

Seasonal Variation in the Aquatic Environment of Ram Ganga River at Moradabad : A Quantitative Study

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Ram Ganga river water at 10 different sites at Moradabad were collected and analysed at pre-monsoon period and after the onset of monsoon following standard methods of sampling and testing. River water is found to be contaminated with reference to almost all the physico-chemical parameters studied at almost all the sites of sampling for pre-monsoon period as well as after the onset of monsoon. To study the pollution potential of effluents on river water quality, 2 effluent samples carrying mixed discharge of industries and city discharge before mixing up with river water and downstream river water samples after mixing up with river water were analysed. A comparison of data for two seasons clearly indicates improvement in the river water quality after the onset of monsoon.

KEYWORD

Aquatic environment, Physico-chemical parameters, Effluents, Seasonal variation.

INTRODUCTION

Water also known as blue gold, one of the most priceless gifts of Nature is also regarded as the life line on Earth, because evolution of life and development of human civilization could not have been possible without water. All great civilizations of the world evolved around the rivers. Rivers have been life line to the Earth and supposed to be yardstick to measure the society. A dirty river means a dirty society. Rapidly increasing population, indiscriminate urbanization and rapid industrialization along the rivers have put tremendous pressure on water resources and their quality (Sinha *et al.*, 2004; Sinha and Srivastava, 1995). The examination of water are necessary for the reasons : to asses its quality to provide a pure and wholesome water to the public for drinking and other purposes; to find out whether water is suitable for the specific industrial purpose, and if so, to choose the most effective treatment; to determine the extent of pollution and to suggest a possible remedy; to determine the efficiency towards natural purification when sewage and industrial wastes are

discharged into water courses; and to ascertain the effect of rain fall on water quality. The level of pollution in the natural environment especially aquatic environment has been of great concern to the scientists, environmentalists and engineers because of its toxic nature and other adverse effects on human beings and other living creatures (Dhanya *et al.*, 2005; Anathussalam and Gnanaganesam, 2004).

Moradabad is a 'B' class city of Uttar Pradesh having urban population more than 41 lakh. Moradabad is situated at the bank of Ram Ganga river and its altitude from sea level is about 670 feet. It is extended from Himalaya in North to Chambal river in South. Moradabad is at 28°20', 29°15'N and 78°4' 79°E. District Bijnor and Nainital are in the North; Rampur is in the East, Ganga river is in the West and district Budaun is in the South of district Moradabad. Moradabad has seen rapid industrialization during last few decades although Brassware industry is an age old for Moradabad. The other major industries are Steelware, Paper mills, Sugar mills, Crushers, Dye factories and a number of ancillaries and small-scale industries, related to these industries, etc. Most of these industries are dumping their effluents in the two major rivers

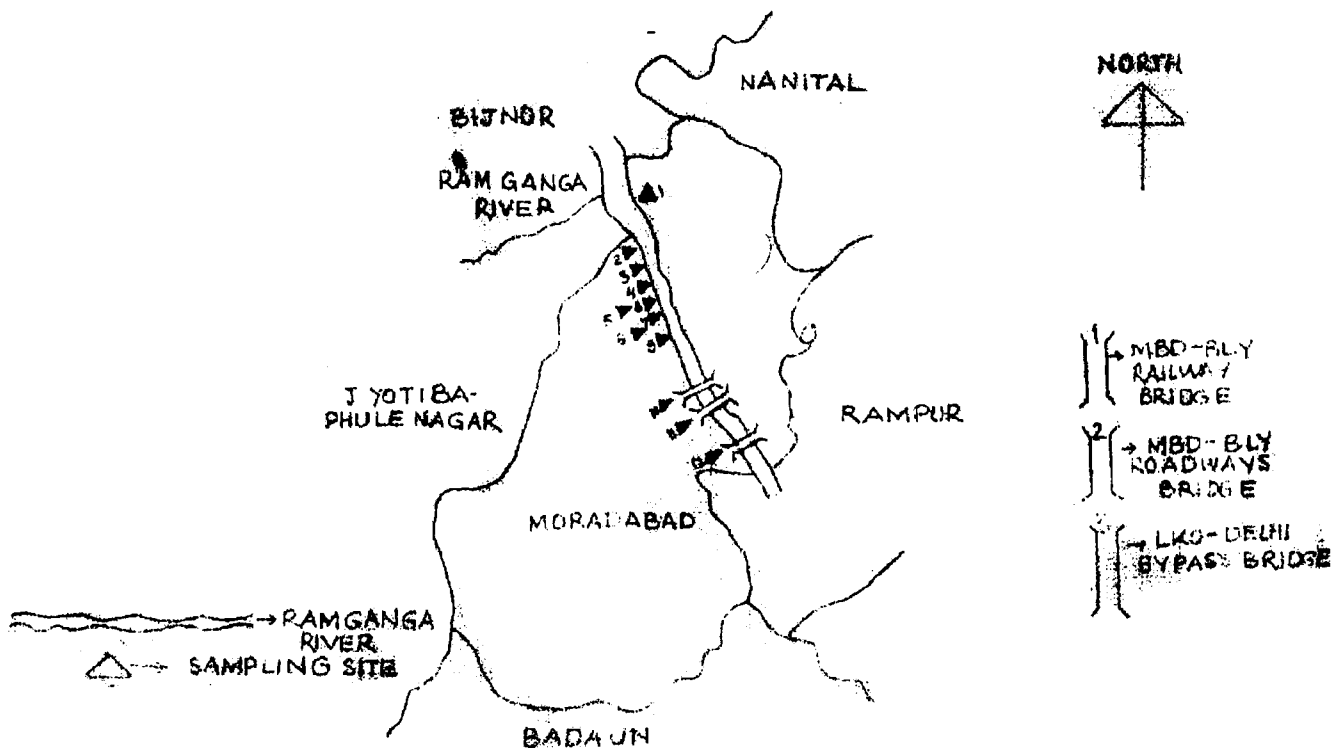


Figure 1. Map of sampling site

of Moradabad-Ram Ganga, Gagan river and thereby polluting it severely. City discharge and different kinds of human activities are also causing river water pollution. The area is characterized by periodic occurrence of hot summers, moderate rains and cold winters. The maximum and minimum atmospheric temperatures are 48°C and 3°C, respectively. The average rainfall varies between 800 to 1000 mm. The relative humidity is up to 90% in monsoon season and in drier part of the year it decreases to less than 20%.

Ram Ganga river is a tributary of very important and holy river of the country-The Ganga. It emerges from lower region of Shivalik particularly from a small place Lamba of district Chamoli of Uttaranchal at the height of 3069 m. Moradabad is the first major city in the way of flow of Ram Ganga river. A dam for irrigational and power generation purposes is made on this river at Kalagarh, Uttaranchal. The Ram Ganga river mixes up with Ganga river at its left bank at Sherpur village of district Farrukhabad, Uttar Pradesh where another river Kali also mixes up with it. Ram Ganga river is

a perennial river. Ram Ganga river is used for bathing, drinking, cremation, dumping of carcasses and sewage, other human activities in addition to industrial discharge. Due to all these activities the Ram Ganga river has become a health hazard for the people on the banks of the river and also for the people using directly or indirectly the river water. The pollution of Ram Ganga river water is also adversely affecting the flora and fauna of aquatic environment which is an essential part of the aquatic eco-system. Ram Ganga river has a total drainage area of about 500 km². The total stretch of river can be divided into three regions- (a) The upstream area; a fertile region, (b) The mild region; full of sand, (c) The down stream region, most alluvial land which is fertile.

MATERIAL AND METHOD

12 different sites at district Moradabad were selected in order to study the physico-chemical characteristics of Ram Ganga river water samples for pre-monsoon period and after the onset of monsoon. Out of these 12 sites, 10 samples are of Ram Ganga river water and the

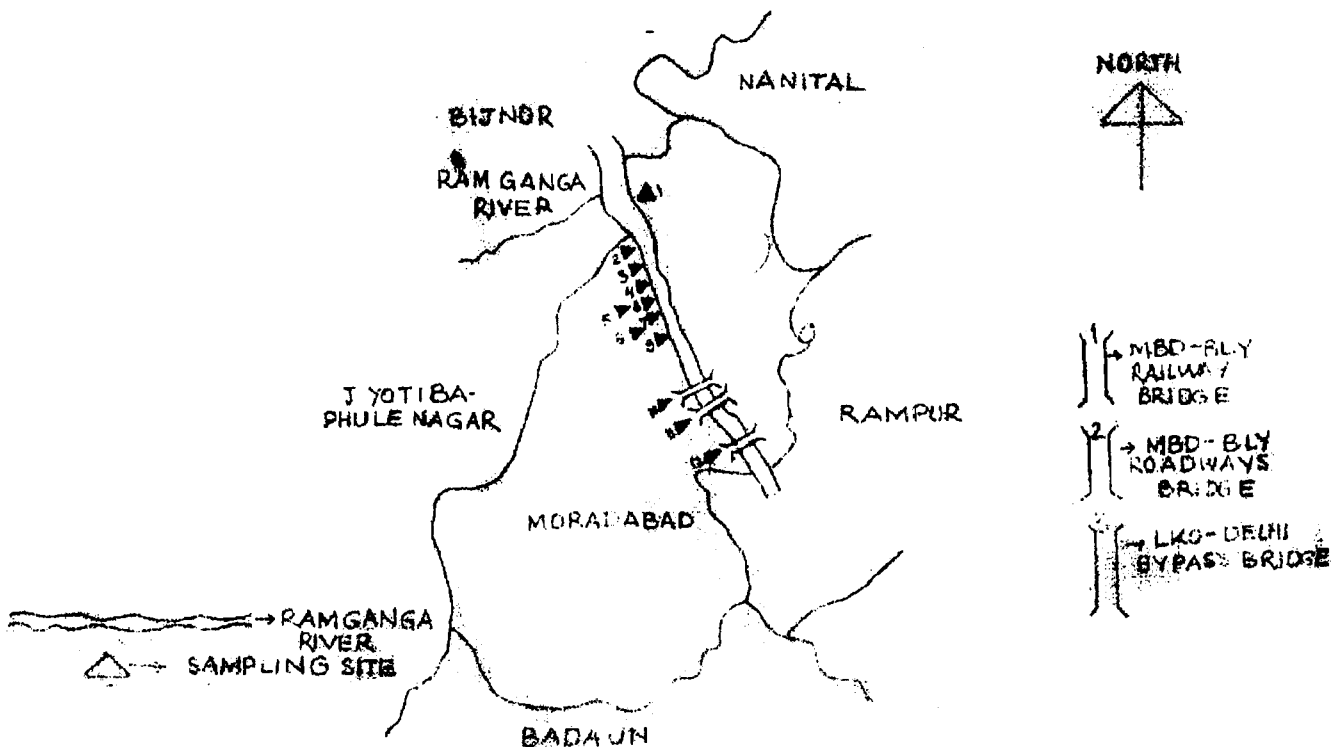


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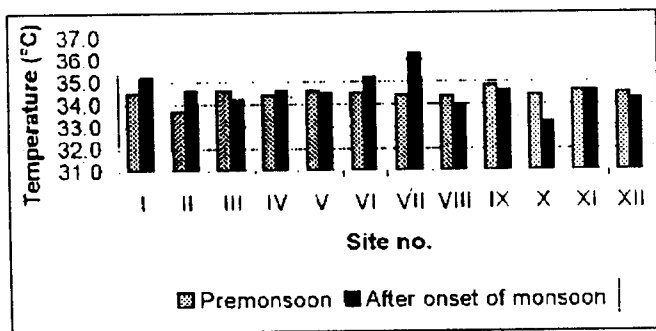


Figure 2. Site-wise seasonal variation of temperature in degree celcius

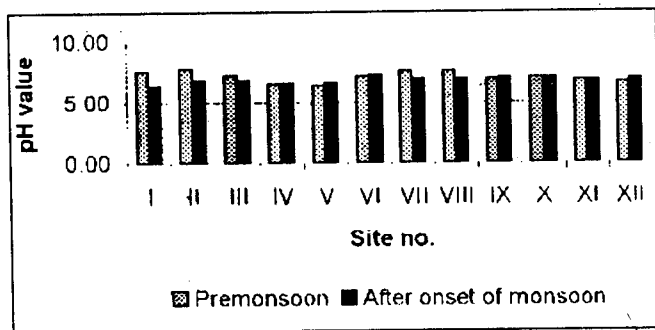


Figure 3. Site-wise seasonal variation of pH value

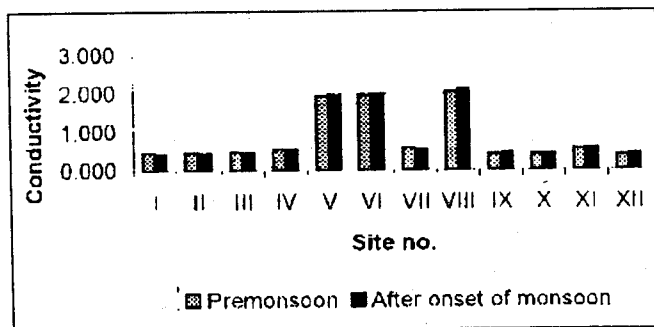


Figure 4. Site-wise seasonal variation of conductivity in μ s/cm

rest 2 are effluent samples carrying mixed discharge of industries and nearby locality. 18 water quality physico-chemical parameters were estimated quantitatively following standard methods and procedures using all the chemicals of anal R grade (APHA, 1995). The estimated physico-chemical parameters are- temperature, pH value, conductivity, turbidity, total solids, total dissolved solids, chemical oxygen demand, hardness, calcium, magnesium, fluoride, chloride, alkalinity, acidity and

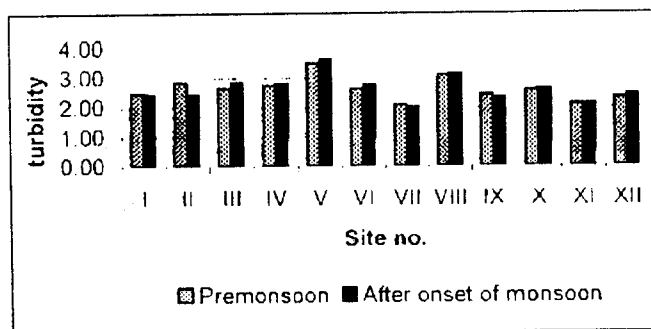


Figure 5. Site-wise seasonal variation of turbidity in NTU

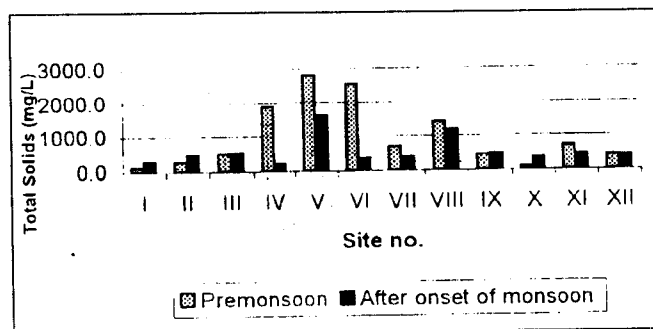


Figure 6. Site-wise seasonal variation of total solids in mg/L

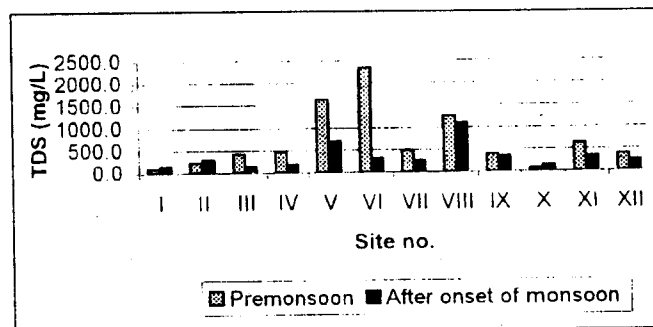


Figure 7. Site-wise seasonal variation of total dissolved solids in mg/L

free CO₂. A brief description of sampling sites is given below :

(I) M.D.A. Colony-This is Ram Ganga river water at Moradabad development authority colony which is about 5 km North to the Moradabad city. This is the site from where river enters in the city. Sand digging and occasional bathing activities are noticed at this site.

(II) Jigar Vihar Colony-This is river water sam-

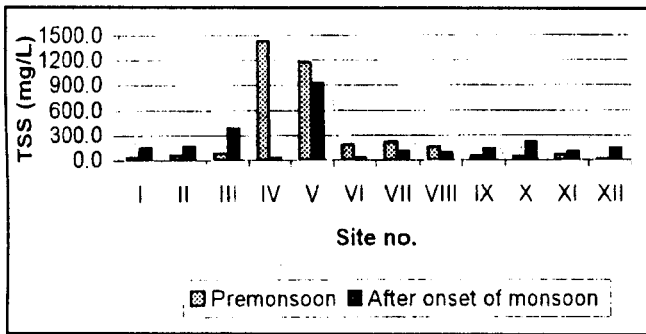


Figure 8. Site-wise seasonal variation of total suspended solids in mg/L

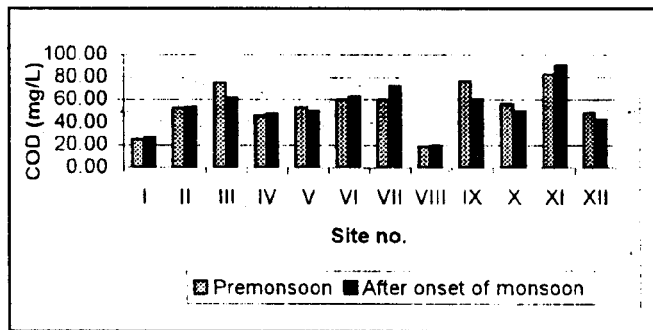


Figure 11. Site-wise seasonal variation of chemical oxygen demand in mg/L

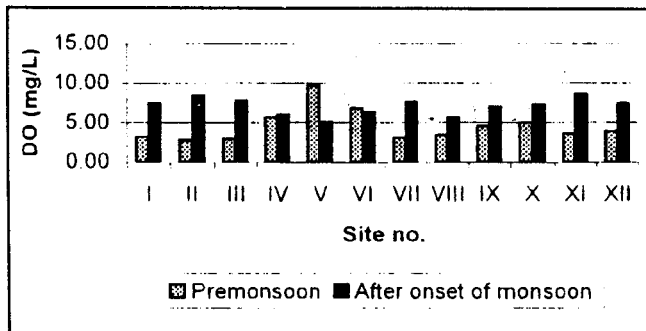


Figure 9. Site-wise seasonal variation of dissolved oxygen in mg/L

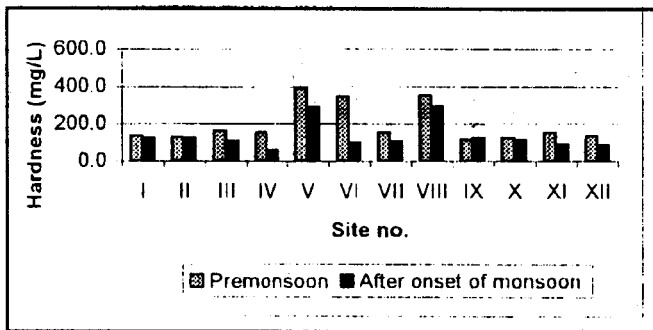


Figure 12. Site-wise seasonal variation of hardness in mg/L

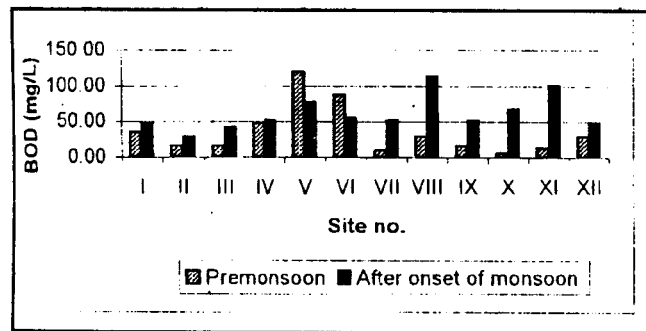


Figure 10. Site-wise seasonal variation of biological oxygen demand in mg/L

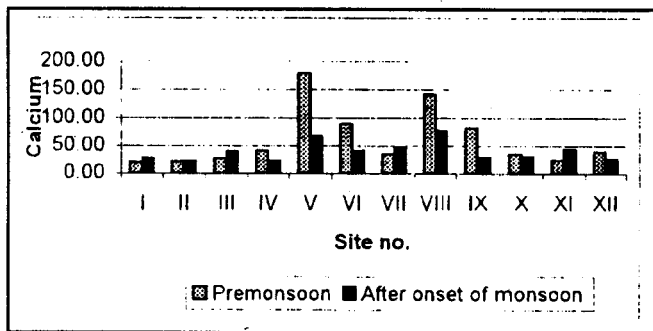


Figure 13. Site-wise seasonal variation of calcium in mg/L

ple at Jigar Vihar colony. It is about 2 km South to the site I and its water is used for washing, laundering and bathing activities. Cattle bathing is a regular feature at this site.

(III) Kali Ji Temple-Ram Ganga river water sample at very famous religious Kali Ji Temple. It is about 2 km far from the previous site. Being adjacent to the holy

temple, bathing activities are common at religious festivals. Some cremation activities are also noticed at the left bank of the river at this site.

(IV) Upstream Nawabpura-This is Ram Ganga river water sample at densely populated Nawabpura Mohallah before mixing up of Nawabpura nullah. It is about 500 m away to the Site no. III.

(V) Nawabpura Nullah - This is a city dis-

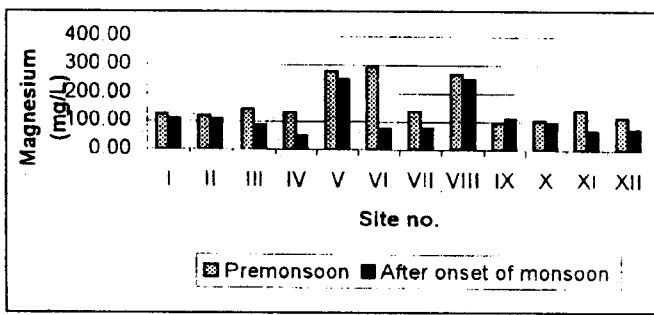


Figure 14. Site-wise seasonal variation of Magnesium in mg/L

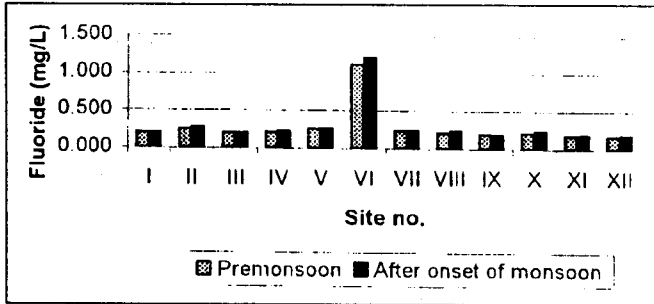


Figure 15. Site-wise seasonal variation of Fluoride in mg/L

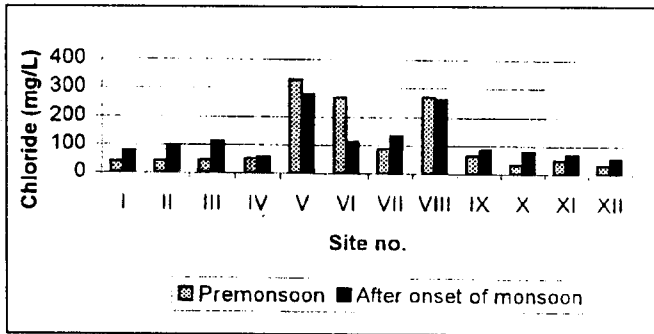


Figure 16. Site-wise seasonal variation of chloride in mg/L

charge coming through a nullah of bigger width of about 3.0 m. The discharge carries the mixture of industrial effluents and city discharge. The sample is having an objectionable odour. The odour is particularly because of hydrogen sulphide.

(VI) Downstream Nawabpura-This is Ram Ganga river water sample at Nawabpura after the mixing up of Nawabpura nullah with it. The sample is collected at a distance of about 50 m from the point of mixing of nullah water with river water.

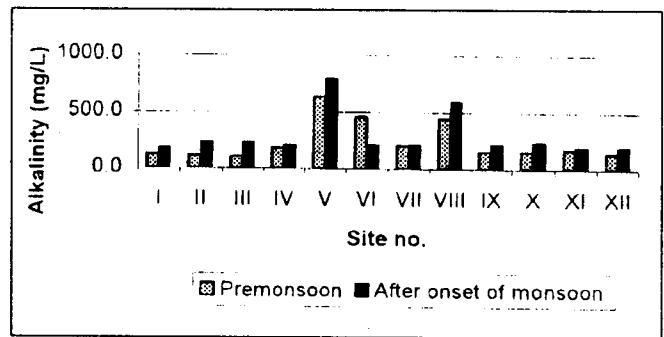


Figure 17. Site-wise seasonal variation of alkalinity in mg/L

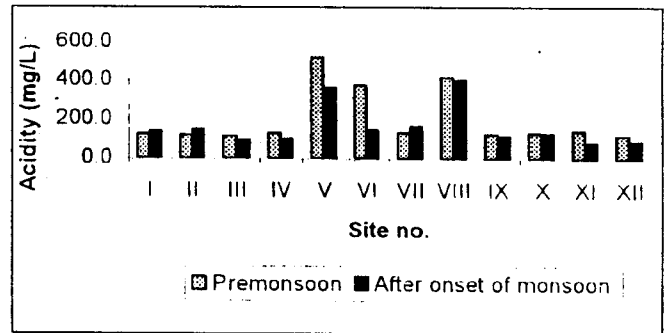


Figure 18. Site-wise seasonal variation of acidity in mg/L

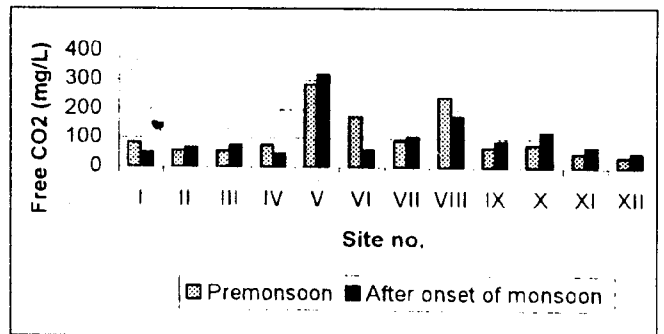


Figure 19. Site-wise seasonal variation of free carbon dioxide in mg/L

(VII) Upstream Barbalan-This is river water sample at mohallah Barbalan before mixing up of Barbalan nullah. This site is about 2 km away from Kali ji temple. Some bathing and cattle activities are noticed at this site at the time of sampling.

(VIII) Barbalan Nullah-This is discharge sample at Barbalan carrying mixed discharge of Dohbi-Ghat, small-scale industries and nearby locality.

Table 1. Site-wise values of water quality parameters for premonsoon period and after the onset of monsoon with their W.H.O. standards, in mg/L

Parameter	Site I		Site II		Site III	
	*	**	*	**	*	**
Temperature, °C	34.5	35.2	33.7	34.6	34.6	34.2
pH value	7.59	6.32	7.80	6.84	7.26	6.81
Conductivity, μ Siemens/cm	0.454	0.434	0.456	0.436	0.457	0.447
Turbidity, NTU	2.48	2.46	2.84	2.44	2.64	2.83
Total solids	138.0	302.0	282.0	474.0	498.0	522.0
Total dissolved solids	104.0	158.0	226.0	310.0	424.0	142.0
Total suspended solids	34.0	144.0	56.0	164.0	74.0	380.0
Dissolved oxygen	3.24	7.45	2.75	8.42	2.92	7.78
Biological oxygen demand	35.64	48.60	16.20	29.16	16.20	42.12
Chemical oxygen demand	24.80	26.40	52.00	53.10	75.20	62.10
Total hardness	136.0	126.0	132.0	124.0	160.0	110.0
Calcium	19.23	26.45	20.84	22.44	27.25	40.08
Magnesium	124.27	109.88	119.80	110.32	143.39	85.58
Fluoride	0.203	0.201	0.245	0.268	0.203	0.204
Chloride	39.76	78.10	42.60	99.40	44.02	-
Alkalinity	120.0	175.0	110.0	230.0	105.0	230.0
Acidity	125.5	137.5	120.0	150.0	117.5	95.0
Free CO ₂	83.6	50.6	55.0	68.2	52.8	74.8

Table 1. (continue)

Parameter	Site IV		Site V		Site VI	
	*	**	*	**	*	**
Temperature, °C	34.4	34.6	34.6	34.5	34.5	35.2
pH value	6.49	6.52	6.40	6.69	7.21	7.31
Conductivity, μ Siemens/cm	0.549	0.528	1.930	1.960	1.960	1.980
Turbidity, NTU	2.76	2.82	3.52	3.66	2.64	2.78
Total solids	1902.0	210.0	2800.0	1624.0	2530.0	344.0
Total dissolved solids	472.0	184.0	1628.0	700.0	2344.0	324.0
Total suspended solids	1430.0	26.0	1172.0	924.0	186.0	20.0
Dissolved oxygen	5.67	5.99	9.72	5.02	6.80	6.32
Biological oxygen demand	48.60	51.84	119.88	77.76	87.48	55.08
Chemical oxygen demand	46.40	48.10	52.80	50.20	60.00	63.30
Total hardness	156.0	60.0	388.0	290.0	346.0	100.0
Calcium	40.88	21.64	177.95	66.53	88.17	40.88
Magnesium	131.09	46.81	279.57	249.46	292.27	75.09
Fluoride	0.207	0.227	0.252	0.262	1.120	1.210
Chloride	51.12	58.22	328.02	278.32	266.96	-
Alkalinity	180.0	205.0	630.0	790.0	460.6	210.0
Acidity	132.5	102.5	520.0	365.0	377.5	145.0
Free CO ₂	74.8	46.2	286.0	321.2	173.8	59.4

Table 1. (continue)

Parameter	Site VII		Site VIII		Site IX	
	*	**	*	**	*	**

Temperature, °C	34.4	36.3	34.3	33.9	34.8	34.6
pH value	7.61	7.01	7.49	7.02	7.00	7.11
Conductivity, μ Siemens/cm	0.592	0.521	2.050	2.110	0.414	0.424
Turbidity, NTU	2.08	2.02	3.12	3.16	2.44	2.34
Total solids	694.0	378.0	1406.0	1176.0	438.0	476.0
Total dissolved solids	482.0	270.0	1250.0	1092.0	390.0	344.0
Total suspended solids	212.0	108.0	156.0	84.0	48.0	132.0
Dissolved oxygen	3.08	7.61	3.40	5.67	4.54	6.97
Biological oxygen demand	9.72	51.84	29.16	113.40	16.20	51.84
Chemical oxygen demand	60.00	72.10	18.40	20.10	76.80	60.80
Total hardness	156.0	106.0	352.0	296.0	116.0	128.0
Calcium	35.27	48.09	141.08	76.15	82.00	29.65
Magnesium	134.51	76.69	266.04	249.60	95.96	109.92
Fluoride	0.234	0.244	0.210	0.231	0.184	0.189
Chloride	88.04	133.48	268.38	261.28	63.99	83.78
Alkalinity	205.0	210.0	445.0	585.0	155.0	215.0
Acidity	135.0	167.5	420.0	405.0	127.5	120.0
Free CO ₂	92.4	103.4	242.0	176.0	68.2	90.2

Table 1. (continue)

Parameter	Site X		Site XI		Site XII		W.H.O. standard
	*	**	*	**	*	**	
Temperature, °C	34.4	33.2	34.6	34.6	34.5	34.2	-
pH value	7.09	7.04	6.88	6.89	6.66	6.92	7.0-8.5(8.0)
Conductivity, μ Siemens/cm	0.402	0.401	0.551	0.562	0.388	0.399	0.300
Turbidity, NTU	2.60	2.62	2.12	2.13	2.32	2.44	5.00
Total solids	104.0	354.0	692.0	428.0	394.0	386.0	500.0
Total dissolved solids	66.0	136.0	628.0	332.0	384.0	252.0	500.0
Total suspended solids	38.0	218.0	64.0	96.0	10.0	134.0	-
Dissolved oxygen	5.02	7.29	3.56	8.59	3.89	7.45	5.00
Biological oxygen demand	6.48	68.04	12.96	100.44	29.16	48.60	6.00
Chemical oxygen demand	56.00	50.20	82.40	90.60	48.80	42.20	10.00
Total hardness	124.0	116.0	154.0	94.0	138.0	90.0	100.00
Calcium	35.27	31.26	24.04	42.48	39.27	25.65	100.00
Magnesium	102.51	96.95	139.34	68.11	114.06	74.37	30.00
Fluoride	0.210	0.230	0.169	0.177	0.164	0.179	1.00
Chloride	31.24	79.52	46.86	69.58	31.24	55.38	200
Alkalinity	155.0	230.0	175.0	190.0	140.0	190.0	100.0
Acidity	135.0	130.0	142.5	82.5	122.5	92.5	-
Free CO ₂	77.0	118.8	50.6	70.4	35.2	50.6	10.0

* Premonsoon period; ** After onset of monsoon

(IX) Downstream Barbalan-This is Ran Ganga river water sample collected at a distance of about 50 m after the mixing up of Barbalan nullah with Ran Ganga river water.

No relevant activity of our concern is noticed during the course of study.

(X) Moradabad-Bareilly Railway Bridge-This is river water collected at Moradabad-Bareilly

railway bridge. It is about 3 km South to Kali ji Temple. Fishing and cattle bathing are regular activities at this site.

(XI) Moradabad-Bareilly Roadways Bridge-This is river water collected at Moradabad-Bareilly roadways bridge which is about 400 m away from site no. X. Some agricultural fields are at the left bank of the river.

(XII) Lucknow-Delhi Bypass Bridge-This is Ram Ganga river water sample at Lucknow-Delhi bypass bridge which is about 1.5 km away from roadways bridge. Agricultural activities are also noticed at the left bank of the river. This is the site from where the Ram Ganga river leaves the Moradabad city. This site is selected to assess the river water quality at the time of leaving the Moradabad city.

The map of sampling sites can be viewed in figure 1. The purpose of estimating physico-chemical parameters and comparing these with the W.H.O. water quality standards is to assess the Ram Ganga river water quality at Moradabad. To assess the pollution potential of effluents and different kinds of human activities, the river water quality is also assessed after the mixing up of effluents. The present study is also aimed to study the variation or river water quality after the onset of monsoon.

RESULT AND DISCUSSION

Site-wise values of water quality physico-chemical parameters with their W.H.O. standards for pre-monsoon period and after the onset of monsoon for Site no. I to Site no. VI are presented in table 1. For Site no. VII to Site no. XII values of water quality parameters with their W.H.O. standards for both the periods are also listed in table 1. Site-wise and parameter-wise seasonal variations are presented graphically in figures 2 to 19. A critical analysis of the data presented in table 1 and the figures showing seasonal variations reveals many interesting features regarding the status of Ram Ganga river water pollution at 12 different sampling sites at Moradabad during the course of study for pre-monsoon period as well as after the

onset of monsoon.

The river is found to be alkaline at almost all the river water sites with high values of pH and alkalinity. The conductivity of river water is in the moderate range although it is higher than the desirable limit prescribed by W.H.O. The range of turbidity for pre-monsoon period is 2.08-2.84 NTU and after the onset of monsoon it is 2.02-2.83 NTU. Therefore, it may be said that the river water turbidity is well within the prescribed limits. The amount of total solids in river water is in the moderate range except at a few sites with higher values for a specific season. The river water is found to be deficient in dissolved oxygen for pre-monsoon period at almost all the sites. In general, the amount of dissolved oxygen is increased to a large extent after the onset of monsoon at almost all the sites.

In the present study, appreciably higher values of biological demand and chemical oxygen demand are noticed for both the periods. This is suggestive of presence of high amount of organic and chemical pollutants in river water which is very alarming. River water is found to be unfit with reference to its hardness values for pre-monsoon period as well as after the onset of monsoon at all the sampling sites. The amount of magnesium in river water as compared to amount of calcium is higher and it is suggestive of that the hardness of river water is mainly due to the salts of magnesium. The river water is deficient of calcium and fluoride at almost all the sites. The river water is enriched with fluoride only at Site no. VI for both the periods. The chloride contents in river water is found to be within the prescribed desirable limit. A very high amount of free CO₂ is observed in river water invariably at all the sites during the course of study. There is no prescribed limit of acidity in water but a low amount is desirable which is not found in Ram Ganga river water at Moradabad.

The effluents collected at Site no. V and Site no. VIII are leaving their usual and expected effects in increasing the river water contamination with reference to almost all

the physico-chemical parameters studied during the course of study. The river water quality shows some improvement after the onset of monsoon with reference to water quality parameters studied in the catchment area of our study.

CONCLUSION

On the basis of above exhaustive discussion, it may be concluded that the Ram Ganga river water is highly contaminated at Moradabad for pre-monsoon period as well as after the onset of monsoon with reference to almost all the water quality physico-chemical parameters studied. The river water is unfit for consumption for living beings. It is also not suitable for domestic and industrial purposes. Supplementary doses of calcium and fluoride must be administered to the people dependent on this river water as the water is highly deficient of calcium and fluoride. The effluent samples carrying the mixed discharge of industries and nearby locality are increasing the level of 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 Ram Ganga river at Moradabad. Onset of monsoon tries to improve the river water quality to some extent during the course of study in the catchment area of our concern. Some strict and effective measures are urgently required to check the level of contamination of Ram Ganga river water to protect the aquatic environment of Ram

Ganga river at Moradabad.

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