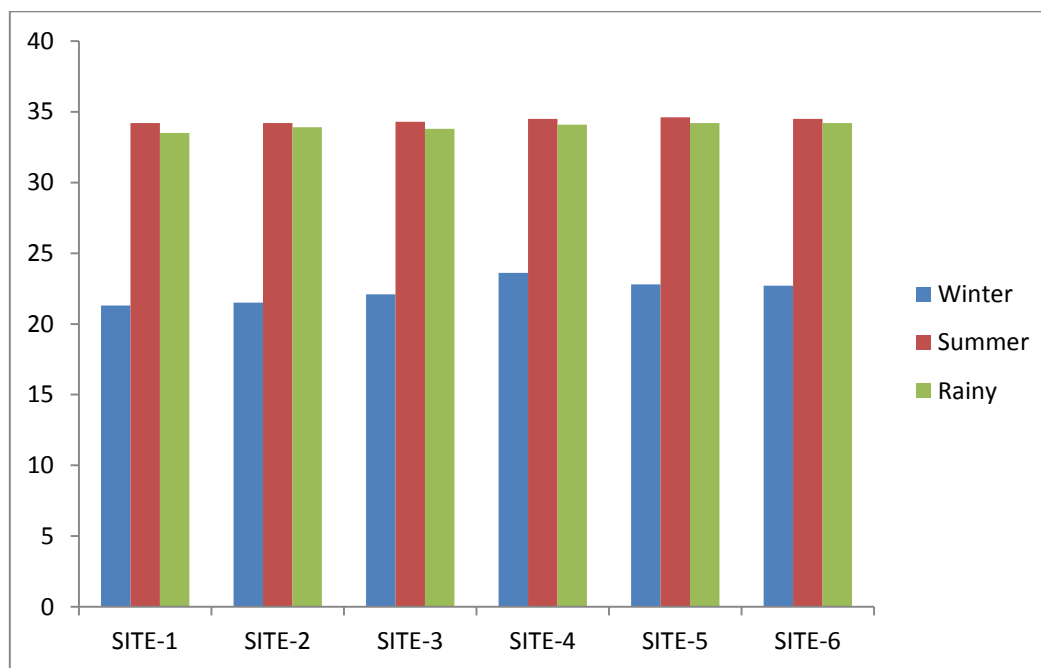
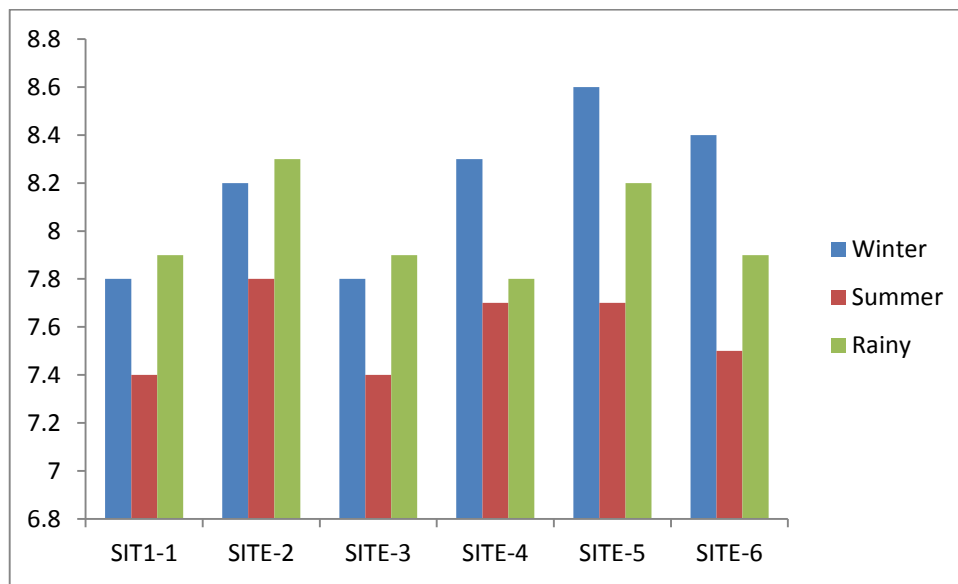


Figure 2: Site –wise seasonal variation of temperature in Gangan River

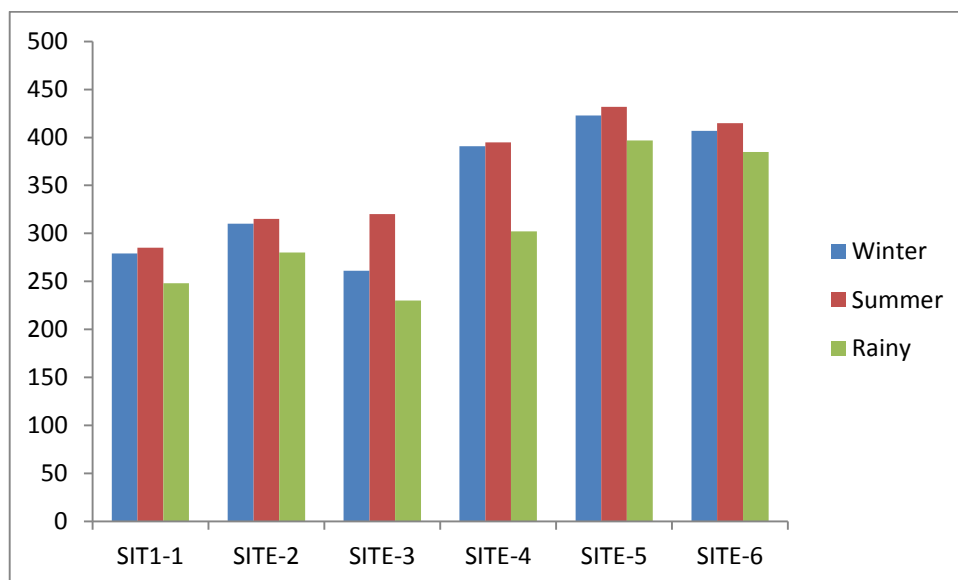
### 3.2 pH

pH is a logarithmic scale value generally used to express the acidic, alkaline or neutral nature of the solution. The pH of any aqueous system is suggestive of the acid base equilibrium achieved by various dissolved compounds. In Gangan river the pH ranges from 7.8 to 8.6 in winter, 7.4 to 7.8 in summer, 7.8 to 8.3 in rainy season(fig.-3). In general the pH values are

higher in winter than other seasons. The variation can be due to the exposure of river water to atmosphere, biological activities and temperature changes. pH plays an important role in the growth and development of flora and fauna of the water body. Therefore, amount of pH is of great importance because most of the biological processes and biochemical reactions are pH dependent.



**Figure 3:** Site –wise seasonal variation of pH values in Gangan River



**Figure 4:-**Site –wise seasonal variation of Total Hardness in mg/L in Gangan River

### 3.3 Total Hardness

Hardness of water is defined as the presence of significant concentration of salts of metallic cations may be  $Ca^{2+}$  and  $Mg^{2+}$  ions dissolved in water. Hardness is classified in to two types. Carbonate hardness and Non- carbonate hardness. Carbonate hardness is due to the presence of Calcium and

Magnesium carbonate and bicarbonate in water. Non Carbonate hardness, this type of hardness in water occurs due to dissolution of salts of Calcium other than Carbonates and bicarbonates, such as Calcium Sulfates ( $CaSO_4$ ) or Calcium Fluoride ( $CaF_2$ ). It is expressed in terms of  $CaCO_3$  concentration in mg/L.

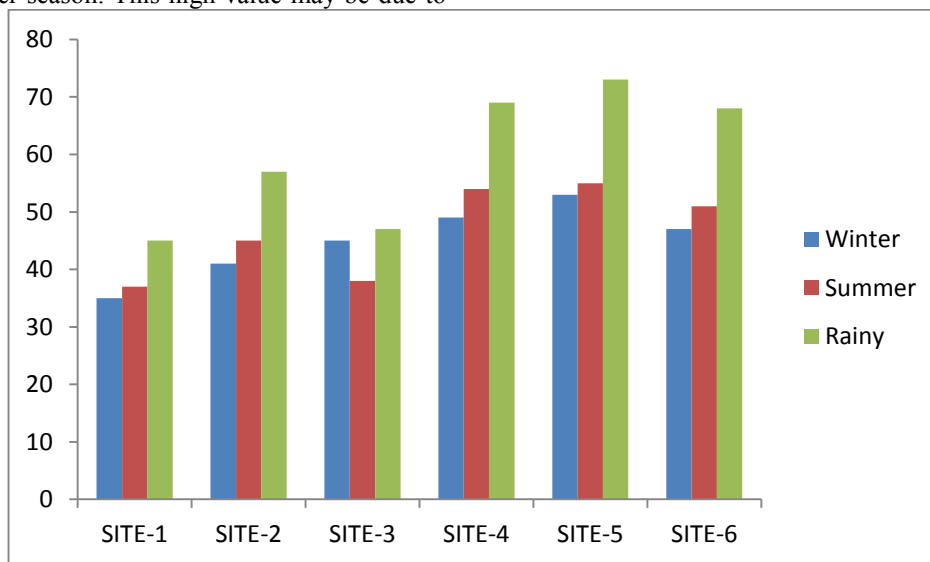
In the present study the observed values of Total Hardness for Gangan river ranges from 261 mg/L to 423 mg/L for winter season, 285 mg/L to 432 mg/L for summer season and 230 mg/L to 397 mg/L for rainy season at different sites. The minimum value of Total Hardness for Gangan river is found 230 mg/L in rainy season at site-3 and the maximum value of Total Hardness is found 432 mg/L in summer season at site-5.

Figure-4 clearly shows that the Total Hardness content of water at all sites was observed lower during rainy season and higher during summer season. This high value may be due to

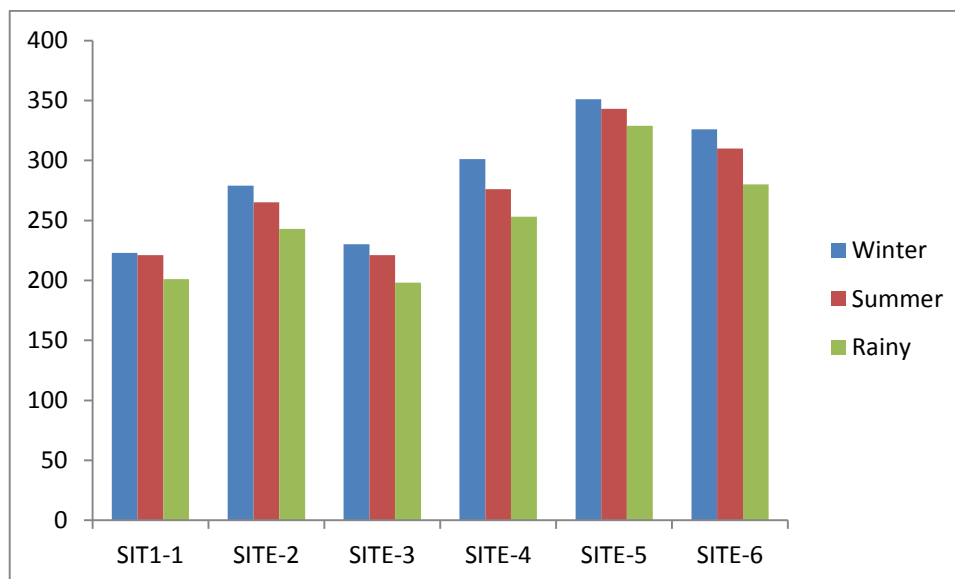
evaporation of water and addition of salts of calcium and magnesium. Although hard water do not effect human health but it is unsuitable for domestic and industrial uses.

### 3.4 Turbidity

Turbidity indicates the light-transmitting capability of water and waste water with respect to colloidal and suspended matter.



**Figure 5:-**Site –wise seasonal variation of Turbidity in NTU in Gangan River



**Figure 6:-**Site –wise seasonal variation of Alkalinity in mg/L in Gangan River

In the present study the observed values of Turbidity for Gangan river ranges from 35 NTU to 53 NTU for winter season, 37 NTU to 55 NTU for summer season and 45 NTU to 73 NTU for rainy season at different sites. The minimum value of Turbidity for Gangan river is found 35 NTU in winter season at site-1 and the maximum value of Turbidity is found 73 NTU in rainy season at site-5.

Figure-5 inferred that the Turbidity is lower during winter season and higher during rainy season. The high value of turbidity in rainy season may be due to the inflow of clay, silt, and various other pollutants along with rain water in the river. The probability of presence of pathogenic organisms is also increased in turbid water.

### 3.5 Alkalinity

Alkalinity is defined as the capability of water and waste water to neutralize H<sup>+</sup> ions. Observed values of Alkalinity for Gangan river summarised in table-2 ranges from 223 mg/L to 351 mg/L for winter season, 221 mg/L to 343 mg/L for summer season and 198 mg/L to 329 mg/L for rainy season at different sites.

The minimum value of Alkalinity for Gangan river is found 198 mg/L in rainy season at site-3 and the maximum value of Alkalinity is found 351 mg/L in winter season at site-5.

### 3.6 Biological Oxygen Demand (BOD)

BOD is a measure of organic material contamination in water, specified in mg/L. BOD is the amount of dissolved oxygen required for the biochemical decomposition of organic compounds and the oxidation of certain inorganic materials (e.g., iron, sulfites).

In the present study the observed values of Biological Oxygen Demand for Gangan river ranges from 6.3 mg/L to 9.8 mg/L for winter season, 6.2 mg/L to 9.5 mg/L for summer season and 6.3 mg/L to 9.7 mg/L for rainy season at different sites. The minimum value of Biological Oxygen Demand for Gangan river is found 6.2 mg/L in summer season at site-1 and site-3 and the maximum value of Biological Oxygen Demand is found 9.8 mg/L in winter season at site-5.

### 3.7 Chemical Oxygen Demand(COD)

COD is the measurement of the amount of oxygen in water consumed for chemical oxidation of pollutants. In the present study the observed values of Chemical Oxygen Demand for Gangan river ranges from 31.9 mg/L to 63 mg/L for winter season, 31.2 mg/L to 65 mg/L for summer season and 31.8 mg/L to 64 mg/L for rainy season at different sites(fig.-8).

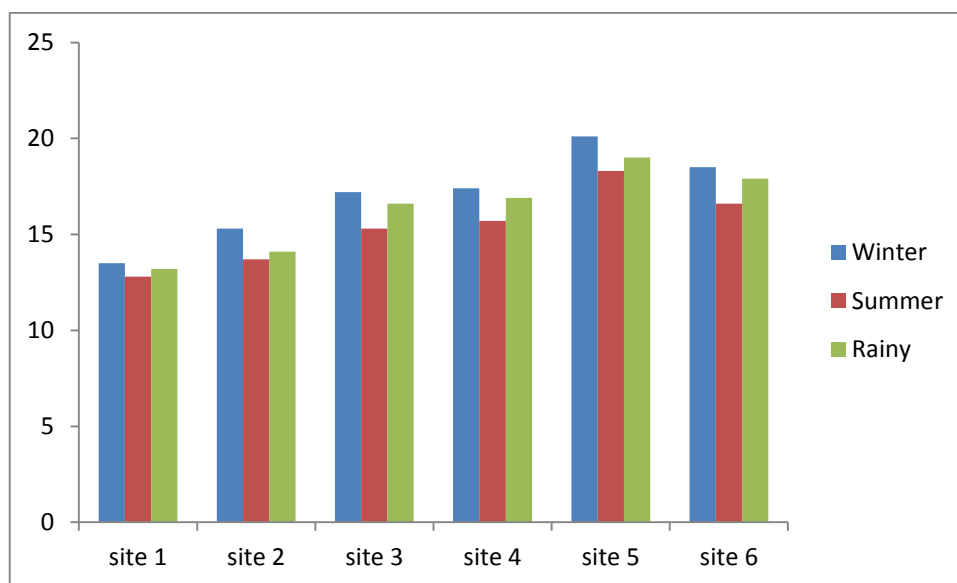


Figure 7:-Site –wise seasonal variation of Biological Oxygen Demand in mg/L in Gangan River

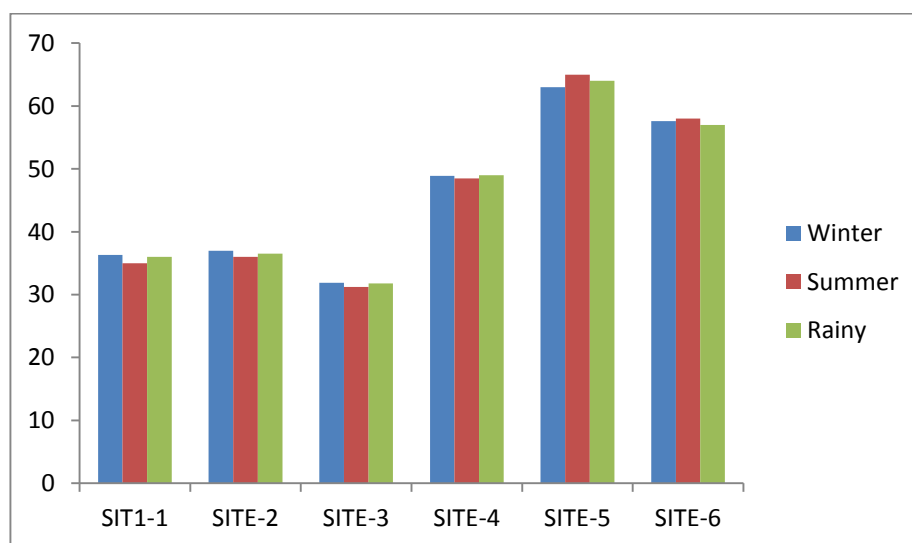
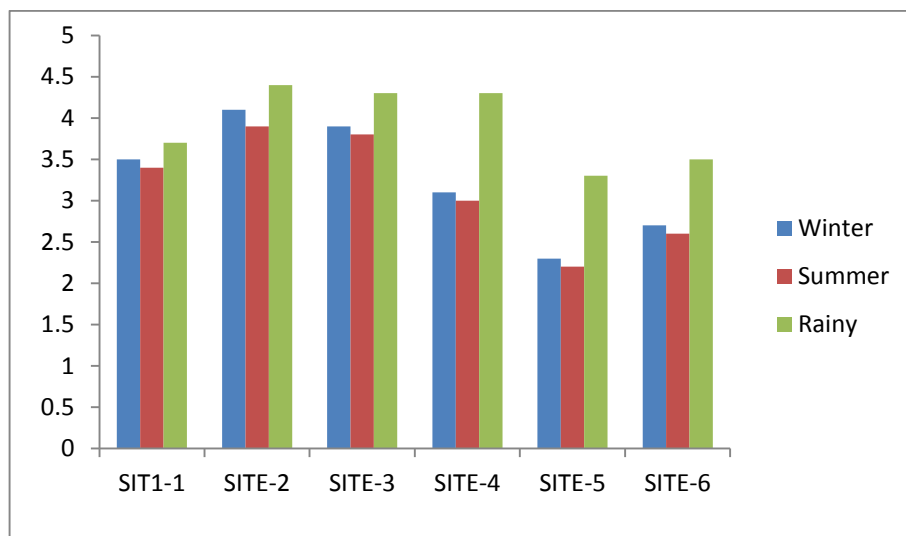


Figure 8:-Site –wise seasonal variation of Chemical Oxygen Demand in mg/L in Gangan River

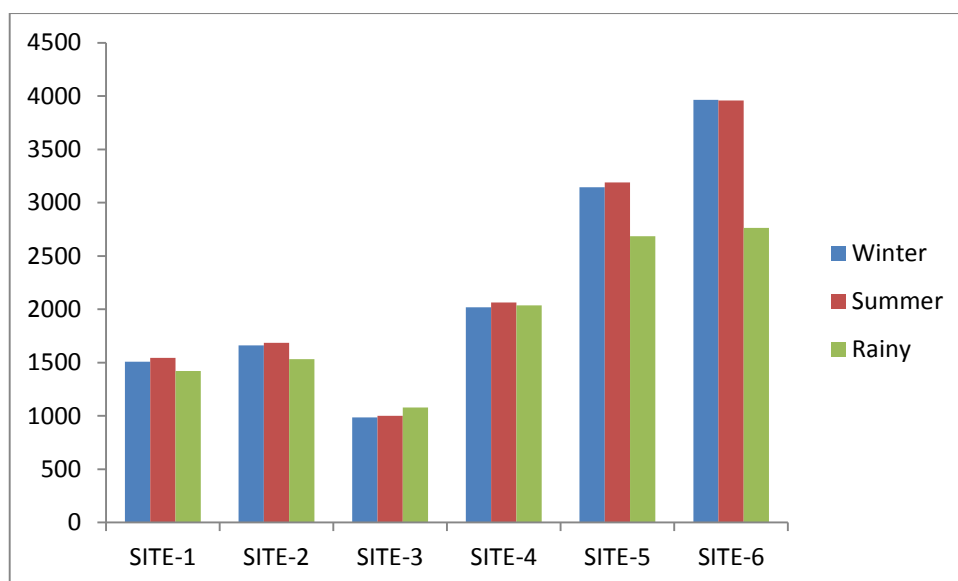
The minimum value of Chemical Oxygen Demand for Gangan river is found 31.2 mg/L in summer season at site-3 and the maximum value of Chemical Oxygen Demand is found 65 mg/L in summer season at site-5.

### 3.8 Dissolved Oxygen (DO)

DO is the amount of oxygen dissolved in a unit volume of water. It is essential for the maintenance of healthy rivers. It is a measure of the ability of water to sustain aquatic life.



**Figure 9:** Site-wise seasonal variation of Dissolved Oxygen in mg/L in Gangan River



**Figure 10:** Site-wise seasonal variation of Total Solids in mg/L in Gangan River

In the present study the observed values of Dissolved Oxygen for Gangan river ranges from 2.3 mg/L to 4.1 mg/L for winter season, 2.2 mg/L to 3.9 mg/L for summer season and 3.3 mg/L to 4.4 mg/L for rainy season at different sites. The minimum value of Dissolved Oxygen for Gangan river is found 2.2 mg/L in summer season at site-5 and the maximum value of Dissolved Oxygen is found 4.4 mg/L in rainy season at site-2.

### 3.9 Total Solids(TS)

Total solids is the term applied to the material residue left in the vessel after evaporation of a sample and its subsequent drying. Total solids are summation of total dissolved solids and total suspended solids.

In the present study the observed values of Total Solids for Gangan river ranges from 986 mg/L to 3965 mg/L for winter season, 1001 mg/L to 3960 mg/L for summer season and 1080 mg/L to 2763 mg/L for rainy season at different sites. The minimum value of Total Solids for Gangan river is found 986 mg/L in winter season at site-3 and the maximum value of Total Solids is found 3965 mg/L in winter season at site-6.

#### 4. CONCLUSION

All environmental studies ultimately depend on the results of chemical analysis of samples of water for pollutants. Policies of reduction of pollutants cannot be designed if the extent and identity of the pollutant is not known. Further the general trend in the polluting factors should be known for effective designing of the treatment strategies. Analysis of the water sample becomes too difficult when the water is contaminated with large number of pollutants.

In the present study water samples were collected from different places in river Gangan and studied under various methods on number of parameters such as temperature, pH, Total Hardness (TH), Turbidity, alkalinity, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO) and Total Solids (TS). In the present investigation extreme care was taken to analyse all the polluting factors of the river Gangan during the three main seasons viz, winter, summer and rainy.

In river Gangan all physico-chemical parameters were found fluctuated in different seasons and at different sites. Raised values of certain parameters clearly indicated pollution in river water. As expected, most of the values were less in rainy season, comparatively more during summer season and high during the winter season.

The present investigation indicated that the river Gangan water was unsuitable for domestic use. To protect the river, there should be provisions for the deposition of domestic wastes, municipal wastes, agricultural runoff, and industrial wastes.

On the basis of above exhaustive discussion it may be concluded that the Gangan river is very much contaminated. The effluent sample carrying the mixed discharge of brass industries of Moradabad and nearby locality are increasing the level of the Gangan river water pollution which is already highly contaminated. Different kinds of human and cattle activities and mixing up of effluents are disturbing the aquatic environment of Gangan river at Moradabad.

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