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Research Article

ASSESSMENT OF WATER QUALITY AT PAON DHOI RIVER DURING MONSOON AND AFTER SEASON, SAHARANPUR (U.P.)

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ABSTRACT
Rivers are main inland water sources for domestic, industrial & irrigation purposes & often carry large municipal sewage, industrial waste, water discharges and seasonal run-off from agriculture. Land Water quality has become a global concern due to over increasing population and developmental activities that had over exploit and polluted the water resources available to us. In the present study, water samples were collected from seven different locations of Paon Dhoi river of Saharanpur in U.P. State, India for physico-chemical analysis. The laboratory test of the collected water samples were performed for analysis of various physical and chemical parameters such as pH, Temperature, Turbidity, Color, Total Dissolved Solids (TDS), Total Hardness (TH), Calcium Hardness and Alkalinity. The results obtained from chemical analysis were compared with four standards namely ISI, ICMR, BIS and WHO. 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.

Keywords: *Physico-chemical Analysis, Total Hardness, pH, Alkalinity, Total Dissolved Solids, Paon Dhoi River*

INTRODUCTION
Paon Dhoi is one of the famous river of Saharanpur (U.P). The human activities like open domestic sewage, agriculture run-off, sewage coming through sewerage pipes, untreated or inadequately treated effluent discharged from several types of industrial units change the chemical, physical, biological and radiological quality of water which make the water of Paon Dhoi River polluted. On the other hand Nutrients generated from natural processes are not considered as Pollutants. According to National Research Council the concerns over water quality relate not just to water itself, but also to the danger of diffusion of toxic substances into other eco system. 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).
However quality degrades in the dry season. 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). In order to address the non point source pollution of water, many agencies have come up with various proposals & some programs are been effectively organized targeting various programs, funds, training, technical assistance, incentives and other management tools. The assimilation of waste water treatment mechanism is essential to have a sustainable environment (Shivaraju, 2011). Enabling the bacteria & chemical oxidation of organic matter derived from any source can reduce the deterioration of water quality. In doing this the major elements from the waste, namely C, N and P can be oxidized thus reducing the biological & chemical oxygen demand of the aquatic system. The levels of suspended and dissolved organic, inorganic matter and gases reflect the chemical characteristic of waste water. DO (Dissolved oxygen), BOD (Biological oxygen demand), COD (Chemical oxygen demand), pH, salinity and turbidity are most extensively measured parameters to quantify the water quality index of the water body. Salinity is identity of a saline water body and accounts for the total amount of salts. Salinity may be affected by human interference in case any industrial waste water is released at sites of low dispersed. Temperature, pH, turbidity, conductivity,

total suspended solid (TSS), nitrates, total nitrogen & total phosphate are the most important physico-chemical properties of water (APHA, 1992).

The main objectives of the study were to assess the river water quality. The physico-chemical properties measured here are pH, Temperature, Turbidity, Color, Total Dissolved Solids (TDS), Total Hardness (TH), Calcium Hardness and Alkalinity.

MATERIALS AND METHODS

Methodology

Sampling Area: In the present study, water samples were collected from seven different locations of Paon Dhoi river of Saharanpur in U.P. State. India, namely S-I (Mansapur), S-II (Sakla Puri), S-III (Dhobi Ghat), S-IV (Rameshwar Temple), S-V (Dal Mandi Pul), S-VI (Jogiyan Pul) and S-VII (Rakesh Cinema) for physico-chemical analysis. Water samples were collected from sampling sites immediately after heavy rain and approximately after one month of monsoon season.

Eight water quality parameters; four physical and four chemical were tested for the samples collected for this research work. Physical parameters tested were pH, temperature, color and turbidity. These four parameters play an important role in the disinfection of water. Turbidity should be less than 5.0 Nephelometric Turbidity Units (NTU) and pH should be less than 8 for effective disinfection (WHO, 2004).

Chemical parameters chosen were Total Dissolved Solids (TDS), Total Hardness (TH), Calcium Hardness and Alkalinity. Total Dissolved Solids (TDS), Total Hardness (TH) and Calcium Hardness results in excessive use of soap for washing purposes in household use while water with high TDS may impart taste. Scales are mainly formed due to carbonate hardness and cause enormous loss of fuel in boilers. Scales deposited mainly due to increase in pH to 9 at which bicarbonates are converted as carbonates are formed in distribution mains reducing their carrying capacity.

The pH and turbidity were measured and estimated at sampling sites by using water analysis kit (systolic).The other parameters were measured by the procedure given by APHA in the laboratory.

Sampling Methodology

From each sampling location, samples were collected immediately after heavy rain and approximately after one month of monsoon season as recommended in WHO guidelines (WHO, 2004, 2009). For statistical significance of the test results, each sampling location was sampled three times during the monsoon and three times after the monsoon on the dates as shown in Table. On a specific date, samples from all the seven sampling locations were collected. In this way a total of 42 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.

The samples were collected as per the schedule given in the table:

Table 1: Sampling Schedule

	During monsoon (Heavy Rain)			**After monsoon**		
Sample No.	**1**	**2**	**3**	**1**	**2**	**3**
Sampling date	08.08.2015	10.08.2015	12.08.2015	10.09.2015	15.09.2015	20.09.2015

Determination of Water Quality Parameters

The analysis of various physico-chemical parameters namely pH, Temperature, Turbidity, Color, Total Dissolved Solids (TDS), Total Hardness (TH), Calcium Hardness and Alkalinity 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. Temperature and pH were measured at the time of sampling itself.
The standard limits of water quality parameters in drinking water prescribed by ISI, ICMR, BIS and WHO is shown in the Table 2.

Table 2: Drinking water parameters prescribed by ISI, ICMR, BIS and WHO

Water	ISI		ICMR		BIS		WHO	
Parameters	**MPL**	**HDL**	**MPL**	**HDL**	**MPL**	**HDL**	**MPL**	**HDL**
pH	--	6.5-8.5	6.5-9.2	7.0-8.5	8.5-9.0	7.0-8.3	6.5-9.5	7.0-8.5
Temp.(^{o} C)	--	--	--	--	--	--	--	--
Turbidity (NTU)	--	--	10.0	5.0	10.0	5.0	10.0	5.0
Color	--	--	--	--	--	--	--	--
TDS (mg/L)	2000	500	1500	500	2000	500	1000	500
Calcium Hardness (mg/L)	200	75	--	--	--	--	200	75
TH (mg/L)	600	300	600	300	600	200	600	200
Alkalinity (mg/L)	600	200	--	--	550	175	600	200

MPL (Maximum Permissible Limit), HDL (Highest Desirable Level), ISI (Indian Standard Institute), ICMR (Indian Council of Medical Research), BIS (Bureau of Indian Standard), WHO (World Health Organization)

Table 3: Analysis of various physico-chemical parameters at Seven Sites

Parameters		**S-I**	**S-II**	**S-III**	**S-IV**	**S-V**	**S-VI**	**S-VII**
pH	During Monsoon	6.7	6.5	7.4	7.6	7.2	7.8	7.5
	After Monsoon	7.4	7.4	8.9	9.2	8.8	9.1	8.7
Temperature	During Monsoon	21.7	19.0	28.6	27.4	28.5	30.0	29.3
(^{0}C)	After Monsoon	27.6	26.9	28.5	27.9	29.5	26.9	28.4
Turbidity	During Monsoon	2.5	2.7	3.3	3.8	4.1	3.6	3.0
(NTU)	After Monsoon	4.1	3.7	5.7	5.9	5.2	5.6	5.3
Color	During Monsoon	Clear	Clear	Clear	Clear	Clear	Clear	Clear
	After Monsoon	Clear	Clear	Black	Black	Black	Black	Black
TDS	During Monsoon	250	256	290	387	455	390	377
(mg/L)	After Monsoon	262	272	624	632	645	612	603
Calcium	During Monsoon	51	53	62	58	55	61	60
Hardness								
(mg/L)	After Monsoon	56	59	94	96	99	101	97
Total Hardness	During Monsoon	150	157	176	164	161	167	166
(mg/L)	After Monsoon	153	160	460	472	456	470	456
Alkalinity	During Monsoon	167	170	174	181	179	178	173
(mg/L)	After Monsoon	171	173	249	243	250	252	248

RESULTS AND DISCUSSION

pH

The mean values of pH at seven sampling points immediately after heavy rain and approximately after one month of monsoon season are shown in Figure 1. ISI, ICMR, BIS and WHO proposed a desirable

range of 6.5 to 8.5 for pH of drinking water (BIS, 1991, 2004, 2005). The pH values immediately after heavy rain at all the sources are well within the ISI, ICMR, BIS and WHO desirable limits and pH values after one month of monsoon season are greater than 8.5 except 1st and 2nd sampling sites. pH is one of the most important operational water quality parameters. pH values higher than 8.5 are not suitable for effective disinfection while values less than 6.5 enhance corrosion in water mains.

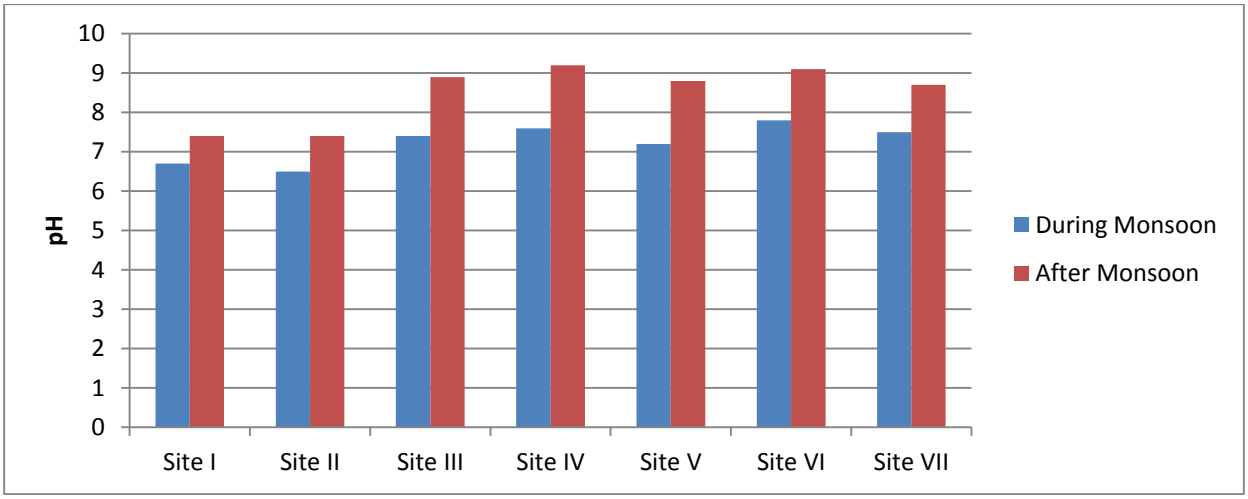

Figure 1: Comparison of mean values of ph during and after monsoon at various sampling locations

Temperature

The mean values of temperature at seven sampling points immediately after heavy rain and approximately after one month of monsoon season are shown in Figure 2 No health based guidelines are proposed for temperature by ISI, ICMR, BIS and WHO. The temperature of the collected water samples varies in between 19 ^{0}C to 30 ^{0}C at all sampling sites after heavy rain and approximately after one month of monsoon season.

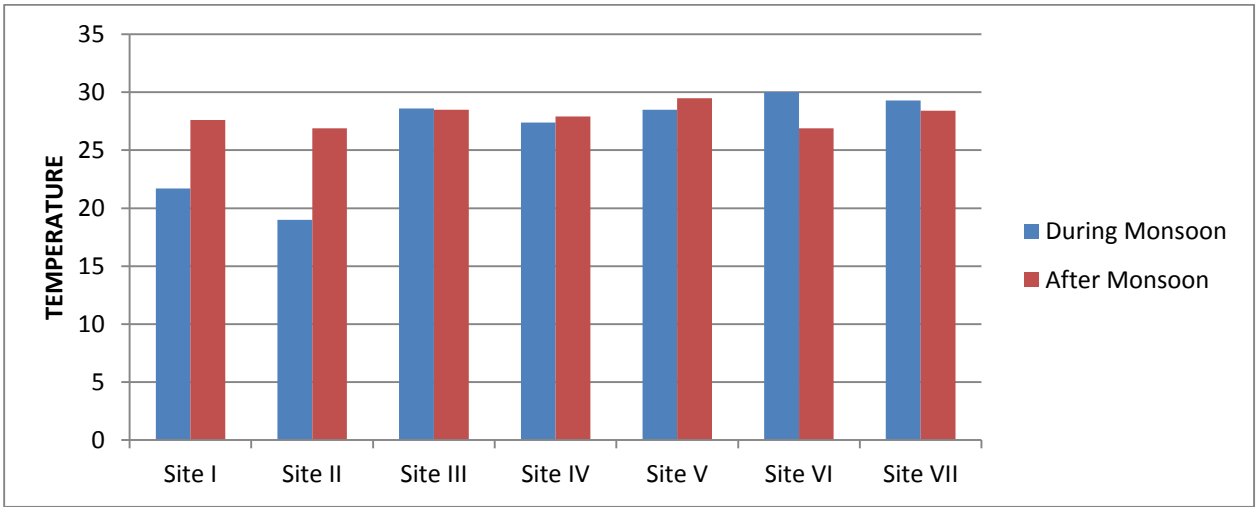

Figure 2: Comparison of mean values of temperature during and after monsoon at various sampling locations

Turbidity

The mean values of turbidity at seven sampling points immediately after heavy rain and approximately after one month of monsoon season are shown in Figure 3 No health based guidelines are proposed for

turbidity by ISI, ICMR, BIS and WHO. Nevertheless, a value of 5.0 NTU is recommended for effective disinfection. It is evident from Fig. 3 that at all the sources, the turbidity in water is in the desirable limit immediately after heavy rain. It rose above 5.0 NTU after one month of monsoon season except 1st and 2nd sampling sites. No apparent reason could be described to this phenomenon on the basis of this study and further research is recommended to find out the facts.

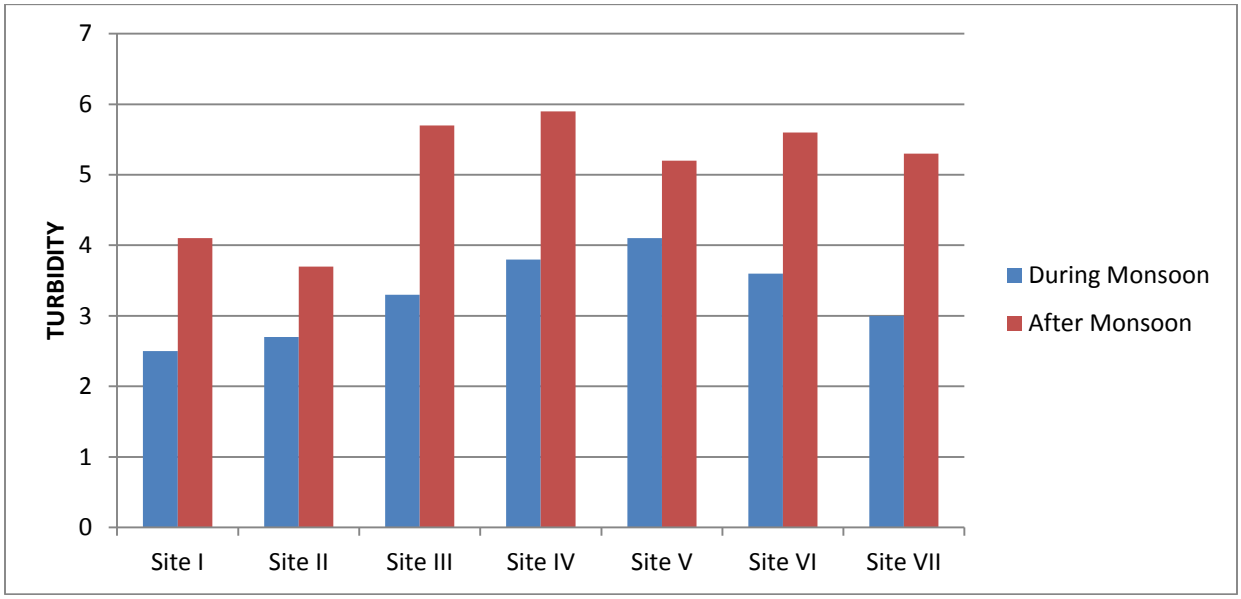

Figure 3: Comparison of mean values of turbidity during and after monsoon at various sampling locations

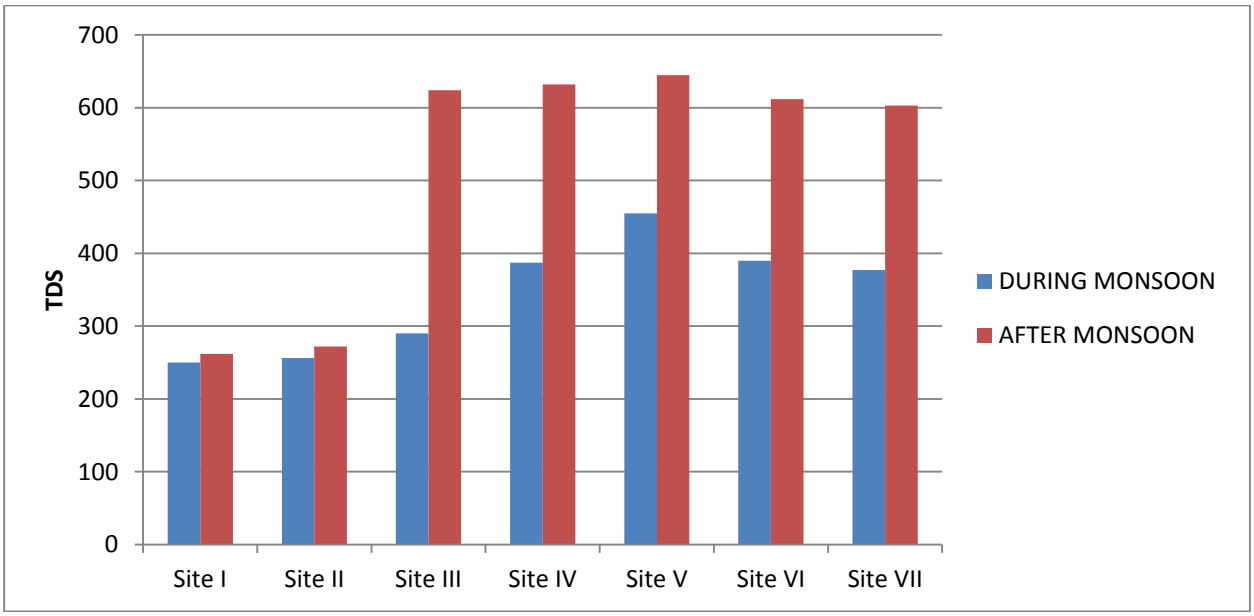

Figure 4: Comparison of mean values of TDS during and after monsoon at various sampling locations

Color

The water samples are generally colored due to the presence of colloidal substance, inorganic impurity, aquatic growth, and decomposition of vegetation. The water sample collected was found to be odorless,

colorless and clear immediately after heavy rain. It becomes blackish after one month of monsoon season except 1st and 2nd sampling sites.

Total Dissolved Solid

The quantity of TDS was proportional to the degree of pollution (Rain *et al.*, 1990; Nasrullah, 2006). The mean values of TDS at seven sampling points immediately after heavy rain and approximately after one month of monsoon season are shown in Figure 4. ISI, ICMR, BIS and WHO proposed a desirable range of 500 mg/L for TDS of drinking water. The TDS values immediately after heavy rain at all the sources are well within the ISI, ICMR, BIS and WHO desirable limits of 250-455 mg/L and TDS values after one month of monsoon season are greater than 600 mg/L except 1st and 2nd 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.

Calcium Hardness

Calcium play important roles in bone structure, muscle contraction, nerve impulse transmission and blood clotting. Some 99% of body calcium is in the bone, which are 40% calcium (WHO, 2009). However, values exceeding 25 mg/l of calcium in drinking water have human health implication, according to WHO 2004 guideline. The mean values of calcium hardness at seven sampling points immediately after heavy rain and approximately after one month of monsoon season are shown in Figure 5. ISI, ICMR, BIS and WHO proposed a desirable range of 75 mg/L for calcium hardness of drinking water. The calcium hardness values immediately after heavy rain at all the sources are well within the ISI, ICMR, BIS and WHO desirable limits and calcium hardness after one month of monsoon season are greater than 90 mg/L except 1st and 2nd 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.

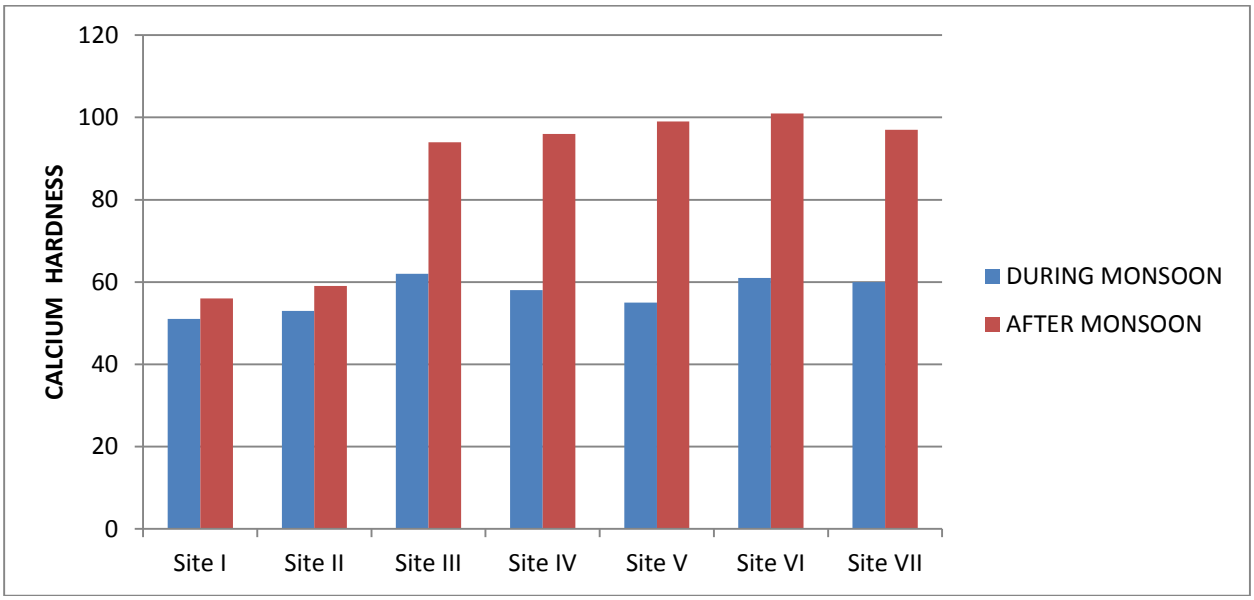

Figure 5: Comparison of mean values of calcium hardness during and after monsoon at various sampling locations

Total Hardness

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. The mean values of total hardness at seven sampling points immediately after heavy rain and approximately after one month of monsoon season are shown in Figure 6. ISI, ICMR, BIS and WHO proposed a desirable range of total hardness of drinking water. The Total Hardness values immediately after heavy rain at all the sources are well within the ISI, ICMR, BIS and WHO desirable limits and total

hardness values after one month of monsoon season are greater than 455 mg/L except 1st and 2nd 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.

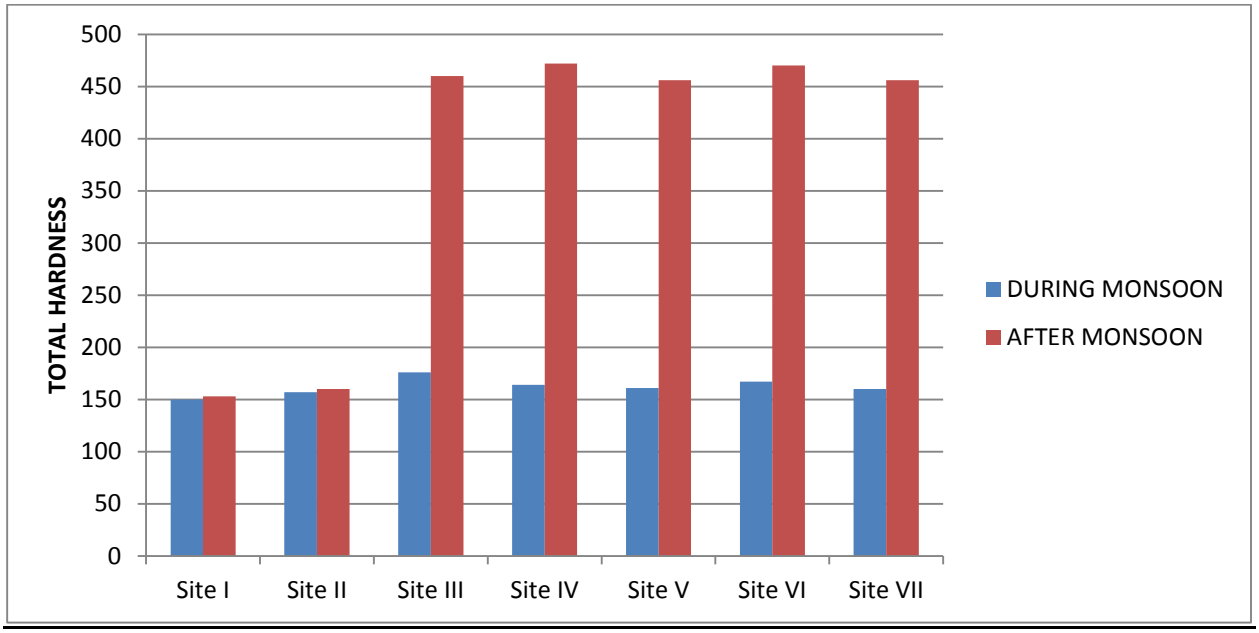

Figure 6: Comparison of mean values of total hardness during and after monsoon at various sampling locations

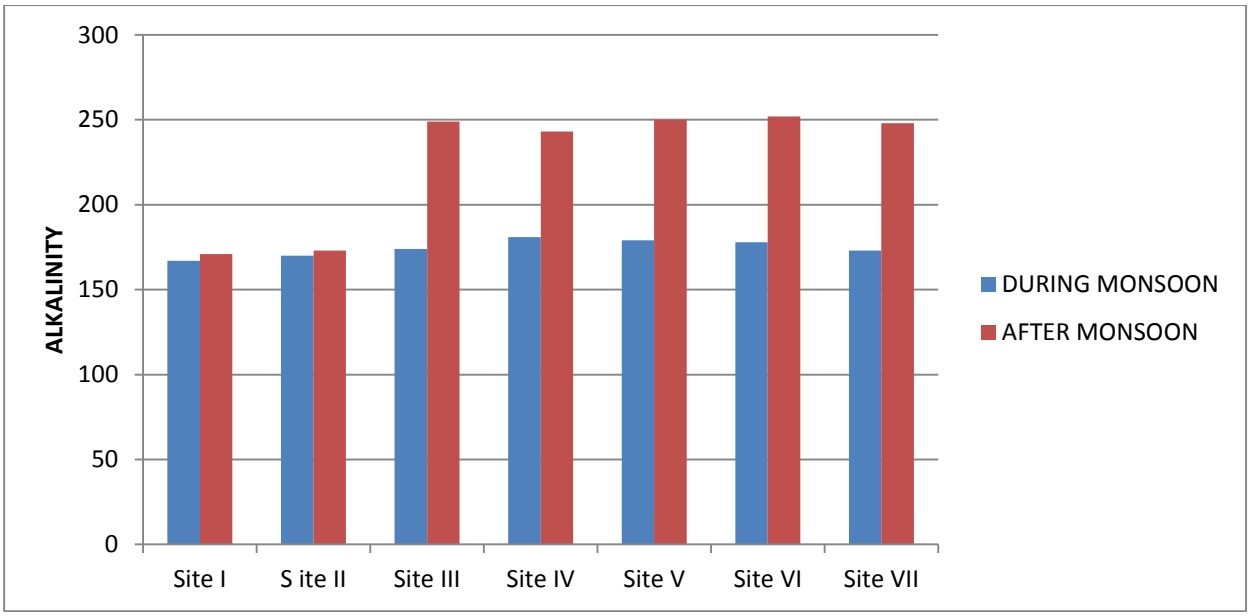

Figure 7: Comparison of mean values of alkalinity during and after monsoon at various sampling locations

Alkalinity

Alkalinity is due to the presence of bicarbonates, carbonates or hydroxides which dissolve in water from soil. The mean values of Alkalinity at seven sampling points immediately after heavy rain and

approximately after one month of monsoon season are shown in Figure 7. ISI, ICMR, BIS and WHO proposed a desirable range of Alkalinity of drinking water.

Figure 8: Water at site 4 during monsoon

Figure 9: Water at site 6 during monsoon

Figure 10: Water at site 2 after monsoon

The Alkalinity values immediately after heavy rain at all the sources are well within the ISI, ICMR, BIS and WHO desirable limits and alkalinity values after one month of monsoon season are greater than 240 mg/L except 1st and 2nd sampling sites. These factors are characteristics of the source of water and natural processes taking place at any given time which do not have proper drainage system. They discharge the waste waters into the soil. This may lead to increase in alkalinity of water in these areas.

Figure 11: Contaminated water at site 4 after monsoon

Figure 12: Contaminated water at site 5 after monsoon

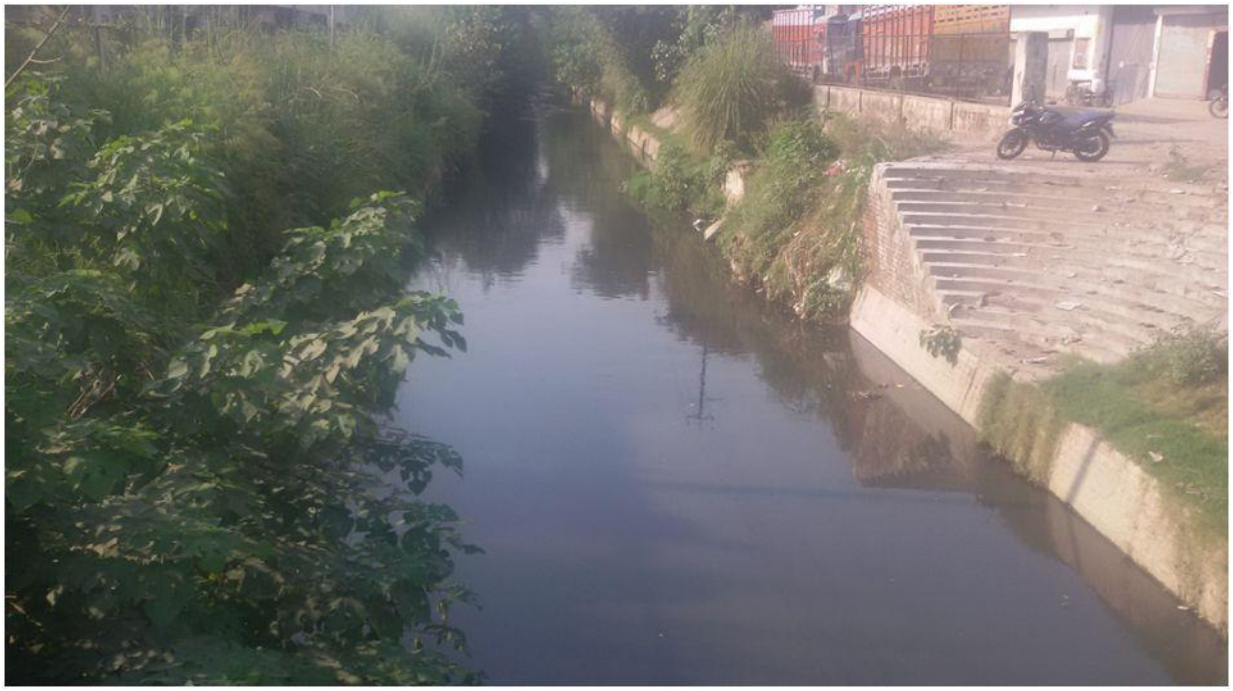

Figure 13: Contaminated water at site 7 after monsoon

Conclusion

1. The physicochemical parameters (pH, Temperature, Turbidity, Color, Total Dissolved Solids (TDS), Total Hardness (TH), Calcium Hardness and Alkalinity) at all the sampling sites in the study area were within the limits after heavy rain and after one month of monsoon season are greater than desirable limits at all sampling sites except 1st and 2nd sampling sites. It can, therefore, be concluded that it is not suitable for drinking and irrigation purpose, so possible remedial methods should be adopted for this water resource for improving its quality.
2. Overall the inland surface water quality in monsoon season is within tolerable limit with respect to the standard set by Department of Environment (DOE). However quality degrades in the dry season. 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.
3. 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.
4. Many values of parameter crossed the highest desirable limit, due to heavy discharge of effluent waste and domestic sewage in the river basin indicating deterioration of Paon Dhoi river water quality.

Recommendations

1. In order to address the non point source pollution of water, many agencies have come up with various proposals & some programs are been effectively organized targeting various programs, funds, training, technical assistance, incentives and other management tools. The assimilation of waste water treatment mechanism is essential to have a sustainable environment.
2. Pounding of wastewater in the streets be avoided through effective wastewater collection system.
3. Sewer lines are laid on the opposite sides of the river to avoid pollution.

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