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Physico-Chemical Analysis of Paon Dhoi River Water and Its Impact on Human Health in Saharanpur (U.P.)

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ABSTRACT

The water quality of Paon Dhoi River, an important domestic and irrigation water source of Saharanpur, has been assessed. Water samples were collected from seven different locations of the river and analyzed for various physico-chemical quality parameters before monsoon, during heavy rain and one month after monsoon season. The results obtained from chemical analysis were compared with four standards namely ISI, ICMR, BIS and WHO. Effects of industrial wastes, municipality sewage and agricultural runoff on the river water were investigated. 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.

INTRODUCTION

Paon Dhoi water is essential for the survival of all forms of life. Though 80% of earth's surface is covered by water, the fresh water supply has increasingly become a limiting factor because of various reasons. 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. The water bodies: rivers and lakes 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. 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. It is a fact that good water quality produces healthier humans than one with poor water quality. 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 assimilation of waste water treatment mechanism is essential to have a sustainable environment (Shivaraju 2011). 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). 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 like pH, Temperature, Turbidity, Color, Total Dissolved Solids (TDS), Total Hardness (TH), Calcium Hardness and Alkalinity of water samples from seven different sampling sites were analyzed.

Table I - Sampling Station in Paon Dhoi River

Sampling Site Number	Location of sampling Sites	Description
I	Mansapur	Starting point where Agricultural runoff sources
II	Sakla Puri	Domestic wastes and Agricultural runoff sources
III	Dhobi Ghat	Municipality wastes and Domestic waste sources
IV	Rameshwar Temple	Municipality wastes, Car and Animal wash, Soaps, Detergents and Domestic waste sources
V	Dal Mandi Pul	Municipality wastes, Industrial Waste, Car and Animal wash, Soaps, Detergents and Domestic waste sources
VI	Jogiyan Pul	Municipality wastes, Industrial Waste, Car and Animal wash, Soaps, Detergents and Domestic waste sources
VII	Rakesh Cinema	Municipality wastes, Industrial Waste, Car and Animal wash, Soaps, Detergents and Domestic waste sources

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 before monsoon, 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 before monsoon then 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 before monsoon, during the monsoon and three times after the monsoon on the dates as shown in Table II. On a specific date, samples from all the seven sampling locations were collected. In this way a total of 63 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.

Table II - Sampling Schedule:

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

S. No.		**Sampling Date**		
Sample No.		**1**	**2**	**3**
1	Pre Monsoon	21.06.2015	01.07.2015	10.07.2015
2	During monsoon (Heavy Rain)	09.08.2015	11.08.2015	13.08.2015
3	After monsoon	13.09.2015	23.09.2015	30.09.2015

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 III.

Table III - Drinking Water Parameters prescribed by ISI, ICMR, BIS and WHO

Water Parameters	ISI		ICMR		BIS		WHO	
	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 IV- Analysis of Various Physico-Chemical Parameters at Sampling Sites

Parameters		**S-I**	**S-II**	**S-III**	**S-IV**	**S-V**	**S-VI**	**S-VII**
pH	Pre Monsoon	7.2	7.5	8.6	9.1	8.9	9.3	9.2
	During Monsoon	6.8	6.6	7.2	7.4	7.5	7.3	7.7
	After Monsoon	7.5	7.4	8.7	9.1	8.7	8.9	9.3
Temperature	Pre Monsoon	29.7	30.2	28.6	28.3	29.4	26.9	30.2
(^{0}C)	During Monsoon	21.8	21.8	27.5	28.4	28.9	30.4	30.3
	After Monsoon	27.3	26.6	28.8	29.1	26.9	28.5	28.8
Turbidity	Pre Monsoon	3.9	4.1	5.8	6.1	5.6	5.5	5.3
(NTU)	During Monsoon	2.7	2.2	3.6	3.5	3.9	3.7	3.4
	After Monsoon	4.0	3.9	6.1	5.5	5.8	5.2	5.8
Color	Pre Monsoon	Black	Black	Black	Black	Black	Black	Black
	During Monsoon	Clear	Clear	Clear	Clear	Clear	Clear	Clear
	After Monsoon	Clear	Clear	Black	Black	Black	Black	Black
TDS	Pre Monsoon	288	292	610	598	632	625	613
(mg/L)	During Monsoon	248	264	278	345	328	310	342
	After Monsoon	297	280	609	623	598	619	601
Calcium Hardness	Pre Monsoon	61	58	84	82	91	80	79
(mg/L)	During Monsoon	49	50	52	51	60	59	55

	After Monsoon	57	63	86	93	89	97	101
Total Hardness	Pre Monsoon	115	126	321	330	325	339	341
(mg/L)	During Monsoon	164	170	163	151	179	158	159
	After Monsoon	165	171	458	447	461	466	459
Alkalinity	Pre Monsoon	152	159	255	239	243	240	230
(mg/L)	During Monsoon	160	148	158	162	154	162	169
	After Monsoon	170	169	237	235	246	249	241

RESULTS AND DISCUSSION

1- pH

The mean values of pH at seven sampling points before monsoon, immediately after heavy rain and approximately after one month of monsoon season are shown in Fig.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 before monsoon and after one month of monsoon season are greater than 8.6 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.

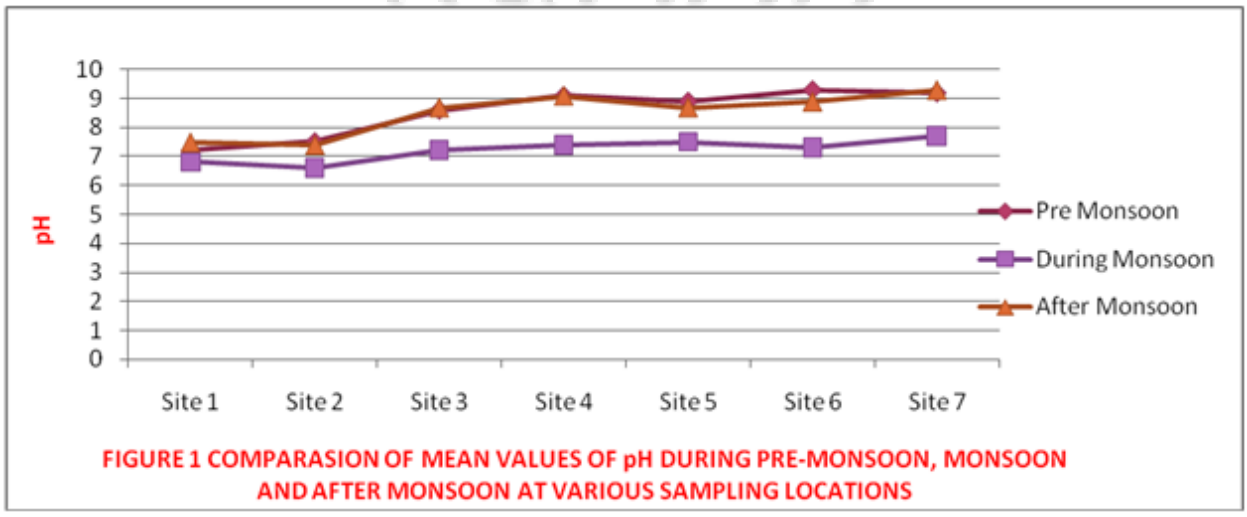

FIGURE 1 COMPARASION OF MEAN VALUES OF pH DURING PRE-MONSOON, MONSOON AND AFTER MONSOON AT VARIOUS SAMPLING LOCATIONS

2- Temperature

The mean values of temperature at seven sampling points before monsoon, immediately after heavy rain and approximately after one month of monsoon season are shown in Fig 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 before monsoon, immediately after heavy rain and approximately after one month of monsoon season.

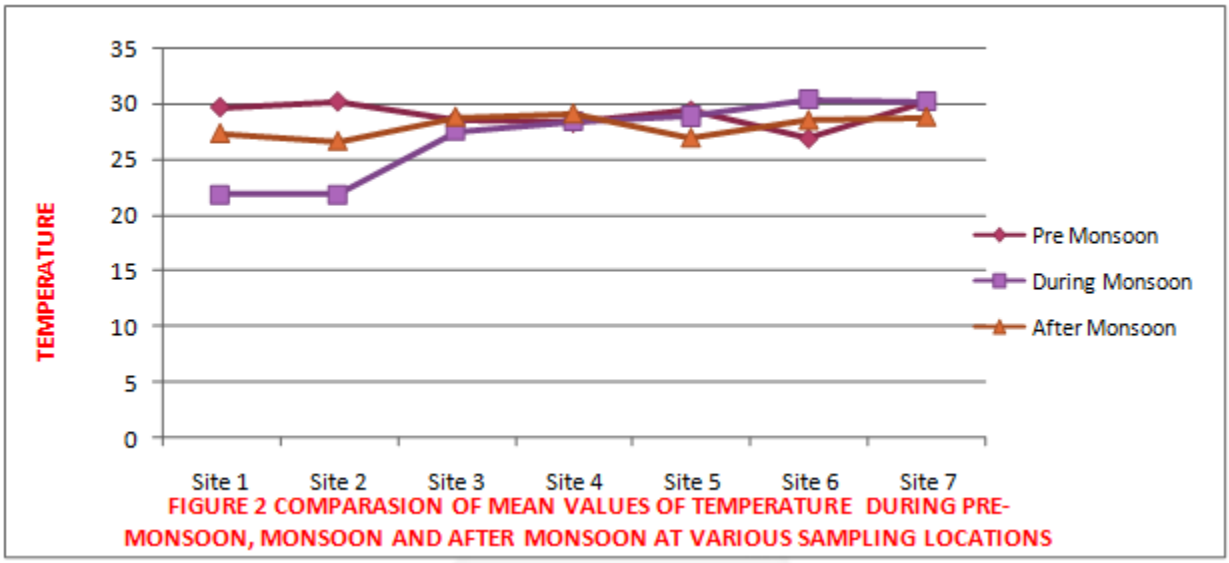

FIGURE 2 COMPARASION OF MEAN VALUES OF TEMPERATURE DURING PRE-MONSOON, MONSOON AND AFTER MONSOON AT VARIOUS SAMPLING LOCATIONS

3- Turbidity

The mean values of turbidity at seven sampling points before monsoon, immediately after heavy rain and approximately after one month of monsoon season are shown in Fig 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 before monsoon and 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.

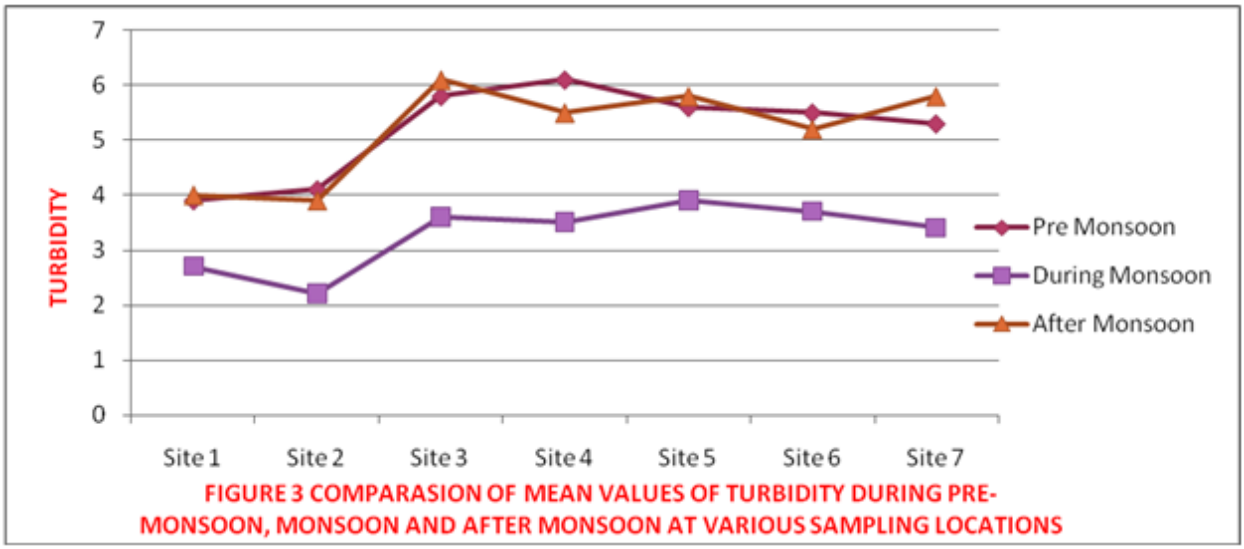

FIGURE 3 COMPARASION OF MEAN VALUES OF TURBIDITY DURING PRE-MONSOON, MONSOON AND AFTER MONSOON AT VARIOUS SAMPLING LOCATIONS

4- 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 before monsoon and after one month of monsoon season except 1st and 2nd sampling sites.

5- 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 before monsoon, immediately after heavy rain and approximately after one month of monsoon season are shown in Fig.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 before monsoon and after one month of monsoon season are greater than 598 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.

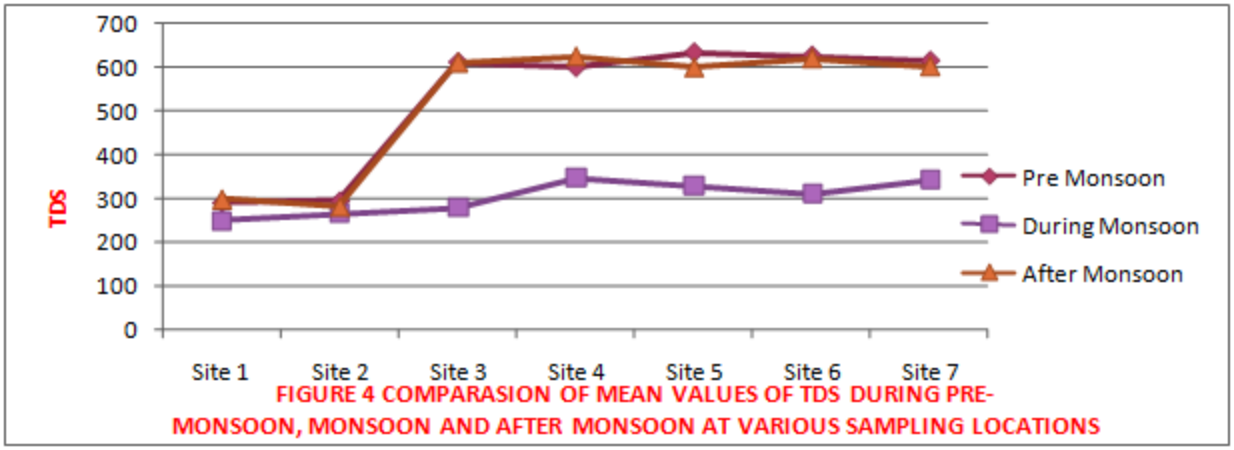

FIGURE 4 COMPARASION OF MEAN VALUES OF TDS DURING PRE-MONSOON, MONSOON AND AFTER MONSOON AT VARIOUS SAMPLING LOCATIONS

6- 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 before monsoon, immediately after heavy rain and approximately after one month of monsoon season are shown in Fig.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. Calcium hardness before monsoon and after one month of monsoon season is greater than 79 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.

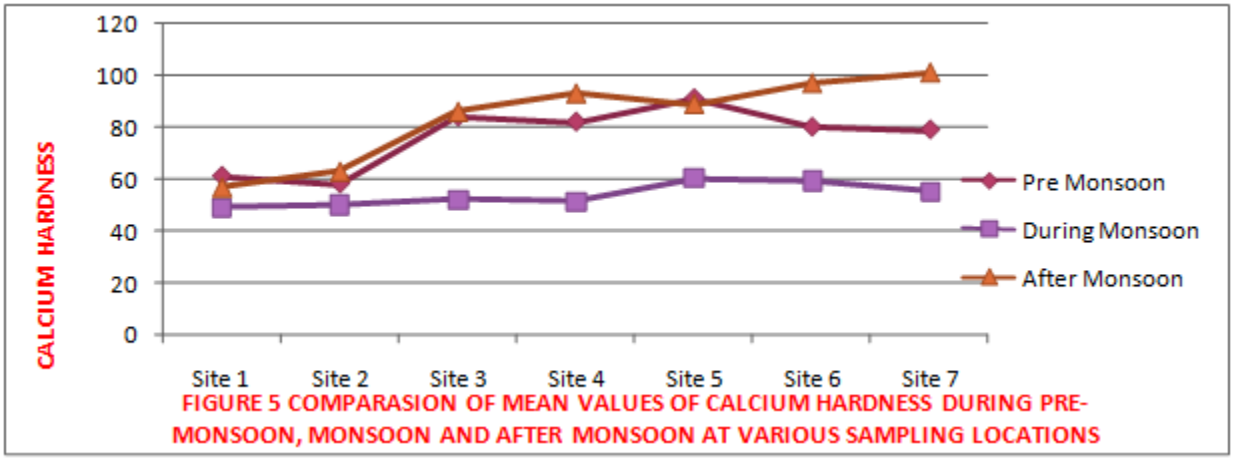

FIGURE 5 COMPARASION OF MEAN VALUES OF CALCIUM HARDNESS DURING PRE-MONSOON, MONSOON AND AFTER MONSOON AT VARIOUS SAMPLING LOCATIONS

7- 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 before monsoon, immediately after heavy rain and approximately after one month of monsoon season are shown in Fig.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. Total hardness values before monsoon and after one month of monsoon season are greater than 321 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.

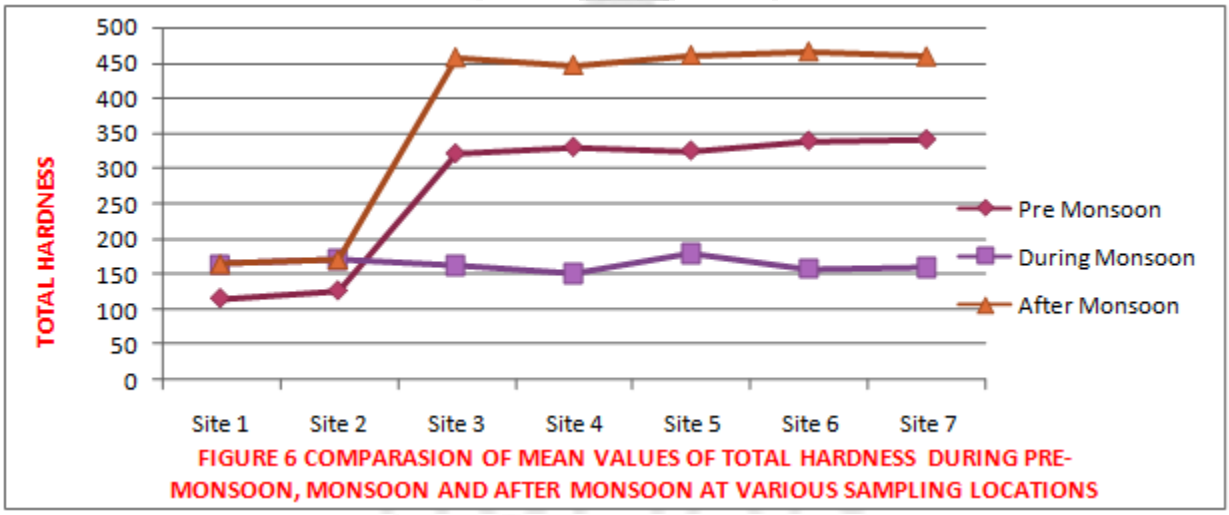

FIGURE 6 COMPARASION OF MEAN VALUES OF TOTAL HARDNESS DURING PRE-MONSOON, MONSOON AND AFTER MONSOON AT VARIOUS SAMPLING LOCATIONS

8- 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 before monsoon, immediately after heavy rain and approximately after one month of monsoon season are shown in Fig.7. ISI, ICMR, BIS and WHO proposed a desirable range of Alkalinity of drinking water. The Alkalinity values immediately after heavy rain at all the sources are well within the ISI, ICMR, BIS and WHO desirable limits. Alkalinity values before monsoon and after one month of monsoon season are greater than 230 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.

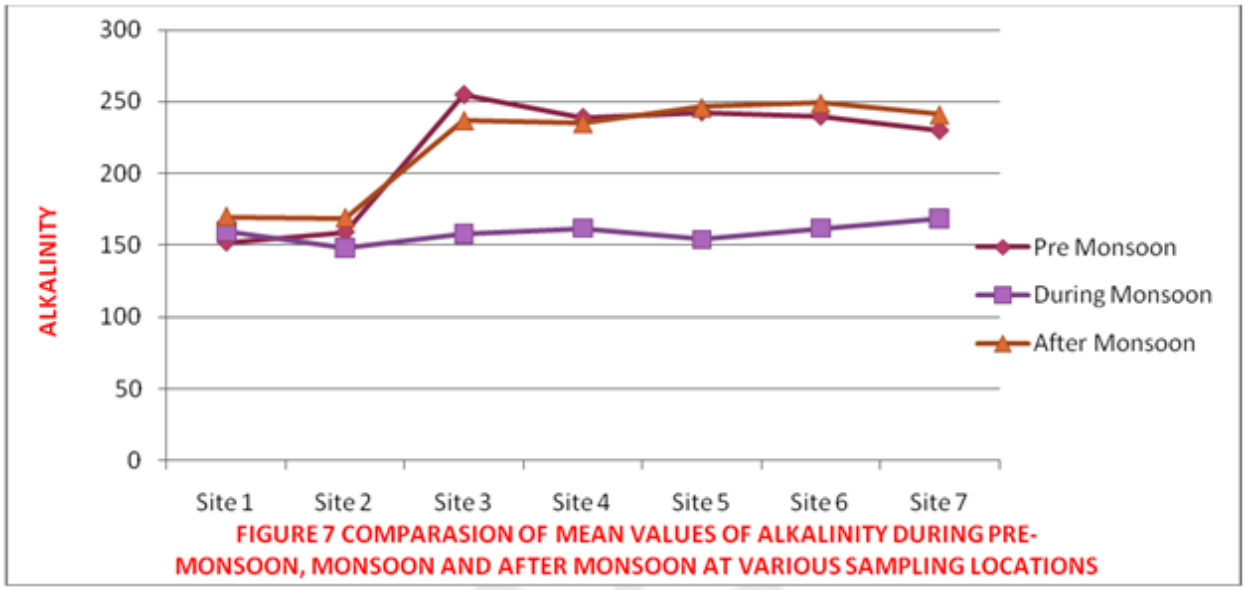

FIGURE 7 COMPARASION OF MEAN VALUES OF ALKALINITY DURING PRE-MONSOON, MONSOON AND AFTER MONSOON AT VARIOUS SAMPLING LOCATIONS

CONCLUSION

The Paon Dhoi River is one of the most important River of Saharanpur that feeding the city in many ways. 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. From the beginning the importance of the river was very much and increasing day by day. But at present that river is under pollution. Like other rivers in the city its water quality is losing day by day. 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 but before monsoon 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 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.

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.
4. Water must not be used for drinking and irrigation purposes without proper treatment.

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