**DETERMINATION OF WATER QUALITY INDEX OF PAON DHOI RIVER AND ITS
IMPACT ON HUMAN HEALTH IN SAHARANPUR (U.P.)****Dinkar Malik***

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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 three different locations of the river and their WQI was determined from various physico-chemical parameters during rainy, winter and summer seasons. Water quality index provides us a single number which expresses overall water quality at a certain location and time which is based on several quality parameters. 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: Dissolved Oxygen, Total Dissolved Solids, Physico-Chemical analysis, Alkalinity, Paon Dhoi River

INTRODUCTION

One of the things which make Earth a unique planet in this universe is continuous availability of water, a vital requisite for the existence of life. 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. Human activities that involve urbanization, agricultural development, over use of fertilizers, inadequate management of land use and sewage disposal have directly or indirectly affected the quality of water and making it unfit for domestic purpose. Therefore now a day's fresh water has become a scare commodity due to over exploitation and pollution (Singh and Mathur 2005). 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. 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. Household water treatment practice may play a vital role in protecting

public health where water sources exist. 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).

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	Saklapuri	Agricultural runoff sources and Animal wash
II	Rameshwar Temple	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

METHODOLOGY

Sampling Area

The water samples from the water body were collected at an interval of 30 days 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:

$$q_n (\text{water quality rating}) = 100 (V_n - V_{io}) / (S_n - V_{io})$$

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.

W_n (Unit weight) = K/S_n .

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.

$$\text{Water Quality Index (WQI)} = \frac{\sum q_n W_n}{\sum W_n}$$

TABLE 1: 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

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 (Saklapuri), S-II (Rameshwar Temple), S-III (Rakesh Cinema) for physico-chemical analysis. Water samples were collected from sampling sites during rainy season, winter season and summer season.

Sampling Methodology

From each sampling location, samples were collected during rainy season, winter season and summer season as recommended in WHO guidelines (WHO 2004, 2009). For statistical significance of the test results, each sampling location was sampled three times during rainy season, winter season and summer season. On a specific date, samples from all the three sampling locations were collected. In this way a total of 117 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 $1-4^{\circ}\text{C}$ 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 precise 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.

TABLE II- Seasonal Variation and Calculation of Water quality index in Rainy, Winter and Summer Season at different Sampling Sites

Parameters	Seasons	S-I	S-II	S-III	Standard Value(S _n)	Unit Weight (W _N)
pH	Rainy Season	7.2	7.5	7.6	6.5-8.5	0.219
	Winter Season	7.4	8.8	8.9		
	Summer Season	7.5	8.4	8.7		
Temperature (°C)	Rainy Season	27.7	29.2	28.6	--	--
	Winter Season	17.6	17.9	18.3		
	Summer Season	32.3	33.6	34.8		
Turbidity (NTU)	Rainy Season	3.9	4.2	4.3	5.00	--
	Winter Season	4.4	5.6	5.8		
	Summer Season	4.0	5.3	5.5		
Color	Rainy Season	Clear	Clear	Clear	--	--
	Winter Season	Clear	Black	Black		
	Summer Season	Clear	Black	Black		
TDS (mg/L)	Rainy Season	294	299	302	500	0.0037
	Winter Season	297	521	532		
	Summer Season	305	535	545		
Calcium Hardness (mg/L)	Rainy Season	52	58	53	75	0.025
	Winter Season	49	79	82		
	Summer Season	50	81	86		
Total Hardness (mg/L)	Rainy Season	210	215	231	300	0.0062
	Winter Season	216	342	363		
	Summer Season	235	371	386		
Alkalinity (mg/L)	Rainy Season	132	129	135	150	0.0155
	Winter Season	130	178	188		
	Summer Season	136	169	199		
Total Suspended Solid (mg/L)	Rainy Season	401	410	418	500	0.0037
	Winter Season	397	563	586		
	Summer Season	402	544	598		
Magnesium Hardness (mg/L)	Rainy Season	17	21	24	30	0.061
	Winter Season	21	38	41		
	Summer Season	23	40	46		
Chloride (mg/L)	Rainy Season	186	195	201	250	0.0074
	Winter Season	189	272	295		
	Summer Season	193	282	298		
Dissolved Oxygen (mg/L)	Rainy Season	2.4	2.5	3.1	5.00	0.3723
	Winter Season	2.7	6.2	6.5		
	Summer Season	2.9	6.5	6.8		
BOD (mg/L)	Rainy Season	3.2	4.1	3.9	5.00	0.3723
	Winter Season	3.7	5.4	5.5		
	Summer Season	3.9	5.3	5.9		
WQI	Rainy Season	57.44	67.14	68.09		
	Winter Season	65.05	115.6	120.85		
	Summer Season	69.12	118.6	128.41		

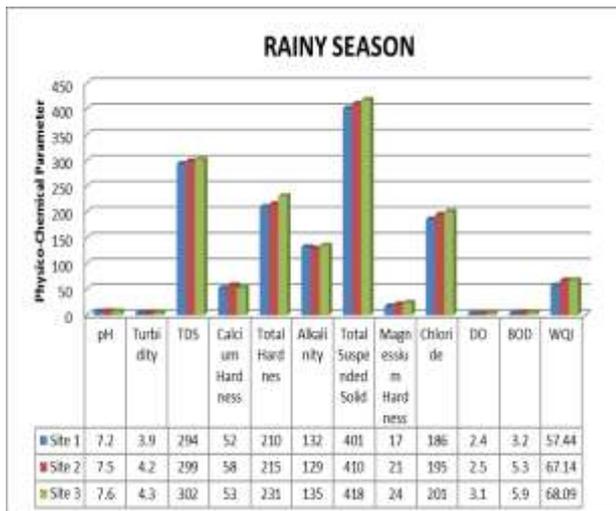


Figure 1: Seasonal changes in physico-chemical parameters with respect to WQI of Paon Dhoi river during Rainy Season



Figure 2: Seasonal changes in physico-chemical parameters with respect to WQI of Paon Dhoi river during Winter Season

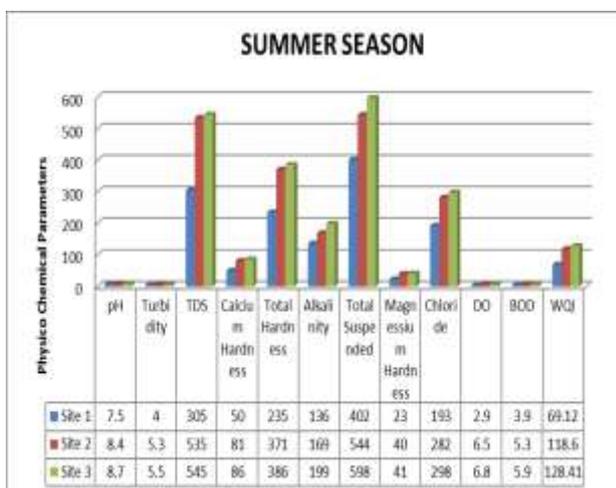


Figure 3: Seasonal changes in physico-chemical parameters with respect to WQI of Paon Dhoi river during Summer Season

RESULTS AND DISCUSSION

Water Quality Index of Paon Dhoi River at three different sampling sites is established from various physico-chemical parameters in different seasons. The values of various physico-chemical parameters for calculation of Water Quality Index are presented in table II. The result shows that the pH values are alkaline in all three sites. The pH values during rainy season at all the sources are well within desirable limits and pH values during winter and summer season are greater than 8.4 except 1st sampling sites. During the investigation period temperature varied from 17.6^oC to 34.8^oC. The water samples collected were found to be odorless, colorless and clear during rainy season. It becomes blackish during winter and summer season except 1st sampling sites. Total Dissolved Solids (T.D.S) ranged from 397-598 mg/L. The TDS values during rainy season at all the sources are well within desirable limits and TDS values during winter and summer season are greater than 521 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 rainy season at all the sources are well within desirable limits and calcium values during winter and summer 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 rainy season at all the sources are well within desirable limits and magnesium values during winter and summer season are greater than 38 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 soaps to form ppt. The Total Hardness during rainy season at all the sources is well within desirable limits and Total Hardness during winter and summer season is greater than 342 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. The alkalinity values during rainy season at all the sources are well within desirable limits however alkalinity values during winter and summer season are greater than 169 mg/L except 1st sampling sites. 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 rainy season at all the sources are well within desirable limits however chloride during winter and summer season are greater than 272 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 rainy season at all the sources are well within desirable limits however DO values during winter and summer season are greater than permissible limit except 1st sampling sites. BOD has been used as a measure of the amount of organic materials in an aquatic solution which supports the growth of micro-organisms. In present study the BOD values during rainy season at all the sources are well within desirable limits however BOD values during winter and summer 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 Paon Dhoi River. The summer, monsoon and winter seasons 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 rainy season however severe pollution at IInd and IIIrd Site during winter and summer seasons. . 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. There is a need of increasing awareness among the people to maintain the river water at their highest quality and purity level. To improve the quality of water there should be continuous monitoring of pollution level and methods should be applied for removing water pollution in the river.

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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