



Comparative Assessment of Seasonal Variations in the Surface Water Quality of Rivers Ramganga and Gangan at District Moradabad Uttar Pradesh

Mohammad Arshad, Gulrez Nizami, Ummul Khair Fatma and Rahila Shauqat

Department of chemistry, Sir Syed, Faculty of Science
Mohammad Ali Jauhar University, Rampur (Uttar Pradesh), India

ABSTRACT

The main objective of the study is to know the impact of urban and industrial activities on the water quality of Ramganga River and Gangan River at Moradabad U.P India. For this, Ramganga river and Gangan River water samples were collected from different locations along the route of Ramganga river main streamline and Gangan river at Moradabad and were analyzed for different physico-chemical parameters like temperature, pH, electrical conductivity (EC), turbidity, total solids, total dissolved solids (TDS), total suspended solids (TSS), dissolved oxygen (DO), biochemical oxygen demand (BOD), and chemical oxygen demand (COD) levels at pre-monsoon period and post-monsoon period following the standard methods of sampling and testing. The value of pH was 7.02-7.10 at Ramganga and 7.3 to 7.5 at Gangan river, the turbidity was in the range of 19.9-25.8 (NTU) at Ramganga while 18.9-26.8 (NTU) was Gangan river. The electrical conductivity of Gangan river was found in the range of 219 to 282 ($\mu\text{S}/\text{cm}$) while 190 to 206 ($\mu\text{S}/\text{cm}$) at Ramganga River. The heavy metals concentration of Pb, Cr, As, Hg and Cd at different locations of Ramganga is suggestive of surface water pollution.

KEYWORDS: - Electrical Conductivity, Water Quality Parameters, Turbidity, BOD, COD.

INTRODUCTION

The surface water contamination is a main area of studies and researches due to extensive urbanization and industrialization. The rivers have been severely falling under threats of water contamination, which is disturbing the aquatic ecosystem particularly in developing countries like India^[1]. On our planet maximum amount of water available is not used for drinking purposes as 97% of it existing in the sea; only 3% is fresh water and from which 2% is locked in the form of polar ice caps and glaciers. Therefore only 1% water is available for portable use^[2]. It is essential to get accurate and suitable evidence to detect the quality of water resources^[3] and the expansion of some valuable techniques to observe the quality of water resources. The rivers are extremely contaminated by the discharge of industrial effluents into river water, indiscriminate throwing of household, clinical, pathological and commercial wastes, fuel and sewage waste^{[4], [5]}. Water is an important source for manufacturing, agriculture and further human actions. In downtown, the sloppy disposal of industrial stream and other wastes in rivers can contribute to the poor quality of river's water^{[6], [7]}. With the uneven rainfall and the meteorological characteristics leading the physico-chemical properties of water to effect the planktonic variety therefore all the physio-chemical and biological factors exert a direct effect on the fish production^[8]. The concentration of heavy Metals Pb, Mn, Fe, As and Cd at different sites in Ganga River, Varanasi stated to be highest by numerous researchers. Similarly, the levels of Cr, Cu and Zn concentrations in the Ganga River water at various sites of Allahabad region were observed to be beyond the permissible limit^[9]. The pollution load of the river has increased due to heavy metals in the industrial disposal, heavy organic waste of tanneries in Moradabad. It was further acknowledged that the BOD load was rising to six thousand Kg per day because of the release of million gallons per day of industrial disposal from tanneries, textile mills and numerous other industrial units in the Gagan River^[10]. The Gangan river water was much polluted in the region of Moradabad. The lethal impact of heavy metals as well as their bioaccumulation has been observed by numerous workers^{[11], [12], [13]}. Copper (Cu) and Zinc (Zn) that are often present in industrial wastewaters are dangerous to the aquatic ecosystem. The effects of metals on aquatic organisms have been the subject of several analyses^{[14], [15]}.

* **Corresponding Author:** Gulrez Nizami, Department of chemistry, Sir Syed, Faculty of Science, Mohammad Ali Jauhar University, Rampur (Uttar Pradesh), India. Email: drgulrez2@gmail.com

The aim of the study was to study the impact of downtown and industrial activities on the water characteristics of Gangan and Ramganga River at Moradabad. The samples of Gangan river and Ramganga river were collected from different points of water depth along the way of Gangan river vital streamline and its parts and were estimated for pH, temperature, electrical conductivity, turbidity, total dissolved solids, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD) as well as heavy metals levels at pre-monsoon phase and post-monsoon phase followed by the standard manner of sampling and testing.

MATERIALS & METHODS

Study Area and Sample Collection:

Ramganga is a tributary of the river Ganga initiating from Uttarakhand state, India. It runs to kumaun Himalaya south east. From Himalayan region Ramganga flows downward with higher velocity and enters Indo-Gangetic plains of National Corbette Park, Ramnagar district Nainital district from where it inclines to plains. Bijnor, Moradabad, Bareilly, Badaun, Shahjahanpur and Hardoi cities of UP are situated on its bank. It has a drainage basin of 30,641 km². Gangan River which is another study area in this paper is the tributary to the Ramganga River, flowing across Moradabad city.

Different sampling locations in Moradabad district were selected in order to study the physico-chemical characteristics of Ramganga River and Gangan river water samples in pre-monsoon and monsoon period. The location of Gangan River for sample collection, selected was 6 km from railway station, near RTO office while for Ramganga sample collection, 1.6 km from new Bus station near Dear Park was selected. The samples were collected following the standard methods described for sampling. The standard methods and procedures were used for quantitative estimation of water quality parameters. The estimated physico-chemical parameters are temperature, pH value, conductivity, turbidity, total dissolved solids, dissolved oxygen, biochemical oxygen demand, oxygen demand and analyses of heavy metals included Pb, Cr, As, Hg, Cd,. Prior to sample collection, all bottles were washed with dilute acid followed by distilled water and were dried in an oven. World Health Organization (WHO) standard were adopted for calculation of water quality index (WQI).^[5]

A Brief description of sampling sites is given below in table 1.0 and table 2.0.

Table 1.0: Sites of Gangan River and Ramganga River:

S.No	Sampling sites	Rural/Urban Location	Geographical locations
1.	Gangan river, Moradabad	6 km from railway station, near RTO office	27.177996°N 79.844112°E
2	Ramganga River, Moradabad	1.6 km from new Bus station near Dear Park	28°47'43"N 78°46'0"E

EXPERIMENTAL METHODOLOGY

In the study of premonsoon and monsoon seasonal variations in the surface water quality of Rivers Ramganga and Gangan at District Moradabad Uttar Pradesh all the analyses were carried out twice in a year i.e. in the pre monsoon and monsoon season systematically. The studies of the several physico-chemical parameters were conducted as per the standard techniques.^[16] The pH was recorded with the digital pH-meter^[17] at Maju. The turbidity of collected water samples was determined by Naphelo-turbidity meter.^[18] The electrical conductivity was calculated with a conductivity meter. The temperature was measured by a digital thermometer. BOD was observed as per standard method and COD was determined by potassium dichromate open reflex method. The Chlorides content were determined by Mohr's argentometry method. The Samples were analyzed for pesticides in Sophisticated Analytical Lab, New Delhi .Heavy metals were estimated at NBRI-CSIR lab Lucknow by atomic absorption spectrophotometer each season.

Table 2.0: description of Site of Gangan River and Ramganga River

S.No	Location Abbreviations	Sample locations details	Depth/ quantity
1	NB-R	Near Bank, Ramganga	Surface
2	SB-R	Surface water of Bank, Ramganga	Surface
3	CP-R	Centre point, Ramganga	Surface
4	CP-20-R	20 cm immersed at centre point, Ramganga	20 cm deep
5	NB-G	Near Bank, Gangan	Surface
6	SB-G	Surface water of Bank, Gangan	Surface
7	CP-G	Centre point, Gangan	Surface
8	CP-20-G	20 cm immersed at centre point, Gangan	20 cm deep

Table 3.0: Accepted parameters of drinking water quality

Parameters	USEPA	WHO	ISI	ICMR	CPCB
pH (mg/l)	6.5-8.5	6.5-8.5	6.5-8.5	6.5-9.2	6.5-8.5
Turbidity (NTU)	-	5	10	-	10
Conductivity ($\mu\text{S}/\text{cm}$)		200-800			
TDS (mg/l)		500			
Lead (mg/l)	-	0.05	0.10	0.05	No relaxation
Mercury (mg/l)	0.002	0.001			No relaxation
Cadmium (mg/l)	-	0.005	5.0	0.10	15.0
Arsenic (mg/l)	0.05	0.05	0.05	0.05	No relaxation
Chromium (mg/l)		0.1			

RESULTS AND DISCUSSION

In the present paper, the premonsoon and monsoon seasonal variations have been taken into consideration, to estimate the quality of Ramganga and Gangan rivers water by determining the levels of heavy metals of the Kosi River in the basin of district Rampur U.P. Aquatic environment temperature is the most significant ecological factor. In India, rivers show seasonal variation in temperature. In the river Gangan the average temperature ranged from 34.1^oC to 34.9 ^oC in pre-monsoon period and 35.9 ^oC to 35.2 ^oC in post monsoon period (Table3.0), whereas the temperature of Ramganga river was found to be in the range of 28.02 to 34.06 ^oC. pH determines the strength of an acid or an alkaline therefore it is also the measure of the hydrogen ions in any solution. The present study aims to present the data comparatively of above mentioned sites. Both the Rivers showed slight variation in the pH values. At Gangan river the pH ranges from 7.5 to 7.10 in the pre monsoon while post monsoon it ranges from 7.1 to 7.4. At Ramganga pre monsoon the pH ranges from 7.2 to 7.6, in the post monsoon it was ranged from 7.2 to 7.4 According to ISI and WHO the appropriate pH of water for drinking purpose is 6.5 to 8.5. It is observed that the pH values of both the study areas are found within the permissible limit as per WHO. The variation in the ideal pH values may be raised due to the changes in the concentrations of mineral or chemical compositions in aquatic systems.^[19] The pH ranging from 5.0 to 8.5 is most favourable for plankton colonies development.^[20] In this study the pH range observed indicated that the water sample of all the sampling sites of both the rivers was slightly alkaline in nature. Increased values of pH during summer may be due to the low water level and high nutrients concentration in water. A slight drop in pH range may be because of the rainwater during monsoon.^{[21], [22], [23]} (Table 03, figure 01).

Turbidity, as an essential parameter to measurement, gives the information of suspended impurities in the water. As per WHO the max permissible limit for turbidity is 5 NTU. The results obtained for turbidity of each sample indicated the range from 19.9 NTU in summer while 25.8 NTU in the spring season at Gangan River while at Ramganga the turbidity was found to be 18.9 NTU in summer and 26.8 NTU in spring season. However; all the site were exceeding in the maximum permissible limit of turbidity for drinking purpose. TDS analysis has great implications in the control of biological and physical wastewater treatment processes. The values recorded for Gangan ranges from 638 to 674 mg/L. in the summer season the average value obtained was 502 mg/l while in spring season the average value recorded was 625 mg/l. At Ramganga river the maximum value recorded for the Ramganga river is 305 mg/l during spring and 250 mg/l in the summer season. The measurement of the conductivity indicates the total dissolved salts in the water and therefore its mineral content. During this study the value of electrical conductivity was ranged from 219.07 $\mu\text{S}/\text{cm}$ to 282.08 $\mu\text{S}/\text{cm}$. In the monsoon period of Ramganga River the conductivity ranges from 190.05 to 206.08 $\mu\text{S}/\text{cm}$. while at Gangan River the values lie between 219.07 to 282.04 $\mu\text{S}/\text{cm}$ in the summer and spring season respectively. As per WHO the value of EC of all the water samples were found within permissible limit for drinking purpose 200-800 $\mu\text{S}/\text{cm}$ (Table 4.0).

The amount of gaseous oxygen (O₂) dissolved in a river is its dissolved oxygen. A decline in DO can create anaerobic surroundings which is harmful for aquatic flora and fauna. At Ramganga the values of DO ranged between 0.071 to 0.079 while at Gangan it was found between 5.52 to 6.09. At Gangan the mean statistical values obtained for BOD varied between to 6.08 mg/l. in summer season the average value obtained was 6.825 mg/l while in spring season the average value obtained was 4.21 mg/l. At Ramganga the mean statistical values obtained for BOD varied between 15.0 to 18.98 mg/l in summer season the average value obtained was 18.98 mg/l while in spring season the average value obtained was 15.89 mg/l. according to WHO the value of BOD of drinking water should be from 3 – 5 mg/l. the Gangan river values indicated moderately clean state of water however at Ramganga BOD level are exceeding the prescribed values and indicating the significant polluted state of water (table 05, figure 01, 02).

The consumption of O₂ during the decay of organic matter and the oxidation of inorganic chemicals indicates the levels of Chemical oxygen demand (COD) of the river system. Both BOD and COD are key indicators of the environmental health of surface water. The range of COD for Gangan River found between 24 to 34.8 mg/L. In summer season the average COD values found 34.8 and in spring season the values obtained was 24 mg/l. At Ramganga River COD were 102 to 122 mg /L. COD levels of water higher than 25 mg/l indicates moderately pollution states while COD values higher than 50 mg/l indicates higher pollution level of water leading to create toxicity for the aquatic ecosystem.

The outcome of the analyses of heavy metals in the collected water samples showed a significant increase in the concentration of Pb, Cu, Hg & As at Ramganga, and the concentration of all the metals at Gangan sites are relatively low. The concentration of Arsenic in drinking water has been investigated at various sites of the both the Rivers. WHO has set a provisional guideline value of As 0.01 mg/l in drinking water and in India standard drinking water specification 1991, the maximum limit is 0.05 mg/l and there is no relaxation for maximum permissible level^[24]. When we examined the value of As in the collected samples was found to be 0.05 in premonsoon period while in monsoon season As was not detected, however the concentration of As was also not detected at Gangan River. These values are indicating the acceptable limits of As as per WHO at all the sampling sites. The chromium content in the Ramganga River was found to be exceeding the permissible value (0.1 mg/l). At Ramganga in pre monsoon season Cr concentration found was 18.98 mg/l while in monsoon it was 15.89 mg/l. higher concentration of Chromium in soil ultimately reaches the underground water and contaminate for drinking purpose^[25]. The results obtained reveal that the concentration of lead in the analyzed waters is very high, varying between 11.46 and 7.0 mg/l at Ramganga in pre monsoon and monsoon season respectively. The values recorded in the different sites are very high than the maximum acceptable value (Table 03). Such pattern may be either due to the leaching of the lead-rich soil or to industrial discharges from the industrial area. While at Gangan River it was found within limit. The data obtained reveal that the total mercury concentrations in the analyzed waters samples were found within the limit, varying from nil to 0.001 mg / l, at Ramganga while at Gangan River Hg concentration was not detected Table 6.0 and figure 3.0 and 4.0.

Table 4.0: Average values of Physico-chemical parameters of Gangan and Ramganga Rivers

SN	Sample sites	Season	Temp ⁰ C	TDS (mg/l)	pH	Conductivity(μS/cm)	Turbidity (NTU)
1-	Gangan	Pre monsoon	34.2	502	7.3	219.07	19.9
		Monsoon	27.5	625	7.1	282.04	25.8
2-	Ramganga	Pre monsoon	34.6	250	7.4	190.05	18.9
		Monsoon	28.02	305	7.3	206.08	26.8

*Whole surface water=Average data of the river and impact point of the river

Table 5.0: Physico-chemical parameters of Gangan and Ramganga Rivers (Gas parameters/demand analysis 5 days)

SN	Sample details	Season	DO	BOD	COD
1-	Gangan	Pre monsoon	0.06	6.825	34.8
		Monsoon	0.050	4.21	24
2-	Ramganga	Pre monsoon	0.071	18.98	112
		Monsoon	0.079	15.89	102

Table 6.0: Heavy metals concentration (mg/l) in Surface Water of Ramganga (chemical/ metals):

SN	Sample details	Season	Pb	Cr	As	Hg	Cd
1-	Gangan	Pre monsoon	0.01	0.50	ND	0.001	0.01
		Monsoon	0.05	0.10	ND	ND	0.05
2-	Ramganga	Pre monsoon	11.46	35.09	0.05	ND	0.54
		Monsoon	07.00	20.08	ND	ND	0.31

Schematic Representation:

Figure:1.0 Seasonal variation in Physico-chemical parameters of Gangan River

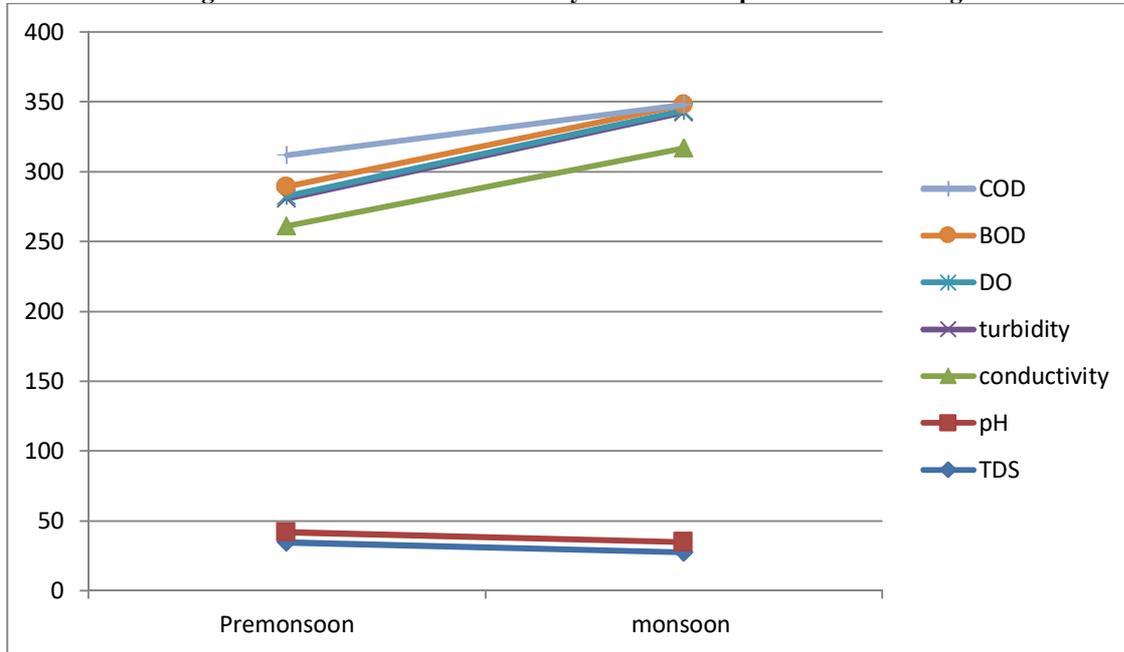


Figure: 2.0 Seasonal variation in Physico-chemical parameters of Ramganga

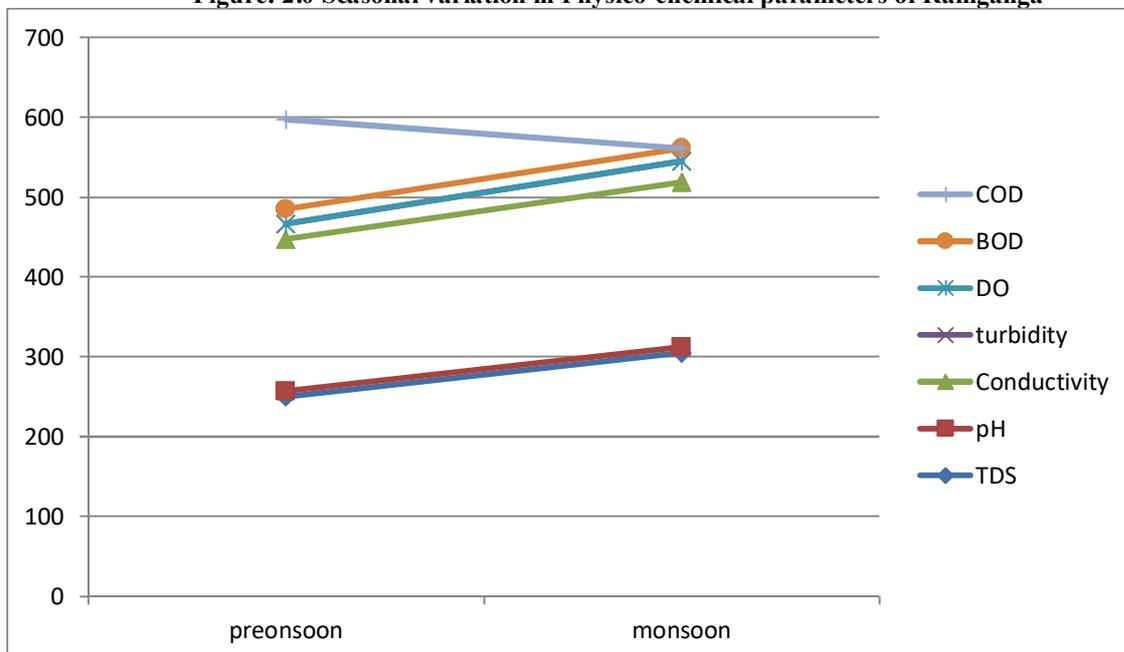


Figure: 3.0 Seasonal variation in Heavy metals concentration at Gangan

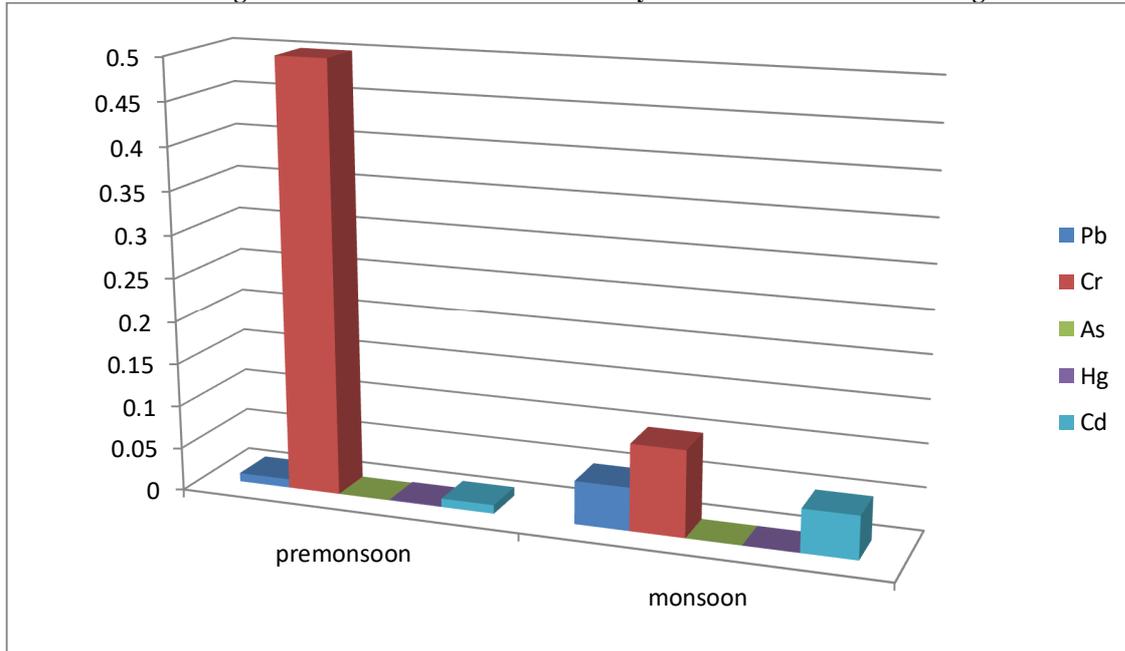


Figure: 4.0 Seasonal variation in Heavy metals concentration at Ramganga

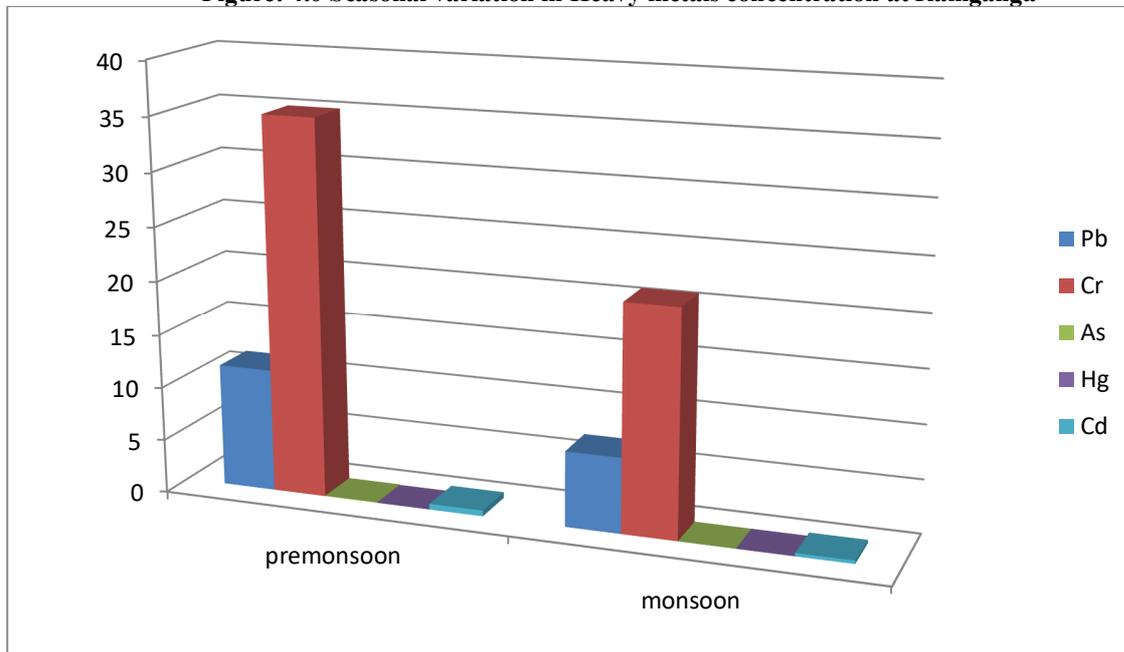
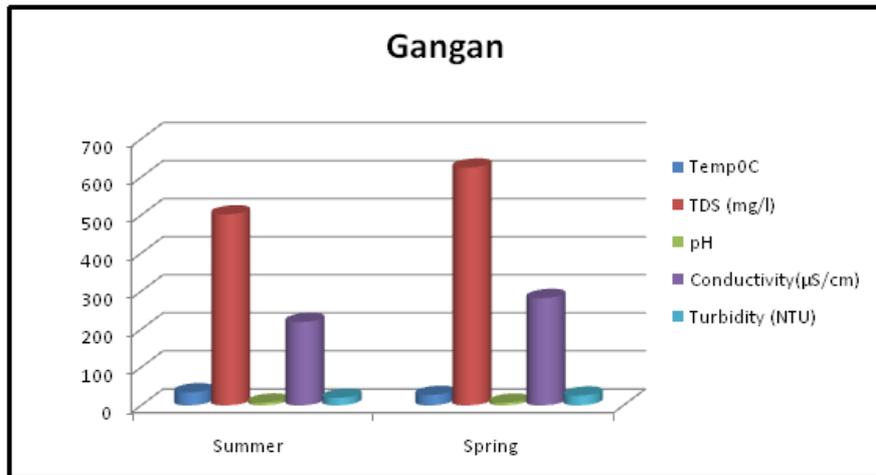
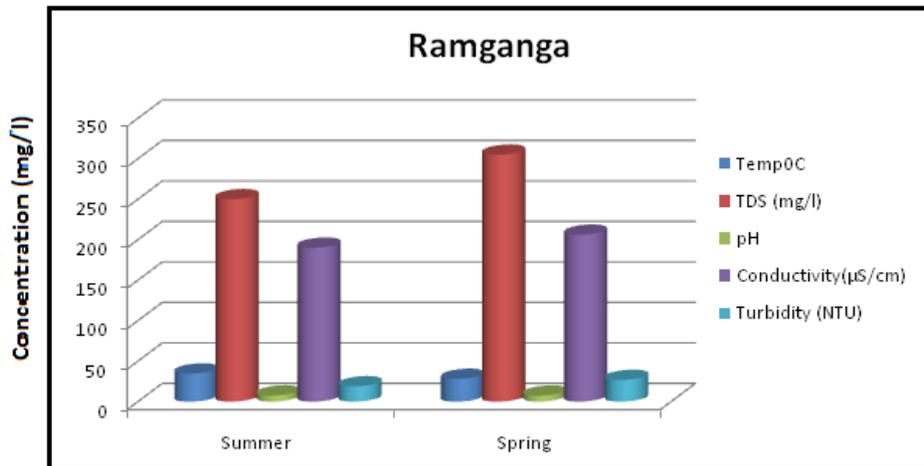


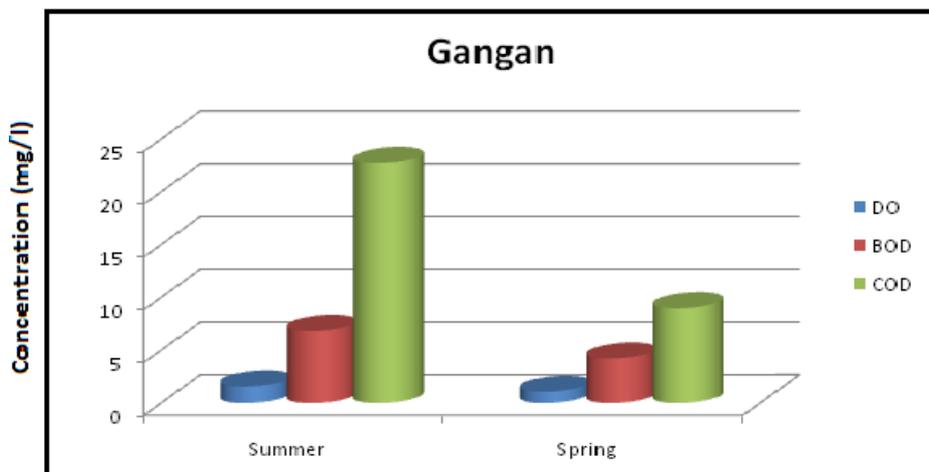
Figure 5.0 Comparative presentations of Ramganga and Gangan Rivers



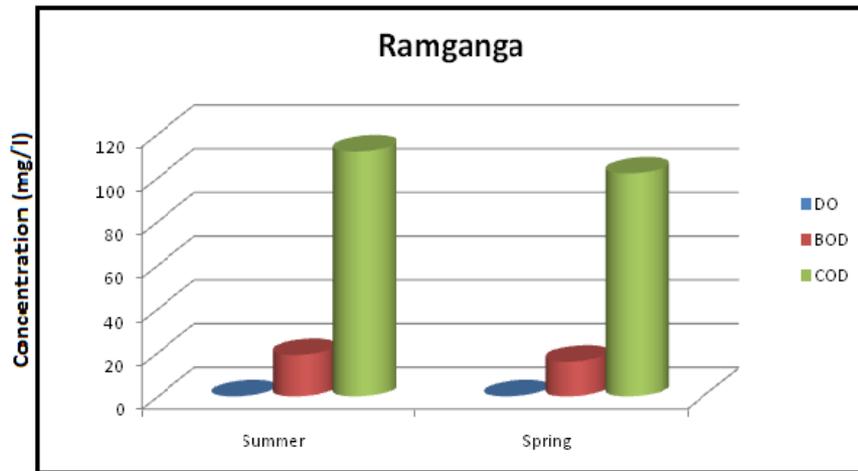
Pre Monsoon and Monsoon seasonal variations in physico chemical parameters



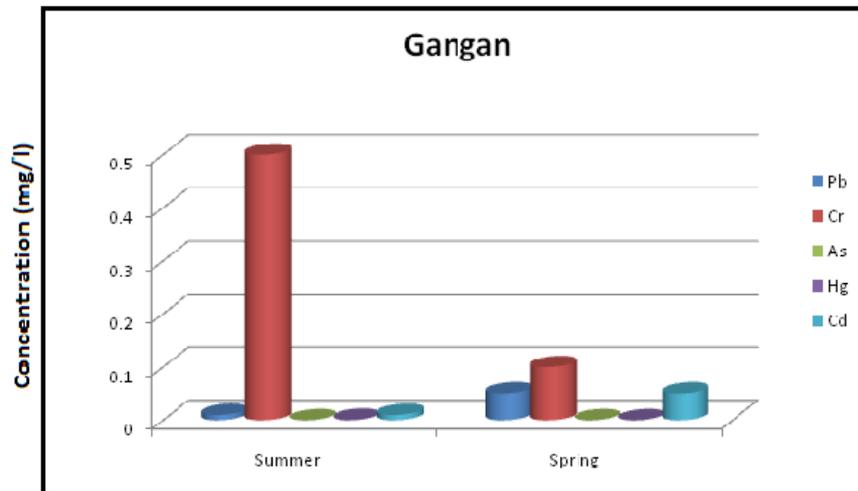
Pre Monsoon and Monsoon seasonal variations in physico chemical parameters



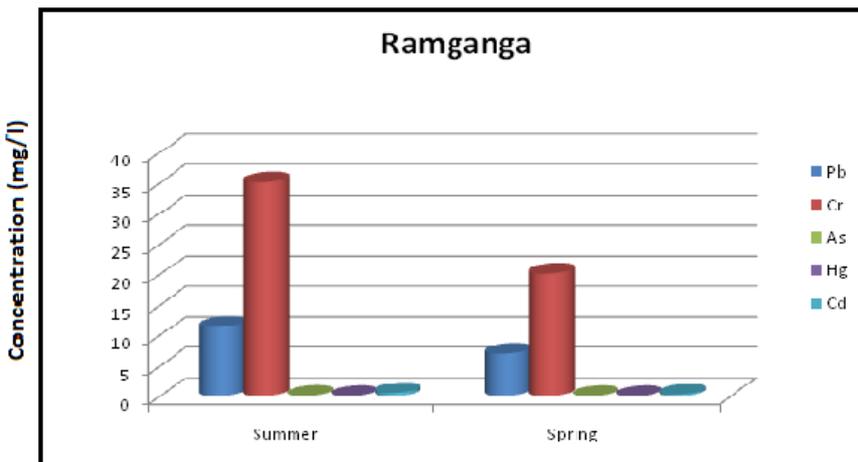
Pre Monsoon and Monsoon seasonal variations in physico chemical parameters



Pre Monsoon and Monsoon seasonal variations in physico chemical parameters



Pre Monsoon and Monsoon seasonal variation in heavy metals



Pre Monsoon and Monsoon seasonal variation in heavy metals

CONCLUSION

Moradabad is an Industrial and Commercial city and Ram Ganga River flows in the north east of the city. It is a central river in Moradabad (U.P) and Gangan River is its tributary at Moradabad. It has been observed that Moradabad city is losing its water quality day by day; consequently affecting its flora and fauna. In the present study the effort has been made to analyze the level of contamination, subsequently the changes in the quality of water of River Ramganga as well as River Gangan at Moradabad.

The consistent seasonal variation of the chemical analysis of Gangan and Ramganga River is suggestive of exceeding limits of drinking water quality parameters. The brass industry in Moradabad is regularly discharging the effluents into the rivers. The physicochemical parameters at different locations of Gangan river and Ramganga River, both rivers waters are found somewhere within the limit however the BOD, COD values and higher concentration of heavy metals in Ramganga are suggestive of significant level of pollution in both the seasons. It has been found that the surface water at various points of Ram Ganga river around Moradabad in Uttar Pradesh is rich in Heavy metals such as Pb, Cr, As and Cd. Heavy metals like Pb, Cr, As and Cd in all samples exceeded WHO limit for drinking water. Therefore conservation and management strategies for both the rivers are suggested through this study.

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