Study of Physico – Chemical Parameters to obtain WQI of Yamuna River Water, New Delhi, India

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Abstract **- Water quality index (WQI) is a remarkable and unique technique to rate and to depict the overall water quality status in a single term. To calculate the WQI the influence of different water quality parameters are studied in detail. The sums of these are then substituted in the numerical formula and the WQI is obtained. The different parameters gives the exact quantity of the impurities present in the water and its toxic level, but the WQI suggests the overall quality of water and also that whether it should be healthy to be used for biotic and abiotic environment. In other words it explains that how healthy the water is.**

Key Words **- Tributary, Water Quality Index, Tourists, Toxicity, Potable**

I. INTRODUCTION

Yamuna River is one of the biggest tributary of the river Ganga. It has its source in Yamunotri Glacier on the southwestern sides of Banderpooch crests in the lower Himalayan ranges. The river Yamuna has both religious and economic importance. The river runs in a span of 1,376 km and has a catchment area of 366,223 Sq.Km. Yamuna flows through the states of Delhi, Haryana and Uttar Pradesh, before merging with the Ganges at Allahabad. Famous cities like Delhi, Mathura and Agra are situated on its banks. All these cities are famous tourist places and attract visitors from India and abroad all throughout the year. World famous monument Taj Mahal in Agra and birth place of Sri Krishna attracts tourists in large number to visit these places. Delhi being the capital of India is always flooded with large number of people including officials, visitors, embassies, industrialist, politicians and job seekers and so on. These big cities and small towns all depend on the Yamuna river water to satisfy their thirst of growth, industries, agriculture, and potable water. The river is getting highly polluted due to all these reasons and its water is almost formidable for use. Several authors have studied various physico – chemical parameters for major rivers to assess their water quality [1] – [11]. To designate the quality of water WQI method is one of the most effective tools that offer a simple, reproducible and effective means to express the quality of water [12] – [18]. It is calculated by substituting the aggregate of many important parameters that affect the quality of water. It gives a clear idea of whether the water can be consumed for drinking purposes.

II. MATERIALS AND METHODS

Samples were collected from Yamuna River as per standard procedures. Several physico – chemical parameters such as Calcium ions, Magnesium ions, pH, Electrical Conductivity, Alkalinity, Total dissolved solids, Total hardness were studied using standard methods [19]. The results were compared with the WHO and ISI standards (table 1) [20]. AR grade chemicals and glass distilled water were employed to prepare the reagents. Systronics – Conductometer and Digital Systronics pH – meter were used for the determination of Conductivity and pH respectively.

III. CALCULATION OF WATER QUALITY INDEX

WQI gives a single numeric value to define water quality in a simple manner. This is calculated on the basis of several physico – chemical parameters of the water. The quality of water is obtained in terms of index number which is easy to understand and also easy to assess the quality of water [21].

Calculation of Quality rating (Q_i):

Quality rating for each parameter was calculated by using the following equation

$$Q_i = \frac{(V_{actual} - V_{ideal})}{(V_{standard} - V_{ideal})} X\ 100$$

Where, Q_i = Quality rating of i^{th} parameter for a total of n water quality parameters.

V_{actual} = Actual value of the water quality parameter obtained from laboratory analysis

V_{ideal} = ideal value of that quality parameter can be obtained from the standard tables.

V_{ideal} for pH = 7 and for other parameters it is equating to zero

$V_{standard}$ = Recommended WHO standard of the water quality parameter.

Calculation of Unit weight (W_i):

Unit weight was calculated by a value inversely proportional to the recommended standard (S_i) for the corresponding parameter using the following expression

$$W_i = \frac{K}{S_i}$$

Where, W_i = Unit weight for nth parameter

S_i = Standard permissible value for nth parameter

K = proportionality constant, For the sake of simplicity,

K is assumed as 1,

The overall WQI was calculated by aggregating the quality rating with unit weight linearly using the following equation

$$WQI = \frac{\sum W_i Q_i}{\sum W_i}$$

Where, Q_i = quality rating, W_i = Unit weight

IV. RESULTS AND DISCUSSION

A. Temperature

It is an important parameter, the dissolution of the minerals increases with a rise in temperature, but the solubility of gases decreases. It was found to be 24^0C for both the samples.

B. pH

pH is defined as the negative logarithm of hydrogen ion concentration. The pH of potable water should be between 7 to 8. It is affected by hydrolysis of salts of strong bases and weak acids vice versa. Dissolved gases such as carbon dioxide, Hydrogen sulphide, ammonia etc also affect the pH. It was reported as 7.10 for S_1 and 7.11for S_2. Table 2, Fig 1.

C. Alkalinity

The capacity of water to neutralize the acids is known as alkalinity. It is due to the presence of bicarbonates, carbonates and hydroxide ions. Alkalinity in water is due to rocks and soils, plant and animal activities, discharge of industrial wastes. It was reported as, 350 mg/L in S_1 and 360 mg/L in S_2 respectively. Table 2, Fig 1.

D. Electrical Conductivity

Electrical conductivity is defined as the capacity of water to conduct electricity. It is due to the presence of dissolved salts and minerals in the water. The Electrical Conductivity was found to be 1290 µs/cm for both the samples. Table 2, Fig 1.

E. Total hardness

The property that prevents lathering of water with the soap solution is termed as hardness. It is due to the presence of calcium and magnesium of bicarbonate, chloride and sulphate. Total hardness was reported as 601 mg/L and 610 mg/L for samples S_1 and S_2 respectively, Table 2, Fig 1.

F. Calcium and Magnesium ions

Excess of calcium and magnesium ions in water leads to various kinds deadly diseases due to their deposition in the soft tissues. Presence of Calcium ions was found to be 319 mg/L and 325 mg/L for S_1 and S_2 respectively, which is a very high concentration for drinking water. Magnesium ion was found to be 282 mg/L and 285 mg/L for sample S_1 and S_2 respectively. These values of calcium and Magnesium ions are very high. Table 2, Fig 1.

G. Total Dissolved Solids

Total Dissolved Solids is the sum of all the dissolved chemicals present in the water. The amount of Total Dissolved Solids was reported as 1136 mg/L for S_1 and 1140 mg/L for S_2. Table 2, Fig 1.

Table 1
Methods employed and Their WHO & ISI Standards

Parameters	Method	WHO Standards	ISI Standards
Temperature	Thermometric	-----	-----
pH	pH metery	7.0 – 8.0	6.5 – 8.5
Electrical Conductivity	Conductometry	1400	-------
Total Dissolved Solid	Filtration Method	1000	500
Total Hardness	EDTA titration	100	300
Calcium	EDTA titration	75	75
Magnesium	EDTA titration	150	30
Alkalinity	Titration Method	120	120

Table 2
Water Quality Parameters of Yamuna river water

Parameters	Method	S_1	S_2
Temperature	Thermometric	24^0C	24^0C
pH	pH metery	7.10	7.11
Electrical Conductivity	Conductometry	1290	1290
Total Dissolved Solid	Filtration Method	1136	1140
Total Hardness	EDTA titration	601	610
Calcium	EDTA titration	319	325
Magnesium	EDTA titration	282	285
Alkalinity	Titration Method	350	360

Table 3
water Qaulity Index (WQI) status of water quality [22]

Water Quality Index Level	Water Quality Status
0 – 25	Excellent water quality
26 – 50	Good water quality
51 – 75	Poor water quality
76 – 100	Very poor water quality
> 100	Unsuitable for drinking

Table 4
Calculation of WQI for S_1 sample

Parameters	Observed values	Standard values	Unit Weight(W_i)	Quality rating (Q_i)	Weighted values (W_iQ_i)
pH	7.10	8.5	0.117647	6.6666	0.78430
Electrical Conductivity	1290	300	0.003333	430	1.43319
Total Dissolved Solid	1136	500	0.002	227.2	0.4544
Total Hardness	601	300	0.003333	200.3333	0.66771
Calcium	319	75	0.01333	425.3333	5.66969
Magnesium	282	30	0.03333	940.0	31.3302
Alkalinity	350	120	0.008333	291.6666	2.43054
			$\sum W_i = 0.181306$		$\sum W_iQ_i = 42.77013$
Water Quality Index (WQI) = $\sum W_iQ_i / \sum W_i = 235.99002$					

Table 5
Calculation of WQI for S_2 sample

Parameters	Observed values	Standard values	Unit Weight (W_i)	Quality rating(Q_i)	Weighted values (W_iQ_i)
pH	7.11	8.5	0.117647	7.3333	0.86274
Electrical Conductivity	1290	300	0.003333	430	1.43319
Total Dissolved Solid	1140	500	0.002	288.0	0.456
Total Hardness	610	300	0.003333	203.3333	0.67770
Calcium	325	75	0.01333	433.3333	5.77633
Magnesium	285	30	0.03333	950.0	31.6635
Alkalinity	360	120	0.008333	300.0	2.4999
			$\sum W_i = 0.181306$		$\sum W_iQ_i = 43.36936$
Water Quality Index (WQI) = $\sum W_iQ_i / \sum W_i = 239.20532$					

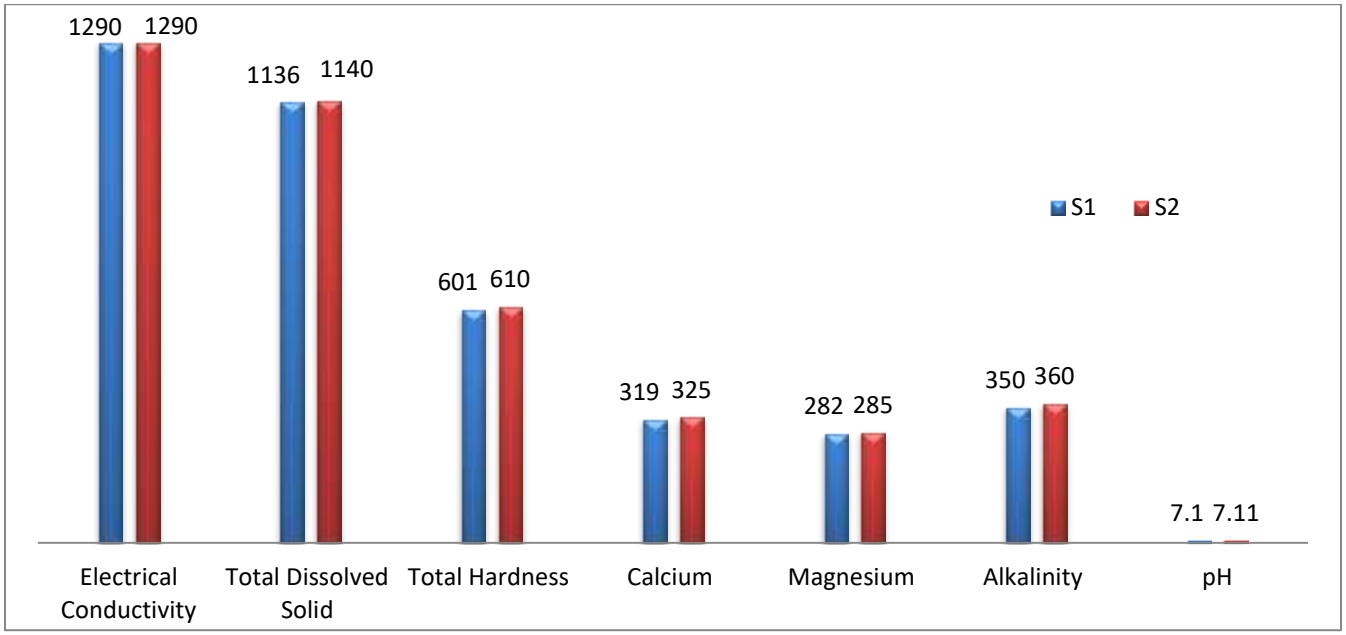

Fig 1 Graphical representation of physico – chemical parameters of Yamuna river water

V. CONCLUSION

The results obtained by the above analysis for Yamuna river water at New Delhi are very alarming. All the parameters studied showed very high values. All the values were above the tolerance limit of the said standards. The WQI calculated on the basis of the parameters was found to be 235.99 [Table 4] and 239.20 [Table 5]. This further suggested that the quality of the water was extremely poor [Table 3] and unfit for drinking. It is not even recommended for consumption in irrigation, agriculture, construction, industries etc. It should be subjected to treatment till the WQI of the water reaches below 50.

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