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Correlation Studies on the Seasonal Variations of Pollution Potential of River Kosi at Rampur (U.P.), India

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Abstract

Water of River Kosi in a stretch of 35 Kms at Rampur was studied for pollution by determining various water quality parameters, for all three seasons viz. winter, summer and rainy season. The river is subjected to severe domestic and industrial pollution at Kashipur (U.A). This polluted water is carried downstream to Rampur (U.P.). The pH range is 7.3 to 7.9. The organic pollution is mild as indicated by DO (6.2-7.5 mg/l) and BOD (5.0-6.0 mg/l). But the higher values of COD ranging between 25.0 mg/l to as high as 40.0 mg/l indicates industrial pollution. To monitor the water quality, samples from six stations were collected monthly. In this paper, the results of one year study are presented.

Key words: River pollution, Water quality, BOD, COD, DO, Correlation

Introduction

Water is a sustainable natural resource; however, the deteriorating water environments are causing serious problems for societies globally. Fresh water is necessary for healthy living (Wang 2021). River water is used for a variety of purposes such as drinking, bathing, irrigation etc. This natural resource is being polluted by disposal of sewage, industrial waste and human activities which affect quality of river water. Water pollution is an acute problem in all the major rivers of India and world over (Rajasekaran 2017) (Kumar 2021). In the wake of increasing urbanization and industrialization, the pollution potential of river Kosi is gaining momentum day by day. The river flows three kilometers, west of Rampur town. The survey of river revealed that villages and towns which fall in the way of river, dump waste water and toxic wastes in the river. This has caused serve pollution in the river to the extent that its water is no more potable and is posing threat to the survival of aquatic flora and fauna. The construction of dam at Lalpur aggravates the pollution situation.

It is, therefore, desirable to monitor the pollution level over the stretch between village Pranpur and Kishanpur (District Rampur) by collecting and analyzing the water samples from different places with a view to study the physical, chemical and biological characteristics and to investigate the factors responsible for causing pollution. The study can also help in formulating remedial measures.

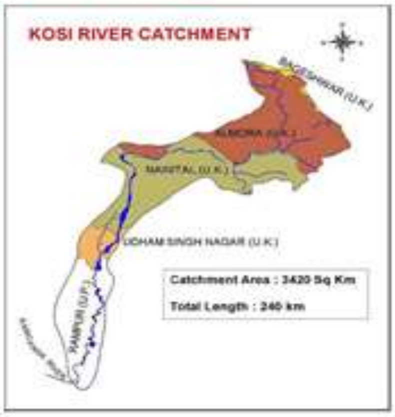
Study Area

The overall study period was divided into three seasons mainly Winter (Nov-Feb), Summer(Mar-June), and Rain(July-Oct). Water samples were collected at monthly intervals from following six sites:-

Sample Station I	:	River Kosi after village Pranpur.
Sample Station II	:	River Bhalla after village Baijana.
Sample Station III	:	River Kosi after joining River Bhalla.
Sample Station IV	:	River Kosi after road bridge (NH- 24) near village Masoorpur.
Sample Station V	:	River Rajera after village Chandpura khurd.

Sample Station VI : River Kosi after joining River Rajera near village Kishanpur.

Map of study area



Materials and Methods

Midstream surface water sample were collected for analysis from six sampling stations. The sample were collected in wide mouthed polythene bottles and stored in ice box for further analysis after determining temperature, pH and electrical conductivity. The samples were analysed for following physico-chemical and biological parameters viz., temperature, pH, total solids, electrical conductivity, turbidity (Nephelometric Method), hardness (EDTA Titrimetric Method), dissolved oxygen (Winkler Method with Azide Modification), biochemical oxygen demand (5 days incubation method), chemical oxygen demand (by dichromate titration method), alkalinity, chloride and MPN of F. coliforms (APHA, 1998; Trivedy & Goyal, 1986).

It is well known that no straightforward reasons can be given for deterioration of water quality, as it depends on several water quality parameters. There are strong correlations among different parameters and a cumulative effect of their mutual relationship affects the water quality. Correlation analysis is a useful statistical tool to determine the extent to which changes in the value of a parameter are associated with the changes in another parameter. Therefore, a systematic statistical study of correlation among the various quality parameters not only helps to assess the overall water quality but also indicates relative concentrations of various pollutants in water. This in turn provides vital information for implementation of rapid water quality management programmes. A large number of workers have undertaken statistical analysis and assessed the river water quality in different parts of the India (Singh 2020)

Results and Discussion

Results of physico chemical and biological analysis are given in table 1.

Correlation study results for three seasons viz. winter, summer and rain are given tables 2, 3 and 4.

Temperature

Temperature was recorded to ± 0.1°C accuracy using a mercury thermometer, immediately after collecting the sample. Table 1 shows average winter, summer and rainy season temperatures of the river water, which vary from 20.1°C to 18.8°C, 34.6°C to 33.4°C and 31.5°C to 30.5°C respectively.

The variation is mainly related with the temperature of atmosphere and weather conditions (Kamboj, 2019). Higher temperature during summer was due to greater heating (Pande & Sharma, 1998)

pH

The pH ranges from 7.7 to 7.9 in winter, 7.3 to 7.8 in summer and 7.3 to 7.8 in rainy season. In general the pH values are higher in winter. The variation can be due to the exposure of river water to atmosphere, biological activities and temperature changes (Bhargava, 1987) (Wang 2021).

Turbidity:

The drinking water limit for turbidity as prescribed by World Health Organization is 2.5 NTU. The turbidity values in samples varied from 25 to 39 NTU in winter, 34 to 43 NTU in summer and 73 to 81 NTU in rainy season. The water at station-1 is most turbid throughout the study period due to low discharge of water from Lalpur dam. The probability of presence of pathogenic organisms is also increased in turbid water (Farahbakhsh & Smith, 2002).

Total Solids

The total solids (TS) determined in these studies range between 325 to 426 mg/l in winter, 347 to 433 mg/l in summer 366 to 405 mg/l in rainy season. Total solids analysis has great implications in the control of biological and physical waste water treatment processes (Zhou & Smith, 2002). The larger amount of total solids adds to the higher turbidity and electrical conductivity similar results were also obtained by Bahadur & Chandra for river Ramganga at Bareilly (1996).

Electrical Conductivity

In present observations the electrical conductivity (EC) varies from station 1 to 6, 522 to 479 μmho/cm in winter, 525 to 485 μmho/cm in summer and 466 to 430 μmho/cm in rainy season as shown in table-1. High Electrical conductivity indicates a larger quantity of dissolved mineral salts, their by making it sour and unsuitable for drinking. (Sawyer et al., 1994). Similar observations were also made by Srivastava & Shina for river Ganga at Phaphamau (Allahabad).

Total Hardness

In present study the observed values range from 173 to 221 mg/l in winter 188 to 227 mg/L in summer and 184 to 220 mg/l in rainy season. Although hard water has no known ill effects on health but is unsuitable for domestic uses. It also forms heat-insulating scales in the boilers reducing their efficiency. Therefore is unsuitable for industrial uses. (Sawyer et al., 1994; Gupta et al., 2003). Therefore the water of river Kosi is not suitable for industrial purposes. These observations are in agreement with those of Pande & Sharma (1998) and Bahadur & Chandra (1996).

Dissolved Oxygen

In liquid wastes, dissolved oxygen is the factor which determines whether the biological changes are brought about by aerobic or anaerobic organism. It reflects the physical and biological processes prevailing in the water. The oxygen present in water can be dissolved from air or produced by photosynthetic organisms. The D.O. varies from 7.4 to 6.5 mg/l in winter, 7.2 to 6.4 mg/l in summer and 6.7 to 6.3 mg/l in rainy season for station 1 to 6. These values indicate relatively mild organic pollution. Game fish needs at least 5 mg/l dissolved oxygen therefore the water of river Kosi can be used for fish culture. These results also agree with those of Pande & Sharma (1998) and Singh (2020).

Biochemical Oxygen Demand

Types of micro-organism, pH, presence of toxins, some reduced mineral matter and nitrification process are the important factors influencing the B.O.D. tests. The aim of B.O.D. test is 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 5.0 to 6.0 mg/l 5.3 to 5.7 mg/l and 5.8 to 6.0 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 (Singh 2020).

Chemical Oxygen Demand

Chemical oxygen is the amount of oxygen consumed during the chemical oxidation of organic matter using a strong oxidizing agents like acidified potassium dichromate. This gives valuable information about the pollution potential of industrial effluents and domestic sewage (APHA, 1998). In present study the values vary from 25 to 40 mg/l in winter 27 to 36 mg/l in summer and 30 to 37 mg/l in rainy season. The higher values of COD indicates that most of the pollution in study zone in caused by industrial effluents discharged by industrial units like pulp and paper mill, sugar factory etc. upstream (Sawyer et al., 1994). Similar results were also reported by Pande & Sharma (1998) and Adedokun (2014).

Alkalinity

It is the quantitative capacity of water sample to neutralize a strong acid to a designated pH (APHA, 1998). In the present study observed values range from 157 to 200 mg/l in winter 131 to 163 mg/l in summer and 91 to 130 mg/l in rainy season. Higher values can be attributed to the industrial effluents discharged upstream. Increased dilution may be responsible for relative lower values in rainy seasons (Bahadur & Chandra, 1996).

Chloride:

This is the most common in organic anion present in water. Man and animals excrete high quantities of chloride, therefore, it indicate sewage contamination. In present study the value range from 13.6 to 25.3 mg/l in winter, 11.8 to 21 mg/l in summer and 12.6 to 20 mg/l in rainy season. The relatively lower values in rainy season can be attributed to the increased dilution by rains water. The results agree with those obtained by Pande & Sharma for Ramganga at Moradabad (1998).

MPN of Coliform

The coliform group of bacteria has been the principal indicator for the suitability of water for domestic use (APHA 1998). In the present study, MPN count is highest at station 1 in all three seasons. In general the values are maximum in rainy season and minimum in winter season. The relative higher values in rainy season can be attributed to the favorable conditions of temperature and nutrients (Pande & Sharma 1998).

CONCLUSION:

In this study many physicochemical parameters and its characteristic behavior of a river water samples in different seasons and different sampling stations, the water quality of river is deteriorated due to direct discharge of industrial effluents directly in to river and various human activities along the banks of the river. Water quality standards WHO (2006) and BIS (1991) shows water quality of none of the samples is not suitable for domestic purposes without prior treatment. None of the samples are potable for drinking purpose. These contain high amount of C.O.D., total solids values as given in table 1. In the light of correlation study, we can clearly observe that all the parameters are more or less correlated with each other. As seen in correlation tables 2, 3 and 4 Conductivity shows strong correlation with total solids in all seasons. It suggests that if any one parameter increases the other also show increasing trend.

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Table 1. Mean Values of Physico-Chemical and Biological parameters of River Kosi at Rampur showing seasonal variations

W: Winter (Nov. – Feb.) S: Summer (Mar.-Jun.) R: Rainy (Jul.-Oct.)

	Temperature			**pH**			**Total solids**			**Conductivity**		
	W	**S**	**R**	**W**	**S**	**R**	**W**	**S**	**R**	**W**	**S**	**R**
Station 1	19.9	33.4	31.5	7.9	7.8	7.45	426	433	405	522	525	466
Station 2	19.2	34.6	31.4	7.9	7.5	7.8	358	378	399	488	500	455
Station 3	18.8	34.3	31.5	7.8	7.6	7.3	368	381	385	495	506	441
Station 4	19.7	34	30.9	7.7	7.5	7.5	365	387	386	493	514	445
Station 5	20.1	33.5	30.7	7.9	7.4	7.6	325	351	366	461	482	421
Station 6	18.9	33.4	30.5	7.8	7.3	7.5	341	347	372	479	485	430
	Turbidity			**Hardness**			**Chloride**			**Alkalinity**		
	W	**S**	**R**	**W**	**S**	**R**	**W**	**S**	**R**	**W**	**S**	**R**
Station 1	39	43	81	221	227	220	23.5	20.1	20.0	200	163	130
Station 2	28	35	79	173	191	189	13.6	11.8	12.6	196	151	91
Station 3	31	38	77	208	199	208	20.5	18.7	18.7	198	160	115
Station 4	32	41	75	205	209	199	25.3	21.0	18.8	195	158	111
Station 5	25	34	73	189	188	184	21.4	19.0	18.1	157	131	91
Station 6	29	36	74	211	207	205	23.8	20.0	18.2	197	153	98
	D.O.			**B.O.D.**			**C.O.D.**			**MPN**		
	W	**S**	**R**	**W**	**S**	**R**	**W**	**S**	**R**	**W**	**S**	**R**
Station 1	7.4	7.2	6.7	5.8	5.4	5.8	38.0	36.0	37.0	206	237	290
Station 2	7.3	6.9	6.1	5.0	5.3	5.5	25.0	27.0	30.0	190	206	235
Station 3	7.5	7.0	6.8	5.8	5.3	5.9	34.0	34.7	35.0	136	141	186
Station 4	6.7	6.8	6.3	5.9	5.7	5.8	39.0	33.0	36.0	121	134	190
Station 5	6.6	6.6	6.2	6.0	5.5	5.9	36.0	32.8	33.5	115	126	179
Station 6	6.5	6.4	6.3	6.0	5.5	6.0	40.0	36.0	36.5	114	129	189

Table – 2: Correlation matrix for winter season

Winter	*Temp.*	*pH*	*T.S.*	*Cond.*	*Turbidity*	*Hardness*	*Chloride*	*Alkalinity*	*D.O.*	*B.O.D.*	*C.O.D.*	*MPN*
Temp.	1											
pH	0.285787	1										
T.S.	0.153128	0.116009	1									
Cond.	-0.00794	-0.01624	0.980941	1								
Turbidity	0.136718	-0.0686	0.967973	0.961302	1							
Hardness	-0.01777	-0.34495	0.563231	0.564647	0.730162	1						
Chloride	0.276437	-0.55781	0.169667	0.151336	0.394739	0.815033	1					
Alkalinity	-0.58498	-0.34141	0.614137	0.749511	0.641524	0.402271	0.010023	1				
D.O.	-0.23068	0.328634	0.671718	0.686949	0.507242	0.043999	-0.46311	0.487825	1			
B.O.D.	0.233834	-0.38865	-0.11578	-0.16301	0.088871	0.68716	0.899502	-0.29967	-0.53218	1		
C.O.D.	0.229931	-0.47492	0.09733	0.071684	0.325794	0.813512	0.983852	-0.03745	-0.52025	0.932506	1	
MPN	0.125246	0.579253	0.762414	0.724927	0.595012	-0.04305	-0.45137	0.434401	0.750211	-0.65141	-0.48626	1

Table – 3: Correlation matrix for summer season

	Temp.	*pH*	*T.S.*	*Cond.*	*Turbidity*	*Hardness*	*Chloride*	*Alkalinity*	*D.O.*	*B.O.D.*	*C.O.D.*	*MPN*
Temp.	1											
pH	0.075522	1										
T.S.	0.015127	0.958376	1									
Cond.	0.150224	0.887014	0.952864	1								
Turbidity	-0.19081	0.758838	0.862957	0.919645	1							
Hardness	-0.47465	0.608211	0.744265	0.730763	0.898442	1						
Chloride	-0.71266	0.054255	0.099617	0.163244	0.513759	0.55231	1					
Alkalinity	0.191147	0.599058	0.68142	0.79706	0.77836	0.72993	0.166831	1				
D.O.	0.318626	0.968407	0.909961	0.867173	0.654786	0.440385	-0.14263	0.586218	1			
B.O.D.	-0.4117	-0.34454	-0.16401	-0.0238	0.241807	0.199346	0.637157	-0.12613	-0.4384	1		
C.O.D.	-0.74144	0.160545	0.154161	0.145939	0.470546	0.633214	0.88394	0.304041	-0.05098	0.248994	1	
MPN	0.107603	0.751316	0.793253	0.635764	0.440641	0.474647	-0.39932	0.429479	0.748958	-0.49244	-0.20979	1

Table – 4: Correlation matrix for rainy season

	Temp.	*pH*	*T.S.*	*Cond.*	*Turbidity*	*Hardness*	*Chloride*	*Alkalinity*	*D.O.*	*B.O.D.*	*C.O.D.*	*MPN*
Temp.	1											
pH	-0.12959	1										
T.S.	0.83149	0.098027	1									
Cond.	0.784619	0.047777	0.993207	1								
Turbidity	0.877319	0.029214	0.9623	0.949452	1							
Hardness	0.400735	-0.69688	0.488607	0.556459	0.550763	1						
Chloride	-0.15473	-0.8344	-0.19706	-0.11002	-0.15448	0.61343	1					
Alkalinity	0.543618	-0.69865	0.572308	0.631771	0.587375	0.897771	0.67628	1				
D.O.	0.562374	-0.87018	0.320484	0.346324	0.43589	0.823565	0.646192	0.850388	1			
B.O.D.	-0.5497	-0.71448	-0.6772	-0.61137	-0.58394	0.302009	0.78768	0.17268	0.369482	1		
C.O.D.	-0.21547	-0.78462	-0.09737	0.007061	-0.08731	0.744282	0.927476	0.688512	0.584435	0.751412	1	
MPN	0.619279	0.137834	0.857474	0.876764	0.900674	0.539819	-0.02251	0.555639	0.280658	-0.4649	0.058549	1