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PHYSICO-CHEMICAL INVESTIGATION ON THE POLLUTION POTENTIAL OF RIVER GANGA WATER AT MIRZAPUR, UTTAR PRADESH (INDIA)

KSHAMA SINGH*

Declaration

The Declaration of the author for publication of Research Paper in The Indian Journal of Research Anvikshiki ISSN 0973-9777 Bi-monthly International Journal of all Research: I, *Kshama Singh* the author of the research paper entitled PHYSICO-CHEMICAL INVESTIGATION ON THE POLLUTION POTENTIAL OF RIVER GANGA WATER AT MIRZAPUR, UTTAR PRADESH (INDIA) declare that , I take the responsibility of the content and material of my paper as I myself have written it and also have read the manuscript of my paper carefully. Also, I hereby give my consent to publish my paper in Anvikshiki journal , This research paper is my original work and no part of it or it's similar version is published or has been sent for publication anywhere else. I authorise the Editorial Board of the Journal to modify and edit the manuscript. I also give my consent to the Editor of Anvikshiki Journal to own the copyright of my research paper.

Abstract

In present study water of River Ganga at Mirzapur was studied for pollution by determining various water quality parameters for all three seasons viz, winter, summer, and rainy seasons. The River is being polluted by severe domestic and industrial pollution at Emilia Ghat, Kacheri Ghat, Oliar Ghat, Pakka Ghat, Naar Ghat and Chaubae Ghat. The pH ranges from 7.3 to 8.0.The organic pollution is high as indicated by Dissolved oxygen (6.6 to8.5mg/l) and BOD (5.2 to 6.0mg/l). Heavy metals concentration was found above the permissible limit, As conc. is maximum at all six sites. To monitor the water quality samples from six sites were collected monthly. In this paper the results of one year study are presented.

Key Words: River pollution, Water quality parameters, Statistical Analysis

Introduction

Fresh water is finite resource, essential for agriculture, industry and even human existence, without fresh water of adequate quantity and quality, sustainable development will not be possible *(Mahananda, 2010)* .The surface water and groundwater resources of the country play a major role in agriculture, hydropower generation, livestock production, industrial activities, forestry, fisheries, navigation, recreational activities, etc. *[Rakesh Kumar, R.D.Singh & K.D.Sharma, 2005).* City sewage and industrial wastewater containing many toxic com pounds are dumped in the river. Some of the pollutants flow away with the water current and some are deposited slowly in the river bed through out the year. *(R.K.*

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Hansh, 1999). Today, over 29 cities, 70 towns, and thousands of villages extend along the Ganga banks. Nearly all of their sewage - over 1.3 billion liters per day - goes directly into the river, along with thousands of animal carcasses, mainly cattle *(Richa Khare, 2011).* Untreated wastewater may contain different range of pathogens including bacteria, parasites, and viruses, toxic chemicals such as heavy metals and organic chemicals from agriculture, industrial and domestic sources *(Andrew et al., 1997; Drechsel and Evans, 2010).*The drinking water quality in Aligarh city has been deteriorating in recent years mainly due to the high growth of population, unplanned growth of cities, mixed land use patterns, no proper sewage system, and poor disposal of the wastewater both from household as well as industrial activities. *(Rahman, 2003).* Tiwari, 2004 studied the pollution potential of river Pandu contaminated heavily by the discharge of various industries. Untreated sewage discharge not only damage for aquatic life but also hazardous to human health used for drinking purpose in the downstream areas of the river.

The Ganga basin covers 861,404 km2, which is approximately 26 percent of the land area of India. There are 52 cities, 48 towns and thousands of villages located in the basin, where about half a billion people live, and this population is expected to double by 2030. It accounts for about 31.6 percent of India's annual utilizable water resources, providing water for agriculture, aquaculture, hydro-power generation, industry, and water supply for several settlements comprising 45 percent of the country's population. In recent times, increasing human and industrial activities along its banks have polluted the sacred river. This is a matter of concern for all of us because her present degenerated state represents such pathetic state.

For the study of pollution status of River certain pollution parameters such as transparency, electrical conductivity, turbidity, total suspended solids, dissolved oxygen, nitrite-nitrogen, phosphates, ammonia, sulphide, BOD and COD were taken) *(Verma ,2010).*The Ganga plain of Jaimau (Kanpur), and Unnao is being polluted because of chemical pollution in soil due to leather processing clusters of tanneries industries along the bank of river Ganga and its bed sediments, besides other industries *(S. Srinivasa Gowd,2009)* . It was *Chandra (1981)* who conducted studies on the pollution status of river Ganga at Allahabad, pointed out that industries manufacturing nitrogenous fertilizers have significant role in polluting the river water. Currently there is a growing awareness of the impact of sewage contamination on groundwater, rivers and lakes; wastewater treatment is now receiving greater attention from the World Bank and government regulatory bodies.*(G.D.Rose,1999)*

The physico- chemical means are useful in detecting effects of pollution on the water quality but changes in the conditions of water are reflected in the biotic community structure including species pattern, distribution and diversity.

Materials and Method

Study area : The study area, is in Nagar block of Mirzapur district of Uttar Pradesh, India bounded by longitudes 82 ^{0}25' to 82 ^{0} 41'30"E and latitudes 25 ^{0}00' to 25 ^{0}14'N. The total geographical area is 255.7 sq.km surrounded by low lying hills. The district has been mentioned in the writings of Tieffenthaler during 1760s. Today, Mirzapur holds on to the legacy of a commercial trading city and the famous brass and carpet manufacturing units that have placed the city, on the global map. Here in the city 15 nalas are present out of which only six are tapped and treated at the only sewerage system present in lower and eastern part of city rest all dispose the waste water in illegal manner into river water.

Mid : stream surface water samples were collected from six sampling sites. The sample were collected in wide mouthered polythene bottles and stored in ice-box for further analysis after determining the temperature, pH and electrical conductivity. The samples were analyzed for following physico-

chemical and biological parameters viz, Temperature, pH, Total solids, Electrical conductivity, Turbidity, Transparency, Acidity, Alkalinity, Hardness, Dissolved oxygen, and Biological oxygen demand &Chemical oxygen demand. Six sites selected for the study of River Ganga Water :

- Site1-Emilia Ghat (EG)
- Site2-Chaubae Ghat (CG)
- Site3-Naar Ghat (NG)
- Site4-Pakka Ghat (PG)
- Site5-Oliar Ghat (OG)
- Site6-Kacheri Ghat (KG)

Result and discussion

Temperature : Temperature was recorded to ±0.1°C accuracy using a mercury thermometer, immediately after collecting the water samples from different sites. Table 1 shows average winter, summer and rainy season temperatures of the river water, Which vary from.21.7°C to 19.7°C, 35.0 °C to 24.6°C and 31.8°C to 28.5°C respectively. The variation is mainly related with the temperature of the atmosphere and weather conditions. Higher temperature during summers was due to greater heating.

Temperature bears a negative correlation with pH(r = - 0.804 in winter; r = - 0.317 in summer; .r = - 0.899($p<0.05$) in rainy season , Total solids(r = - 0.904 ($p<0.05$) in winter ; r = - 0.651 in rainy , alkalinity(r = - 0.523 in summer ; r = - 0.344 in rainy , Total hardness(r = - 0.748 in winter , turbidity (r = - 0.162 in winter ; r = - 0.286 in summer ; r = - 0.267 in rainy season , transparency (r = - 0.735 in winter ; r = - 0.410 in summer ; r = - 0.356 in rainy season , chloride (r = - 0.919 ($p<0.01$) in winter ; r = - 0.008 in summer ; r = - 0.043 in rainy season , DO (r = - 0.150 in winter ; r = - 0.895 ($p<0.05$) in summer ; r = - 0.802 in rainy season , BOD (r = - 0.194 in winter ; r = - 0.266 in summer ; r = - 0.257 in rainy season , COD (r = - 0.481 in winter and r = - 0.517 in rainy season.

pH : The pH ranges from 7.5 to 7.7 in winter, 7.5 to 8.0 in summer, 7.3 to 7.5 in rainy season Collected. In general the pH value is higher in winters than other seasons. The variation can be due to the exposure of river water to atmosphere, biological activities and temperature changes.

pH has a negative correlation with acidity(r – 0.459 in winter ; r = - 0.335 in summer ; r = - 0.697 in rainy season , alkalinity(r = - 0.763 in winter , total solids(r = - 0.832 ($p<0.05$) in winter ; r = - 0.586 in summer , chloride (r = - 0.939 ($p<0.0.1$) in winter ; r = - 0.068 in summer , total hardness (r = - 0.572 in summer ; r = - 0.045 in rainy season , electrical conductance(r = - 0 .680 in summer ; r = - 0 038 in rainy season , DO (r = - 0.054 in winter , BOD (r = - 0.236 in winter ; r = 0.853 ($p<0.0.5$) in summer season .

Acidity: Acidity of water is its quantitative capacity to react with a strong base to a designated pH. All water having a pH lowers than 8.5 contains acidity. In the present investigation monitored values varies from 1.2 to 1.8 mg/l in winter, 0.8 to1.5 mg/l in summer, 2.1 to 3.2 mg/l in rainy seasons. In all site areas water sample is acidic. Water which has a pH value of more than 9 or less than 4.5 becomes unsuitable for most life forms and also for most other uses.

Acidity bears negative correlation with alkalinity (r = - 0.080 in winter ; r = - 0.864 ($p<0.05$) in summer ; r = - 0.042 in rainy season , Total solids (r = - 0.184 in winter ; r = - 0.838 ($p<0.05$) in rainy season , electrical conductance (r = - 0.658 in winter season , turbidity (r = - 0.443 in winter ; r = - 0.713 in summer ; r = - 0.682 in rainy season , transparency (r = - 0.156 in winter ; r = - 0.500 in summer ; r = - 0.299 in rainy season , chloride (r = - 0.503 in winter ; r = - 0.947 in summer season , DO (r =

- 0.035 in summer ; r = - 0.954 ($p<0.01$) in rainy season , COD (r = - 0.611 in winter ; r = - 0.226 in summer ; r = - 0.211 in rainy season.

Alkalinity: It is the quantitative capacity of water sample to neutralize a strong acid to a designated pH [5.8].In the present study observed value ranges from 127 to 132 mg/l in winter, 171 to 181 mg/l in summer and 132 to 190 mg/l in rainy seasons. Higher values (Table 1) can be attributed to the industrial effluents discharged upstream, as in summer and winter carpet and brass industry runs at the highest capacity. Increase dilution may be responsible for relative lower values in rainy seasons.

Alkalinity has a negative correlation with total solids (r = - 0.755 in winter ; r = - 0.455 in summer season , total hardness (r = - 0.729 in winter ; r = - 0.738 in summer season , electrical conductance (r = - 0.151 in winter ; r = - 0.737 in summer season , turbidity (r = - 0.535 in winter ; r = 0.813 ($p<0.05$) in summer ; r = - 0.613 in rainy season , transparency (r = - 0.458 in in winter ; r = - 0.478 in rainy season , chloride (r = - 0.599 in winter ; r = - 0.734 in summer ; r = - 0.850 ($p<0.05$) in rainy season , DO (r = - 0.194 in winter , BOD (r = - 0.114 in rainy season ,COD(r = - 0.409 in winter season.

Electrical Conductivity (EC): In present observations the electrical conductivity varies from site 1 to 6. 478 to 503 μmho/cm in winter, 468 to 497 μmho/cm in summer and 428 to 468 μmho/cm in rainy season. High electrical conductivity indicates a larger quantity of dissolved mineral salts, thereby making it sour and unsuitable for drinking. Similar observations were also reported by *Srivastava* and *Sinha* at Phaphamau, Allahabad.

Electrical conductance bears a negative correlation with turbidity (r = - 0.516 in summer ; r = - 0.437 in rainy season , transparency (r = - 0.641 in summer ; r = - 0.349 in rainy season ,DO (r = - 0.572 in winter ; r = - 0.745 in summer ; r = - 0.607 in rainy season , BOD (r = - 0.455 in winter ; r = - 0.327 in summer season , COD (r = - 0.162 in summer ; r =- 0.551 in rainy season.

Turbidity: The drinking water limit for turbidity as Ganga at Phaphamau (Allahabad). Prescribed by World Health Organization is 2.5 NTU. The turbidity values in samples varied from 26 to 30 NTU .in winter, 41 to 53 NTU in summer and 52 to 76 NTU in rainy season. The probability of presence of pathogenic organisms is also increased in turbid water.

Turbidity has a negative correlation with DO (r = - 0.123 in winter season, BOD (r = - 0.455 in winter season , COD (r = - 0.0 182 in rainy season , chloride (r = - 0.468 in summer ; r = - 0.861 ($p<0.05$) in rainy season. Turbidity also has a negative correlation with temperature , acidity , alkalinity , DO , BOD in winter ,turbidity has a positive correlation with alkalinity and negative correlation with temperature , acidity , total solids , total hardness , and electrical conductance in summer , temperature, acidity , alkalinity , total hardness , electrical conductance , chloride , and COD bears negative correlation with turbidity in rainy season .

Total Hardness (TH): In present study the observed values ranges from 131 to196 mg/l in winter 181to200 mg/l in summer and 176 to 196 mg/l in rainy seasons. It forms heat insulating scales in the boilers reducing their efficiency. Therefore the water of River Ganga is unsuitable for industrial uses. These observations are in agreement with those obtained by *pandey and Sharma.*

Total hardness bears a negative correlation with electrical conductance (r = - 0.485 in winter season , turbidity (r = - 0.880($p<0.05$) in summer ; r = - 0.423 in rainy season, transparency (r = - 0.535 in summer ; r = - 0.863 ($p<0.05$) in rainy season , DO (r = - 0.292 in summer ; r = - 0.249 in rainy season , BOD (r = - 0.048 in winter ; r = - 0.507 in summer season , COD (r = - 0.162 in summer ; r = - 0.454 in rainy season.

Total Solids (TS): The total solids determined in these studies ranged between 297 to 340 mg/l in winter, 365 to 385 mg/l in summer 396 to 448 mg/l in rainy season. Total solids analysis has great implications in the control of biological and physical waste water treatment processes. The largest

amount of total solids adds to the highest turbidity and electrical conductivity. Similar results were also obtained by *Bahadur and Chandra.*

Total solids has a negative correlation with turbidity(r = - 0.835 ($p<0.05$) in summer season , total hardness (r = 0.885 ($p<0.05$) in winter ; r = - 0.025 in rainy season , electrical conductance (r = - 0. 139 in winter ; r = - 0.567 in rainy season , transparency (r = - 0.825($p<0.05$) in summer ; r = - 0.133 in rainy season , chloride (r = - 0.900 ($p<0.05$) in winter ; r = - 0.032 in rainy season , DO (r = - 0.290 in summer ; r = - 0.947 ($p<0.01$) in rainy , BOD (r = - 0.048 in winter ; r = - 0.743 in summer ; r = - 0.490 in rainy season , COD (r = - 0.177 in summer season.

Transparency: Secchi disc transparency (SDT) and light penetration in these sites provided valuable information about the condition of the water, e.g. Algal growth, organic pollution, erosion etc. All the sites had very high turbidity. The present observation reported that transparency in winters, summers and rainy seasons are 18.1 to 18.9cm, 23.4 to 25.9 cm and 27.7 to 28.5 cm respectively. When SDT is least turbidity is high. Highest turbidity is observed in water of site 1 as it has least value of SDT.

Transparency bears a negative correlation with chloride (r = - 0.212 in summer ; r = - 0.260 in rainy season ,COD (r = - 0.001 in winter season) , transparency also bears negative correlation with temperature , acidity , alkalinity and COD in winter, negative correlation with temperature , acidity , total solids , total hardness , electrical conductance and chloride in summer ,negative correlation with temperature , acidity , alkalinity, total solids , total hardness , electrical conductance and chloride in rainy season .

Chloride : This is the most common inorganic anion present in water. Man and animals excrete high quantities of chloride, therefore it includes sewage contamination. In present study the value ranges from 13.1 to 16.1 mg/l in winter, 12.6 to 17.9 mg/l in summer and 11.7 to 14.8 mg/l in rainy seasons. The lowest relatively values in rainy seasons can be attributed to the increase dilution by rains water.

Chloride bears a negative correlation with DO (r = - 0.057 in winter ; r = - 0.124 in rainy season ,BOD (r = - 0.034 in winter season .Chloride bears a significant positive correlation with total solids and pH, negative correlation with temperature , acidity , alkalinity , turbidity , transparency ,total solids , DO, BOD and COD in all three seasons.

Dissolved Oxygen (DO): The DO varies from 7.4 to 8.0 mg/l in winter, 6.7 to8.5 mg/l in summers and 6.6 to 7.3 mg/l in rainy seasons for sites 1 to 6.These values indicate high organic pollution. The fish needs 5mg/l dissolved oxygen therefore the water of River Ganga can be used for fish culture. These results were also agreed with *Bhargawa.*

DO has a negative correlation with BOD (r = - 0.287 in rainy season , COD (r = - 0.267 in winter ; r = - 0.381 in rainy season. DO also have a negative correlation with temperature, pH, acidity, alkalinity, electrical conductance, turbidity, total solids, total hardness and chloride.

Biochemical Oxygen Demand (BOD): The aim of B.O.D. test is to determine the amount of bio-chemically oxidisable carbonaceous matter. The biochemical oxygen demand observations for the three seasons i.e. winter, summer and rainy season vary from 5.2 to 5.7 mg/l, 4.7 to 6.0 mg/l and 5.2 to 5.8 mg/l, respectively. Like D.O. it also indicates presence of organic pollution which can be attributed to the non-point sources scattered over the entire study zone.

BOD has a negative correlation with COD(r = -0. 377 in winter season).Temperature also has a negative correlation with temperature , pH, total solids , total hardness , Electrical conductance , turbidity , chloride , alkalinity ,and DO.

Chemical Oxygen Demand (COD): Chemical oxygen Demand gives valuable information about the pollution potential of industrial effluents and domestic sewage .In present study the value ranges from 28.8 to 33.2 mg/l in winter, 28.7 to 31.6 mg/l in summer and 32.8 to 40.0 mg/l in rainy season.

The highest values of COD indicate that most of the pollution in study zone in caused by industrial units like carpet industry, metal industry and automobile industries upstream etc.

COD has a negative correlation with temperature, acidity, alkalinity, transparency, DO and BOD in winter, in summer acidity total solids, total hardness, chloride, and DO has a negative correlation with COD, temperature, acidity, total hardness, electrical conductance, turbidity has a negative correlation with Chemical Oxygen Demand.

Heavy metal analysis: Lead (Pb) Maximum Pb concentration at control site 0.29 ppm in the month of May (summer) and minimum concentration is 0.14 ppm in January (winter).Average concentration of Pb throughout the study period (2010- 2011) is 0.19 ppm. Other than concentration of Pb were recorded at site 2 in the month of November (0.35 ppm) in winter season and minimum concentration in September of rainy season (0.1ppm)

Pb has negative correlation with Cd (r = - 0.461at control site ; r = - 0.556 at site 3 ; r = - 0.205 at site 4 , As (r = - 0.169 at control site ; r = - 0.463 at site 4, Hg (r = - 0.008 at site 5 ; r = - 0.228 at site 4 .

Cadmium (Cd): Maximum concentrations of cadmium were recorded 0.08 ppm at control site in winters (November) and minimum concentration (0.04 ppm) in June &July of the summer and rainy season at control site. Maximum concentration of Cd has been recorded at downstream site in winter (0.09ppm) and minimum concentration of Cd has been recorded at site 4 (0.0.1 ppm) other than control site.

Cd bears negative correlation with Hg(r = - 0.109 at control site ; r = - 0.323 at site 1 ; r = - 0.518 at site 2 ; r = - 0.228 at site 3 ; r = - 0.444 at site 4 ; r = - 0.130 at downstream site ,and a significant ($p < 0.05$) positive correlation is found with As (r = 0.627 at site 5.

*Mercury (Hg) :*At control site Hg concentration was found maximum (0.024 ppm) in the month of February and May & minimum in the month of October (0.01 ppm). Other than control site, maximum concentration (0.35ppm) at site 4 in the month of December of winter season and minimum concentration (0.026 ppm) at site 5 in the month of January in winter season. Average concentration throughout the year is 0.30 ppm.

Hg bears negative correlation with As (r = - 0.052 at control site; r = - 0.356 at site 1; r = - 0.169 at site 5, Hg also have negative correlation with Cd (r = - 0.130 at downstream site. Mercury also has negative correlation with Pb.

Arsenic (As) : Maximum concentration was recorded (1.8ppm) at control site in the month of January of winter season and minimum concentration (1.2 ppm) in December (winter).Average concentration through out the year at control site is 1.5 ppm respectively. Other than control site maximum concentration has been recorded (0.33 ppm) in the month of May at downstream site and minimum concentration (0.2ppm) at site 4 in rainy season. Average concentration at downstream site was 0.98 ppm.

Arsenic also has a negative correlation with mercury and lead and significant positive correlation with cadmium.

T A B L E 1, 2, 3 *Physico-chemical parameters of River Ganga at Mirzapur showing seasonal variations (Average value)*

Sampling Sites	Winter												
	Temp	pH	Acid	Alka	TS	TH	EC	Turb.	Trans.	Chlo	DO	BOD	COD
EG	19.7	7.7	1.8	127	340	196	483	29	18.9	16.0	8.0	5.4	32.3
CG	20.1	7.7	1.2	130	322	140	503	30	18.9	16.1	7.4	5.4	33.2
PG	20.7	7.5	1.6	132	315	156	478	27	18.0	14.4	7.7	5.5	32.5
NG	20.5	7.5	1.7	131	310	146	482	26	18.7	14.0	7.6	5.5	28.8

OG	20.9	7.5	1.8	132	297	134	487	28	18.7	13.7	8.0	5.7	29.0
KG	21.6	7.5	1.7	130	298	131	496	29	18.1	13.1	7.6	5.2	30.5
Sampling Sites						Summer							
	Temp	pH	Acid.	Alka.	TS	TH	EC	Turb.	Trans.	Chlo.	DO	BOD	COD
EG	35.0	7.5	1.1	171	385	200	497	41	23.5	14.7	6.7	5.1	31.2
CG	25.0	7.6	1.5	171	382	196	491	39	23.6	17.9	8.3	5.6	28.7
PG	25.3	7.5	0.8	181	386	190	482	44	23.4	12.6	7.8	4.7	28.7
NG	25.2	7.8	0.9	178	384	200	468	44	25.0	14.0	8.5	5.5	29.8
OG	24.6	7.8	0.8	181	365	181	480	53	25.9	14.1	8.1	5.9	29.8
KG	27.7	8.0	0.9	181	376	182	477	51	24.7	14.4	8.2	6.0	31.6
Sampling Sites						Rainy							
	Temp.	pH	Acid.	Alka.	TS	TH	EC	Turb.	Trans.	Chlo.	DO	BOD	COD
EG	31.8	7.3	3.1	132	396	186	464	72	28.2	11.8	6.6	5.8	33.7
CG	30.9	7.4	3.2	190	417	196	468	52	27.8	14.8	6.8	5.5	36.5
PG	30.9	7.3	2.9	147	421	190	431	67	28.0	11.7	6.9	5.3	39.1
NG	30.4	7.4	2.4	151	432	176	428	69	28.5	12.6	7.2	5.2	40.0
OG	28.5	7.5	2.1	164	434	187	446	73	28.4	12.5	7.3	5.9	39.7
KG	30.4	7.4	2.2	166	448	192	443	76	27.7	12.1	7.3	5.2	32.8

T A B L E 4, 5, 6 *Statistical analysis of heavy metals in Ganga River water in Mirzapur*

S. No.	Metals	Site 1			Site 2		
		Range(ppm)	Average	STDEV	Range(ppm)	Average	STDEV
1.	As	1.2 -1.8	1.533333	0.184089	2.1- 2.8	2.441667	0.217786
2.	Pb	0.14 – 0.29	0.2075	0.043421	0.16-0.35	0.245833	0.068125
3.	Cd	0.04 -0.08	0.0575	0.011637	0.02-0.09	0.060833	0.020599
4.	Hg	0.01 -0.024	0.020083	0.011637	0.029-0.034	0.001567	0.008436
S. No.	Metals	Site 3			Site 4		
		Range(ppm)	Average	STDEV	Range(ppm)	Average	STDEV
1.	As	2.2-2.8	2.508333	0.170579	2.0-2.9	2.466667	0.311805
2.	Pb	0.1-0.21	0.1525	0.040026	0.14-0.21	0.1625	0.030585
3.	Cd	0.02-0.07	0.048333	0.014044	0.02-0.07	0.0425	0.018314
4.	Hg	0.27-0.36	0.303333	0.025604	0.27-0.35	0.305833	0.023614
S.No.	Metals	Site 5			Site 6		
		Range(ppm)	Average	STDEV	Range(ppm)	Average	STDEV
1.	As	2.1-3.2	2.791667	0.327766	0.28-0.33	0.986667	1.181943
2.	Pb	0.13-0.28	0.203333	0.042098	0.16-0.23	0.2	0.019579
3.	Cd	0.04-0.08	0.065833	0.013202	0.04-0.09	0.069167	0.016051
4.	Hg	0.26-0.34	0.03025	0.002521	0.28-0.34	0.31	0.02

Conclusion

Due to high Alkalinity River water is not suitable for agriculture. The highest values in winter may be attributed to increase industrial discharge from carpet industries & metal industries. C.O.D. is much higher than B.O.D.; it indicates that most of the pollution in river Ganga, in the study zone, is caused by industrial discharge. The main sources of organic pollution are non-point sources like agricultural run-off, domestic run-off & cattle-dropping.

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