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Assessment of Water Quality: A Case Study of River Yamuna

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Abstract: *According to the Hindu mythology, river Yamuna is considered as one of the most sacred rivers after the Ganges. In this study water quality of the river Yamuna was assessed at four different sampling locations during the months of May to August 2014. Physico-chemical parameters like pH, EC, turbidity, TDS, DO, BOD, COD, Cl^- and SO42- were analyzed and the observed results were compared with the standard limits of BIS and WHO. The mean pH, EC, turbidity, TDS, DO, BOD, COD, Cl^- and SO_4^{2-} values at the four sampling sites were observed in the range of 7.81-8.00, 1046.5-1195.3 µS/cm, 27.0-37.3 NTU, 856.5-936.0 mg/l, 4.5-5.2 mg/l, 19.3-25.8 mg/l, 58.0-85.0 mg/l, 242.5-267.0 mg/l and 97.75-114.0 mg/l respectively. The results on the water quality parameters of Yamuna river indicate that the river is not safe for domestic purposes.*

Keywords: Water Quality, River water, BIS, WHO, Physico-chemical.

1. Introduction

Clean and wholesome water is required for several purposes for healthy living. Rivers are ideally considered as one of the important natural resource for the development of human civilization and is being polluted by various sources e.g. disposal of agricultural wastes, sewage, industrial waste etc., ultimately affecting its physico-chemical and microbiological quality. River Yamuna has been well known as a holy river in Indian mythology and various pilgrimage centers e.g. Yamunotri (Uttaranchal), Paonta Sahib (Himachal Pradesh), Mathura (Uttar Pradesh), Vrindavan (Uttar Pradesh), Bateshwar (Uttar Pradesh) and Allahabad (Uttar Pradesh) are situated at the banks of this river. Major urban centers e.g. Yamuna Nagar, Sonepat, Delhi, Gautam Budh Nagar, Faridabad, Mathura, Agra etc. are also setup on its banks. The holy river Yamuna is subjected to may uses for community such as bathing, domestic water supply, irrigation, and disposal of sewage and industrial effluents. River ecosystems are most vulnerable habitats and likely to be altered by the anthropogenic inputs [1].

The physico-chemical analyses of river water provide a good indicator of the physical as well as chemical state of the river ecosystem. Therefore qualitative and quantitative analyses of different types of water quality parameters can be used to assess the pollution status. Attention has also been paid on the monitoring of Indian rivers [2,3,4,5,6,7,8]. Keeping this in view the study was under taken to assess the physico-chemical characteristics of water in river Yamuna at district Yamuna Nagar, Haryana.

2. Materials and Methods

The investigation was carried out at four designated sampling locations selected on the basis of occurrence of industries which are responsible for point source of pollution and accessibility where peoples are using the river water for domestic purposes. River water samples were collected from four selected locations (on monthly basis) in 1-L sampling bottles and thereafter stored at 4°C. All the sampling locations are shown in Figures 4-7. The study was conducted over a period of 4 months (May-August, 2014). All the parameters of water were analyzed according to the standard methods [9].

3. Results and Discussion

A comparison of water quality parameters of the Yamuna river as observed with drinking water quality standards [10,11] was given in Table 1. In the sub-headings, a brief discussion of parameters like pH, EC, turbidity, TDS, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), chloride (Cl^-) and sulphate (SO_4^{2-}) is being presented.

3.1 Hydrogen ion activity (pH)

Considering the average values (Figure 3.2) the pH of the river water varied from a minimum of 7.81 at sampling station 1 to a maximum of 8.00 at sampling station 3. As the pH values were observed to be alkaline, which indicate that alkaline nature of river water might be due to reduced solubility of CO_2. The average results (Figure 3.2) indicate that river water samples collected from four different sampling stations were moderately alkaline (pH 7.81-8.00) and within the permissible limits i.e., pH 6.5-8.5 of BIS (Table 1).

3.2 Electrical Conductivity

The EC values (considering the average values) of the river water varied from a minimum of 1046.5 µS/cm at sampling station 1 to a maximum of 1195.3 µS/cm at sampling station 4. The average results (Figure 3.4) show that EC values were within the permissible limit (3000 µS/cm) of BIS (Table 1).

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3.3 Turbidity

The Considering the average values the turbidity of the river water varied from a minimum of 27.0 NTU at sampling station 1 to a maximum of 37.3 NTU at sampling station 3 (Figure 3.4). The results also shows that turbidity content of river water collected from four different sampling stations were at least 5-7 times more than the maximum permissible limit (5 NTU) of BIS (Table 1).

3.4 Total dissolved solids (TDS)

Considering the average values the TDS content of the analyzed river water varied from a minimum of 856.5 mg/l at sampling location 1 to a maximum of 936.0 mg/l at sampling location 4 (Figure 3.8). The average results also shows that TDS content of river water collected from different sampling locations were not satisfying the desire limit (500 mg/l) of BIS (Table 1).

3.5 Dissolved oxygen (DO)

It is an indicator of purity of water. Decrease of DO concentration in water is generally due to respiration of biota, biodegradation of organic matter, rise in temperature, oxygen demanding wastes and inorganic reluctant [12]. Considering the average values the dissolved oxygen (DO) content of river water varied from a minimum of 4.5 mg/l at sampling station 4 to a maximum of 5.2 mg/l at sampling station 2.

The results show that during pre-monsoon session the dissolved oxygen levels of river water were more than that of post-monsoon session (Figures 3.9 & 3.10).

3.6 Biological oxygen demand

The fluoride It is the amount of oxygen (O_2) required by the microbes for complete degradation of biodegradable organic matter present in water at a particular temperature, given time period and in a given volume. The average BOD of the river water samples varied from a minimum of 19.3 mg/l at sampling station 2 to a maximum of 25.8 mg/l at sampling station 4 (Figure 4.12). The BOD value indicates the pollution contributed by biodegradable organic matter coming from various sources [1].

3.7 Chemical oxygen demand

It is an estimation of oxygen (O_2) equivalent to the requirement of oxidizing organic matter contents by an oxidizing reagent i.e. $K_2Cr_2O_7$ in presence of a catalyst i.e. H_2SO_4.

The COD test indicates the toxic conditions and the presence of biodegradable organic substances. Considering the average values the COD of the analyzed river water samples varied from a minimum of 58.0 mg/l at sampling station 1 to a maximum of 85.0 mg/l at sampling station 4 (Figure 3.14). The results show that COD of river water were exceeding the limits of BIS and WHO.

3.8 Chloride (Cl)

Chlorides in natural water are due to leaching of rocks. The major source of chlorides in fresh water is sewage and industrial waste. Human body releases a very high quantity (6 g/person/day) of chloride. Since presence of higher concentrations of Cl^- are usually indicative of pollution. Considering the average values the chloride content of the analyzed river water samples varied from a minimum of 242.5 mg/l at sampling station 1 to a maximum of 267.0 mg/l at sampling station 4 (Figure 3.18). The results shows that chloride content of river water were within the maximum limit (1000 mg/l) of BIS (Table 1).

3.9 Sulphate (SO_4^{2-})

Considering the average values the SO_4^{2-} content of the analyzed river water samples varied from a minimum of 97.75 mg/l at sampling station 3 to a maximum of 114.0 mg/l at sampling station 4 (Figure 3.18). The results indicate that sulphate content of collected river water were within the desirable limit (200 mg/l) of BIS (Table 1).

4. Conclusions

In this study nine water quality parameters along the river Yamuna at four different sampling locations of Yamuna Nagar City, during the months of May to August 2014 were assessed. The results revealed that except pH and sulphate all the remaining water quality parameters were exceeding the desire prescribed limit of BIS. Therefore it is concluded that River Yamuna in Yamuna Nagar City is severely polluted and unsafe for domestic consumption. The deterioration of river water quality may be due to both point and non-point sources of pollution i.e. large as well as small scale industrial units and agriculture sectors of the city.

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Table 1: *Comparison of observed water quality parameters of Yamuna river and drinking water quality standard (BIS and WHO)*

Parameters	Range of samples		BIS Standards		WHO Limit
	Minimum	Maximum	Desirable	Maximum	
pH	7.81	8.00	6.5-8.5	No Relaxation	6.5-9.2
EC	1046.5	1195.3	-	3000 µS/cm	-
Turbidity	27.0	37.3	1	5	5
TDS	856.5	936.0	500	2000	500
DO	4.5	5.2	>6	>6	>5
BOD	19.3	25.8	<2	<2	3
COD	58.0	85.0	-	-	-
Cl^-	242.5	267.0	250	1000	-
SO_4^{2-}	97.75	114.0	200	400	-

** All parameters are in mg/l except pH, EC in µS/cm and turbidity in NTU*

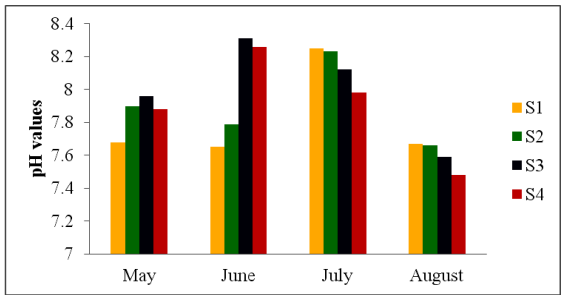

Figure 3.1: *pH values of river Yamuna at sampling locations*

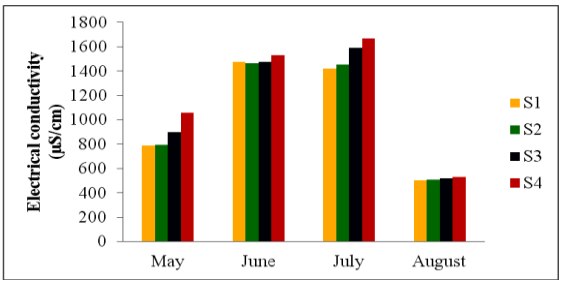

Figure 3.3: *EC values of river Yamuna at sampling locations*

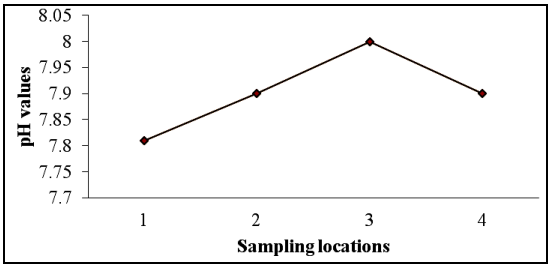

Figure 3.2: *Average pH values of river Yamuna at sampling locations*

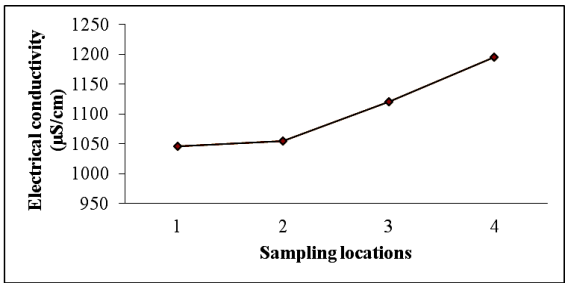

Figure 3.4: *Average EC values of river Yamuna at sampling locations*

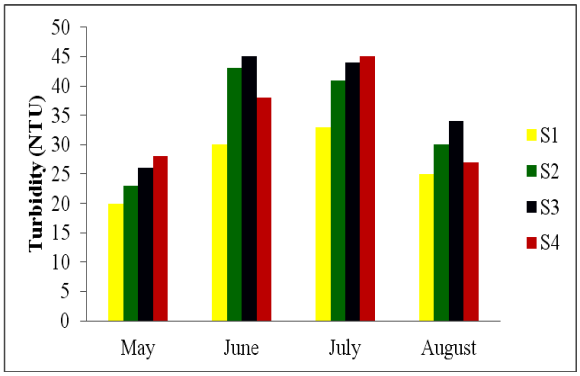

Figure 3.5: *Turbidity content of river Yamuna at sampling locations*

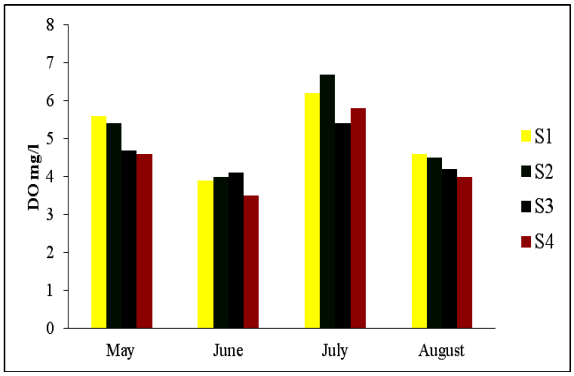

Figure 3.9: *Dissolved oxygen content of river Yamuna at sampling locations*

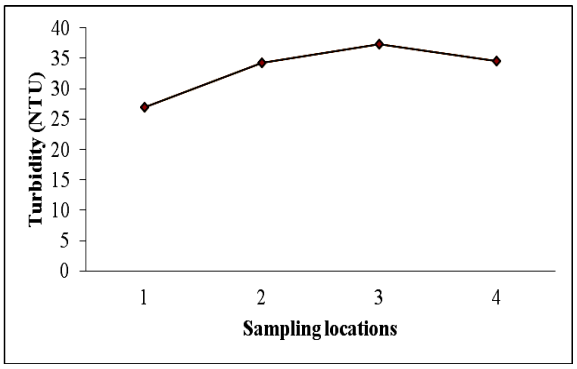

Figure 3.6: *Average turbidity content of river Yamuna at sampling locations*

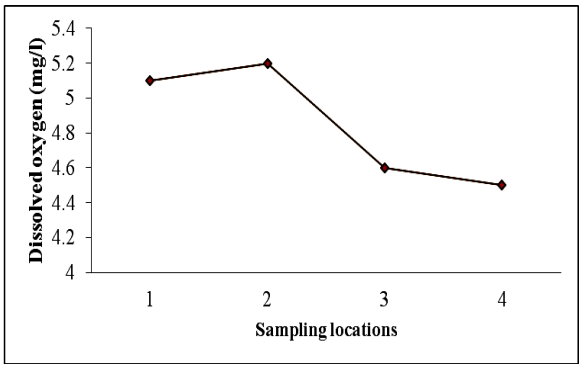

Figure 3.10: *Average dissolved oxygen content of river Yamuna at sampling locations*

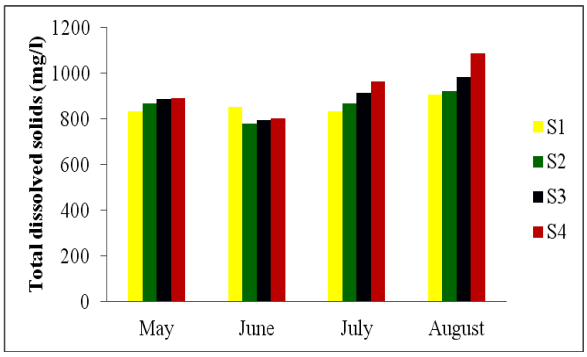

Figure 3.7: *TDS content of river Yamuna at sampling locations*

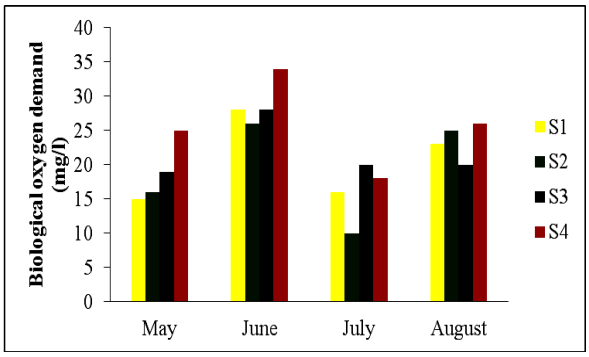

Figure 3.11: *BOD of river Yamuna at sampling locations*

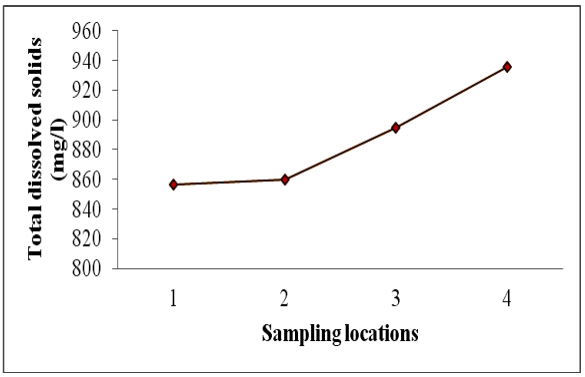

Figure 3.8: *Average TDS content of river Yamuna at sampling locations*

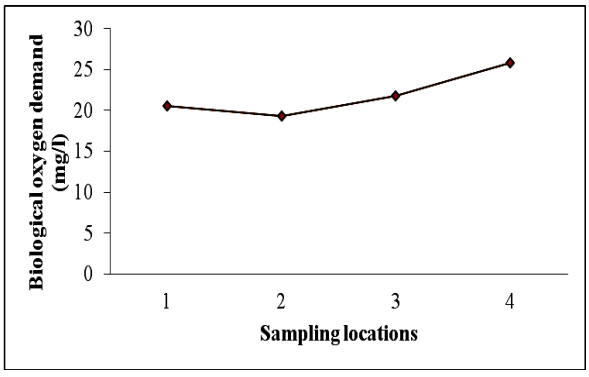

Figure 3.12: *Average BOD of river Yamuna at sampling locations*

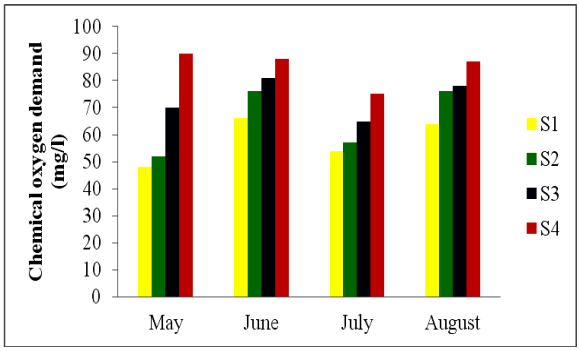

Figure 3.13: *COD of river Yamuna at sampling locations*

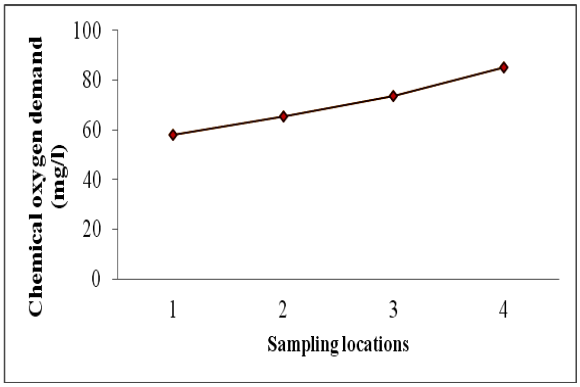

Figure 3.14: *Average COD of river Yamuna at sampling locations*

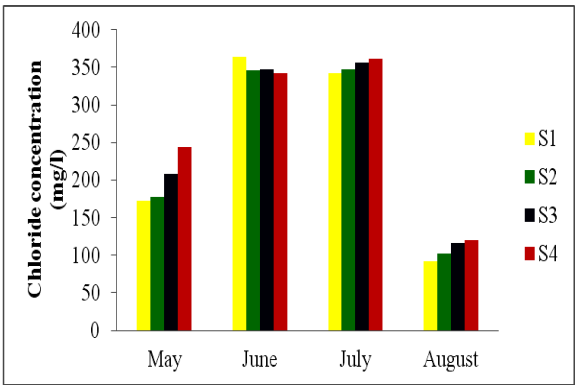

Figure 3.15: *Chloride content of river Yamuna at sampling locations*

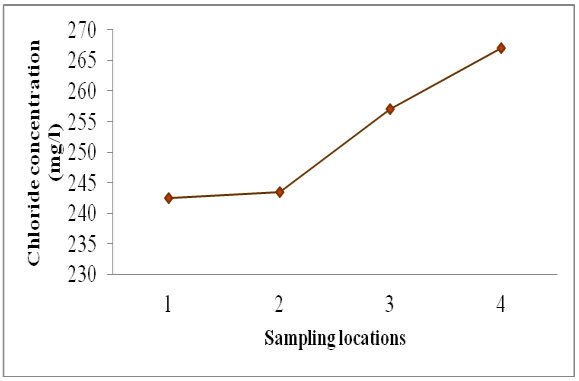

Figure 3.16: *Average chloride content of river Yamuna at sampling locations*

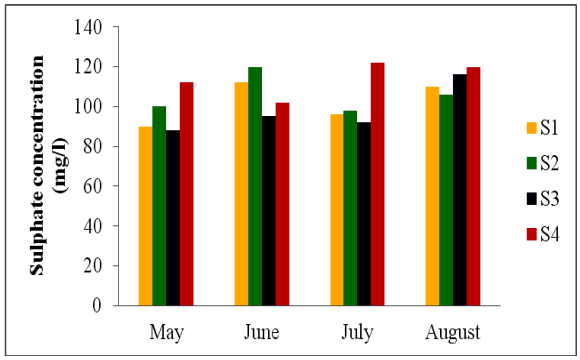

Figure 3.17: *Sulphate content of river Yamuna at sampling locations*

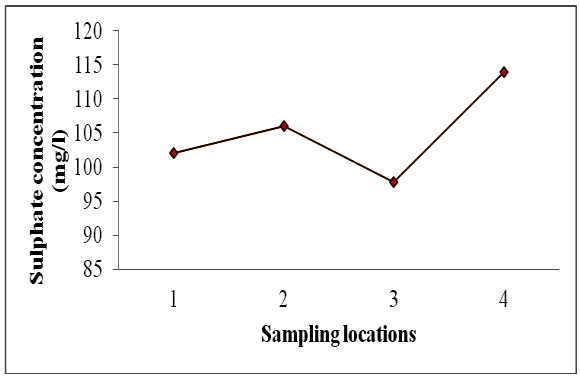

Figure 3.18: *Average sulphate content of river Yamuna at sampling locations*

Figure 4: *Sampling Station-1 Near Chhota Bridge*

Figure 5: *Sampling Station-2 Near O.P. Jindal Park*

Figure 6: *Sampling Station-3 Near Railway Bridge*

Figure 7: *Sampling Station-4 Near Old Hamida Barrage*