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Research Article

COMPARATIVE ANALYSIS OF PHYSICO-CHEMICAL PARAMETERS OF PAON DHOI RIVER AND ITS IMPACT ON HUMAN HEALTH IN SAHARANPUR (U.P.) IN THE YEAR 2016

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ABSTRACT
The river Paon Dhoi, the life line of millions of people, provides water for the essential requirements of life. However, over the years it has been subject to tremendous pressure due to untreated sewage and industrial effluents being dumped in to the river at numerous places and the residues of pesticides and insecticides used in the farms are washed in to it. Water samples were collected from three different locations of the river and their WQI was determined from various physico-chemical parameters during pre monsoon (April - May), monsoon (July - August) and post monsoon (September - October) phase in year 2016. The objective of this index is to turn complex water quality data into information that is understandable and usable by the public. It is found that this water body is not suitable for drinking and irrigation purpose, so possible remedial methods should be adopted for this water resource for improving its quality. In this study Water quality Index was determined on the basis of various physico-chemical parameters like pH, temperature, turbidity, color, TDS, calcium hardness, total hardness, alkalinity, total suspended solid, magnesium hardness, chloride, DO and BOD.

Keywords: *Total Dissolved Solids, Paon Dhoi River, Physico- Chemical Analysis, BOD, Total Hardness, Alkalinity*

INTRODUCTION
Rivers are designated as sacred and have remained a lifeline in India and other countries. A large proportion damp the solid and liquid wastes in Paon Dhoi River like domestic usage (bathing, laundry and public defecation), Sewage wastes etc. The water bodies: rivers, lakes and estuaries are continuously subjected to a dynamic state of change with respect to their geological age and geo chemical characteristics. This dynamic balance in the aquatic ecosystem is upset by human activities results in pollution which in turn manifests dramatically as fish kill, bad taste of drinking water, offensive odors and unchecked growth of aquatic weeds etc.

Therefore, now a day's fresh water has become a scare commodity due to over exploitation and pollution (Singh and Mathur, 2005). The aquatic environment for living organisms can be affected & bio-accumulation of harmful substances in water-dependent food chain can occur. Overall, the inland surface water quality in monsoon season is within tolerable limit with respect to the standard set by Department of Environment (DOE). Paon Dhoi River is life line of Saharanpur and its water is used for domestic and agriculture purposes.

Therefore, effective maintenance of water quality is required through appropriate measurements. The pollution problems in industrial areas are significant. In particular, the water quality around Saharanpur city is so poor that water from the surrounding rivers can no longer be considered as a source of water supply for human consumptions (Agarwal *et al.,* 2011; Kumar *et al.,* 2004; APHA, 1989; ISI, 1983; WHO, 1984; Malik, 2015). The WQI can be used to monitor water quality changes in a particular water supply over time or it can be used to compare a water supply's quality with other water supplies in the region or from around the world (Srivastawa and Kumar, 2013). The assimilation of waste water treatment mechanism is essential to have a sustainable environment (Shivaraju, 2011). Physico-chemical and micro-biological characteristics may describe the quality of water (Mahananda *et al.,* 2005; Piecznska *et al.,* 1975; Gopalsami *et al.,* 1990; Vijayaram *et al.,* 2003; Trivedi *et al.,* 1984; Upadhyay *et al.,* 2005). In the present study Water quality Index was determined on the basis of various physico-chemical

parameters like pH, temperature, turbidity, color, TDS, calcium hardness, total hardness, alkalinity, total suspended solid, magnesium hardness, chloride, DO and BOD.

Table I: Sampling Station in Paon Dhoi River

Sampling Site Number	Location of Sampling Sites	Description
I	Mansapur	Agricultural runoff sources and Animal wash
II	Dhobi Ghat	Municipality wastes, Car and Animal wash, Soaps, Detergents and Domestic waste sources
III	Rakesh Cinema	Municipality wastes, Industrial Waste, Car and Animal wash, Soaps, Detergents and Domestic waste sources

MATERIALS AND METHODS

Methodology

Sampling Area

The water samples from the water body were collected at an interval of 30 days during pre monsoon (April - May), monsoon (July - August) and post monsoon (September - October) phase in year 2016 and analyzed for 13 parameters by following the established procedure. The pH, dissolved oxygen and turbidity were measured and estimated at sampling sites. The other parameters were measured in laboratory by the procedure given by APHA in the laboratory. In this study for the calculation of Water Quality Index (WQI), 13 important parameters were chosen. Water Quality Index (WQI) may be defined as the rating that reflects the composite influence of a number of water quality factors on the overall quality of water. It reduces the large amount of water quality data to a single numerical value. It is one of the most effective ways to communicate information on water quality trends to policy makers, to shape sound public policy and implement the water quality improvement programmes efficiently (Tiwari and Mishra, 1985). The weighted arithmetic index method has been used for the calculation of Water Quality Index of water body. Quality rating q_n was calculated by using the formula:

q_n (water quality rating) = 100 (Vn-Vio) / (Sn-Vio)

where,

q_n = Quality rating for the n^{th} Water Quality parameter

V_n = Estimated value of the n^{th} parameter at a given sampling station

S_n = Standard value of the n^{th} parameter

V_{io} = Ideal value of the n^{th} parameter in pure water (0 for all parameters except pH and DO which are 7.0 and 14.6 mg/L respectively).

Unit weight was calculated by a value inversely proportional to the recommended standard value S_n of the corresponding parameter.

Wn (Unit weight) = K/Sn.

W_n = Unit weight of the n^{th} parameter

S_n = Standard value of the n^{th} parameter

K = Proportionality constant

The overall Water Quality Index was calculated by aggregating the quality rating with the unit weight linearly.

Water Quality Index (WQI) = $\Sigma\, q_n W_n / \Sigma\, W_n$

Table II: Categories the Water Quality Index (WQI) with Range of Pollution

S. No.	WQI	Range of Pollution
I	< 50	Slightly polluted
II	51-80	Moderately polluted
III	80-100	Excessively polluted
IV	> 100	Severely polluted

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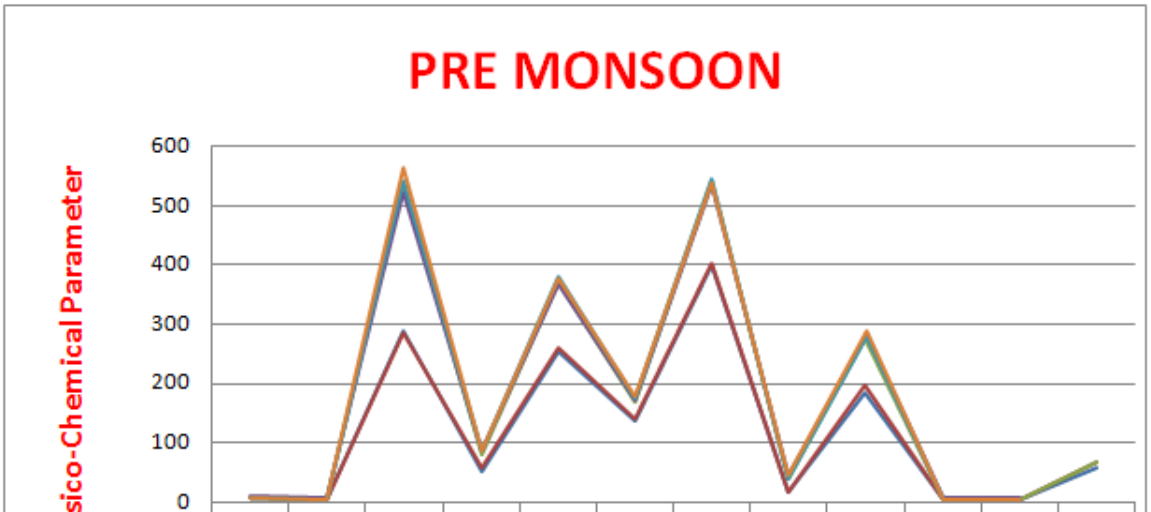
In the present study, water samples were collected from three different locations of Paon Dhoi river of Saharanpur in U.P. State. India, namely S-I (Mansapur), S-II (Dhobi Ghat), S-III (Rakesh Cinema) for physico-chemical analysis during pre monsoon (April - May), monsoon (July - August) and post monsoon (September - October) phase in year 2016.

Sampling Methodology

From each sampling location, samples were collected during pre monsoon (April - May), monsoon (July - August) and post monsoon (September - October) phase as recommended in WHO guidelines (WHO 2004, 2009). For statistical significance of the test results, each sampling location was sampled three times during pre monsoon, monsoon and post monsoon season. On a specific date, samples from all the three sampling locations were collected. In this way a total of 234 samples were collected and tested during this study. For physico-chemical analysis, water samples were collected in a one liter polyethylene (PET) bottle 15-20 cm below the water surface which was filled to the top to exclude air, analyzed within 24 hours and stored at 1- 4^0 c temperature. Care must be taken not to catch any floating material or bed material into the container.

Determination of Water Quality Parameters

The analysis of various physico-chemical parameters namely pH, temperature, turbidity, color, TDS, calcium hardness, total hardness, alkalinity, total suspended solid, magnesium hardness, chloride, DO and BOD were carried out as per the method described in (APHA 1998). The instruments used were in the limit of précised accuracy. The chemicals used were of AR grade. Utmost care was taken during sampling to avoid any kind of contamination. pH, dissolved oxygen and turbidity were measured at the time of sampling itself.

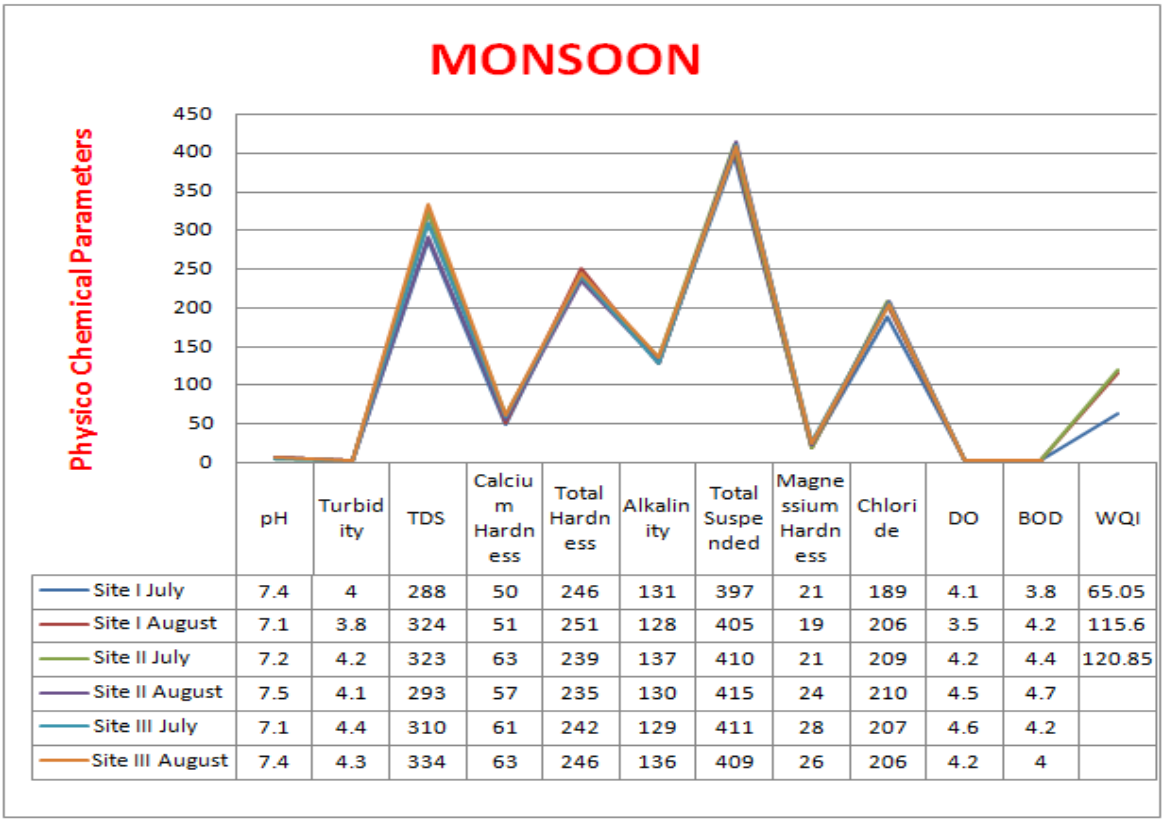


	pH	Turbidity	TDS	Calcium Hardness	Total Hardness	Alkalinity	Total Suspended Solid	Magnessium Hardness	Chloride	DO	BOD	WQI
Site I April	7.2	4.2	290	52	254	136	401	17	186	4	4.4	57.44
Site I May	7.3	4.3	286	59	261	139	403	17	198	3.8	4	67.14
Site II April	8.8	5.4	540	81	371	169	542	40	278	6.5	6	68.09
Site II May	8.6	5.6	523	85	368	172	536	44	281	6.1	5.9	
Site III April	8.2	5.5	545	87	382	176	547	39	280	6	5.1	
Site III Mat	8.8	5.4	564	88	379	180	540	47	288	5.8	5.2	

Figure 1: Seasonal Changes in Physico-Chemical Parameters with Respect to WQI of Paon Dhoi River during Pre Monsoon Season

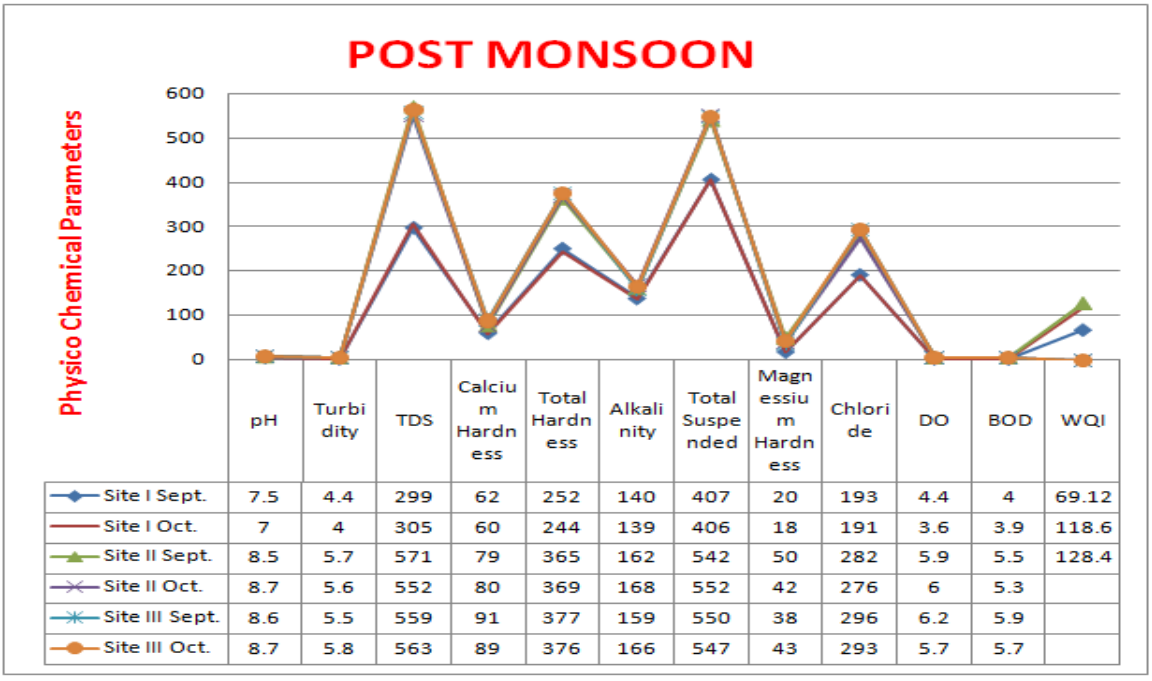
Table III: Seasonal Variation and Calculation of Water Quality Index in Pre Monsoon (April - May), Monsoon (July - August) and Post Monsoon (September - October) Phase at Different Sampling Sites

Parameters	Seasons	S-I		S-II		S-III		Standard Value (S_n)	Unit Weight (W_N)
pH	Pre Monsoon	7.2	7.3	8.8	8.6	8.2	8.8		
	Monsoon	7.4	7.1	7.2	7.5	7.1	7.4	6.5-8.5	--
	Post Monsoon	7.5	7.0	8.5	8.7	8.6	8.7		
Temperature	Pre Monsoon	20.6	19.9	29.2	30.6	30.9	30.4		
(^{0}C)	Monsoon	19.8	19.6	21.9	22.4	21.3	21.7	--	--
	Post Monsoon	21.6	21.1	33.6	33.2	33.8	33.5		
Turbidity	Pre Monsoon	4.2	4.3	5.4	5.6	5.5	5.4		
(NTU)	Monsoon	4.0	3.8	4.2	4.1	4.4	4.3	5.00	--
	Post Monsoon	4.4	4.0	5.7	5.6	5.5	5.8		
Color	Pre Monsoon	Clear	Clear	Black	Black	Black	Black		
	Monsoon	Clear	Clear	Clear	Clear	Clear	Clear	--	--
	Post Monsoon	Clear	Clear	Black	Black	Black	Black		
TDS	Pre Monsoon	290	286	540	523	545	564		
(mg/L)	Monsoon	288	324	323	293	310	334	500	0.0037
	Post Monsoon	299	305	571	552	559	563		
Calcium	Pre Monsoon	52	59	81	85	87	88		
Hardness	Monsoon	50	51	63	57	61	63	75	0.025
(mg/L)	Post Monsoon	62	60	79	80	91	89		
Total	Pre Monsoon	254	261	371	368	382	379		
Hardness	Monsoon	246	251	239	235	242	246	300	0.0062
(mg/L)	Post Monsoon	252	244	365	369	377	376		
Alkalinity	Pre Monsoon	136	139	169	172	176	180		
(mg/L)	Monsoon	131	128	137	130	129	136	150	0.0155
	Post Monsoon	140	139	162	168	159	166		
Total	Pre Monsoon	401	403	542	536	547	540		
Suspended	Monsoon	397	405	410	415	411	409	500	0.0037
Solid	Post Monsoon	407	406	542	552	550	547		
(mg/L)									
Magnesium	Pre Monsoon	17	17	40	44	39	47		
Hardness	Monsoon	21	19	21	24	28	26	30	0.061
(mg/L)	Post Monsoon	20	18	50	42	38	43		
Chloride	Pre Monsoon	186	198	278	281	280	288		
(mg/L)	Monsoon	189	206	209	210	207	206	250	0.0074
	Post Monsoon	193	191	282	276	296	293		
Dissolved	Pre Monsoon	4.0	3.8	6.5	6.1	6.0	5.8		
Oxygen	Monsoon	4.1	3.5	4.2	4.5	4.6	4.2	5.00	0.3723
(mg/L)	Post Monsoon	4.4	3.6	5.9	6.0	6.2	5.7		
BOD	Pre Monsoon	4.4	4.0	6.0	5.9	5.1	5.2		
(mg/L)	Monsoon	3.8	4.2	4.4	4.7	4.2	4.0	5.00	0.3723
	Post Monsoon	4.0	3.9	5.5	5.3	5.9	5.7		
WQI	Pre Monsoon	79.01		121.16		109.11			
	Monsoon	77.46		79.83		78.56			
	Post Monsoon	76.44		113.8		118.38			



	pH	Turbidity	TDS	Calcium Hardness	Total Hardness	Alkalinity	Total Suspended	Magnessium Hardness	Chloride	DO	BOD	WQI
Site I July	7.4	4	288	50	246	131	397	21	189	4.1	3.8	65.05
Site I August	7.1	3.8	324	51	251	128	405	19	206	3.5	4.2	115.6
Site II July	7.2	4.2	323	63	239	137	410	21	209	4.2	4.4	120.85
Site II August	7.5	4.1	293	57	235	130	415	24	210	4.5	4.7	
Site III July	7.1	4.4	310	61	242	129	411	28	207	4.6	4.2	
Site III August	7.4	4.3	334	63	246	136	409	26	206	4.2	4	

Figure 2: Seasonal Changes in Physico-Chemical Parameters with Respect to WQI of Paon Dhoi River during Monsoon Season



	pH	Turbidity	TDS	Calcium Hardness	Total Hardness	Alkalinity	Total Suspended	Magnessium Hardness	Chloride	DO	BOD	WQI
Site I Sept.	7.5	4.4	299	62	252	140	407	20	193	4.4	4	69.12
Site I Oct.	7	4	305	60	244	139	406	18	191	3.6	3.9	118.6
Site II Sept.	8.5	5.7	571	79	365	162	542	50	282	5.9	5.5	128.4
Site II Oct.	8.7	5.6	552	80	369	168	552	42	276	6	5.3	
Site III Sept.	8.6	5.5	559	91	377	159	550	38	296	6.2	5.9	
Site III Oct.	8.7	5.8	563	89	376	166	547	43	293	5.7	5.7	

Figure 3: Seasonal Changes in Physico-Chemical Parameters with Respect to WQI of Paon Dhoi River during Post Monsoon Season

RESULTS AND DISCUSSION

Water Quality Index of Paon Dhoi River at three different sampling sites is established from various physic-chemical parameters in different seasons. The values of various physico-chemical parameters for calculation of Water Quality Index are presented in table III. The result shows that the pH values are alkaline in all three sites. The pH values during monsoon season at all the sources are well within desirable limits and pH values during pre and post monsoon season are greater than 8.4 except 1st sampling sites. During the investigation period temperature varied from 19.6^0C to 33.8^0C.

The water samples collected were found to be odorless, colorless and clear in monsoon season. It becomes blackish during pre and post monsoon season except 1st sampling sites. Total Dissolved Solids (T.D.S) ranged from 286-564 mg/L. The TDS values during monsoon season at all the sources are well within desirable limits and TDS values during pre and post monsoon season are greater than 523 mg/L except 1st sampling sites. This is because of the addition of solids from open domestic sewage, agriculture run-off, sewage coming through sewerage pipes and untreated or inadequately treated effluent discharged from several types of industrial units. The sources of Ca and Mg in natural water are various types of rocks, industrial waste and sewage. There is evidence that hard water plays a role in heart diseases. Higher concentration of Mg makes the water unpalatable and act as laxative to human beings.

The Calcium values during monsoon season at all the sources are well within desirable limits and calcium values during pre and post monsoon season are greater than 79 mg/L except 1st sampling sites. This is because of the addition of sewage coming through sewerage pipes and untreated or inadequately treated effluent discharged from several types of industrial units. The Magnesium values during monsoon season at all the sources are well within desirable limits and magnesium values during pre and post monsoon season are greater than 38 mg/L except 1st sampling sites.

The Total Hardness during monsoon season at all the sources is well within desirable limits and Total Hardness during pre and post monsoon season is greater than 365 mg/L except 1st sampling sites. The total hardness is mainly due to Ca, Mg and Eutrophication (Sharma, 2001; De, 1994). The water containing excess hardness is not desirable for potable water as it forms scales on water heater and utensils when used for cooking and consume more soap during washing of clothes. Hardness is caused by divalent metallic ions that are capable of reacting with sops to form ppt.

The alkalinity values during monsoon season at all the sources are well within desirable limits however, alkalinity values during pre and post monsoon season are greater than 159 mg/L except 1st sampling sites. Alkalinity is due to the presence of bicarbonates, carbonates or hydroxides which dissolve in water from soil. If alkalinity is higher, more neutralizing agents are needed to counteract it. They discharge the waste waters into the soil may lead to increase in alkalinity of water in these areas. Almost all natural water contains chloride and sulphate ions. Their concentrations vary considerably according to the mineral content of the Earth in any given area. Low to moderate concentrations of both chloride and sulphate ions add palatability to water. Excessive concentrations of either, of course, can make water unpleasant to drink. The chloride values during monsoon season at all the sources are well within desirable limits however chloride during pre and post monsoon season are greater than 276 mg/L except 1st sampling sites. DO is the amount of oxygen dissolved per liter volume of the water. High rate of microbial growth and activity decrease the DO level in water body. The DO values during monsoon season at all the sources are well within desirable limits however, DO values during pre and post monsoon season are greater than permissible limit except 1st sampling sites.

Conclusion

The Paon Dhoi River is frequently used for different purposes. Present study indicates the pollution state of river Paon Dhoi River. The pre monsoon (April - May), monsoon (July - August) and post monsoon (September - October) phase in year 2016 showed different level of seasonal fluctuations in various physicochemical parameters and Water Quality Index. The major sources of pollutants are local anthropogenic activities, open domestic sewage, sewage coming through sewerage pipes, agricultural runoff containing fertilizers, pesticides, insecticides and industrial effluent containing toxic chemicals in higher amount. Water quality Index determined on the basis of various physico-chemical parameters like

pH, temperature, turbidity, color, TDS, calcium hardness, total hardness, alkalinity, total suspended solid, magnesium hardness, chloride, DO and BOD, indicates moderate pollution at Ist, IInd and IIIrd Site during monsoon season however, severe pollution at IInd and IIIrd Site and moderate pollution at Ist Site during pre and post monsoon season. It can, therefore, be concluded that it is not suitable for drinking and irrigation purposes without any form of treatment, so, possible remedial methods should be adopted for this water resource for improving its quality. It is very much necessary to conduct more research on this river and has to make awareness among the people about the pollution problem.

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