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Water Quality Index of Ganga River Water, Rishikesh, Uttarakhand, India.

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Abstract*: *A systematic study was carried out to assess the water quality index of River Ganga from Rishikesh, Uttarakhand. Water samples were collected and analysed for physic – chemical parameters like pH, Alkalinity, total hardness, Electrical Conductivity, Calcium ions, magnesium ions and total dissolved solids. All the quality parameters were compared with the standard Values of WHO and ISI. For the assessment of water quality of River Ganga, these parameters substituted in the mathematical equation to get the WQI as it facilitates a single numeric value that defines overall water quality for a definite location

Keywords: Rishikesh, Ganga River, Water quality index, Alkalinity, Hardness

I. INTRODUCTION

Ganga is a major an important river of India which originates from Gadgetry, Uttarakhand in the Himalayas and runs through almost 52 densely populated cities and 48 towns to meet the Bay of Bengal. This river has both emotional and spiritual value among Indians. The water of Ganga carries religious sentiments and is considered as the purest water which can wash off all the sins of the human beings. It is one of the longest river in India and also third largest river in the world in terms of water discharged into sea. Ganga plays an important role in the life of Indian people as the Genetic basin is highly fertile and ideal for cultivation of many crops. It also acts as an abode to some of the rarest species of the planet. The river water is used for irrigation, transportation and fishing. Rishikesh is an important point because it is here it first enters into the plain terrain and from here the city pollution starts contaminating its water. The two rivers Bhagirathi and Alakhnanda join just before Rishikesh to form Ganga. Unfortunately, the water of this holy river is getting polluted by increasing human activities including dumping of sewage water, washing clothes, bathing of animals, agriculture run away water, and release of effluents from the industries. All these activities are responsible for dumping loads of organic and inorganic matter into the river daily thus making the water highly polluted and unfit for drinking. In the recent past, there have been numerous studies in the on assessment of quality of its water [1 – 11]. However, present study is carried out with an objective to assess the water quality index of the Ganga water at its descendent point on the plains where it is supposed to be least polluted. This study can be a bench mark for further studies on water quality of Ganga at different places in the downstream.

II. MATERIALS AND METHODS

Samples were collected as per standard procedures. Various parameters were studied using standard methods [12]and the results obtained were compared with the WHO and ISI standards [13]. All reagents employed were prepared using AR grade chemicals. Glass distilled water was used throughout the analysis. Systronics – Conduct meter and Digital Systronics pH – meter was used for the determination of Electrical Conductivity and pH respectively. Other parameters that were studied during the analysis were ions of Calcium and Magnesium, Alkalinity, Total dissolved solids, Total hardness.

III. CALCULATION OF WATER QUALITY INDEX

The complicated scientific information can be converted into a single number through WQI. It is a dimensionless number that can be arrived by studying many parameters that affects water quality into a single number making it easy for a common man to understand the quality of water. WQI is calculated on the basis of several physic – chemical parameters which is then multiplied by a weighing factor and the final aggregate is obtained using arithmetic mean. WQI tool is used successfully by many authors as a means to state the quality of water for water bodies [14 - 20]. The calculation of the WQI is well explained [21] and the same formula was applied to calculate the WQI in the present study.

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 and DO V_{ideal} = 14.6 mg / L

$V_{standard}$ = 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

Temperature is an important parameter as it is responsible to increase the solubility of many minerals, salts and gases. It was found to be 20^0C for both the samples. (Table I).

B. pH

pHis defined as the negative logarithm of hydrogen ion concentration. The pH for potable water should be between 7 to 8. There are many factors that affect the pH of the water such as presence of dissolved gases, salts, bases, acids. In the present study the pH was found to be 7.88 for S_1 and 8.0 for S_2, which according to ISI and WHO standards is high. (Table I, Fig 1).

C. Alkalinity

Alkalinity is the capacity of water to neutralize the acids. The presence of bicarbonates, carbonates and hydroxides causes alkalinity in the water. These salts in water are due to the dissolution of minerals from rocks, soils, plant and microbial activities and discharge of industrial wastes. The alkalinity that was reported in the present study was also found to be on the higher end 125 mg/L in S_1 and 130 mg/L in S_2respectively.(Table I, Fig 1).

D. Electrical Conductivity

Electrical conductivity is capacity of water to conduct electrical current. It is due to the presence of dissolved salts and minerals. The conductivity was found to be 90 µs/cm for both S_1 and S_2 samples.(Table I, Fig 1).

E. Total hardness

Hardness is an important property of water that prevents lathering of water with the soap solution and if exceeds the tolerance limit may lead to serious illness. It causes serious damage to the products of industries and machinery if untreated water is used. The

main causes of hardness in water are the presence of bicarbonates, chlorides and sulphates of calcium and magnesium. Total hardness was reported as 133 mg/L and 138 mg/L for samples S_1 and S_2 respectively, which according to WHO standards is high but average according to ISI standards.(Table I, Fig 1).

F. Calcium and Magnesium ions

The presence of calcium and magnesium ions leads to hardness in the water. They are responsible for the formation of scales and sludge. The presence of Calcium ions was found to be 93 mg/L and 95 mg/L for S_1 and S_2 respectively, which is a very high concentration for drinking water. Magnesium ions according to ISI standards should not be exceed 30 mg/L but in the present study it was found to be 40 mg/L and 43 mg/L for sample S_1 and S_2 respectively. These values suggest a very high concentration of Magnesium ions.(Table I, Fig 1).

G. Total Dissolved Solids

Total Dissolved Solids is an aggregate of all the dissolved solids present in the water. The amount of Total Dissolved Solids was reported as 80 mg/L for both $S_1$and S_2samples which is not a matter of concern as it is in the safe limits. (Table I, Fig 1).

TABLE I
Water quality parameters and there who & ISI standards.

Parameters	Method	WHO Standards	ISI Standards	Samples of Ganga river water	
				S_1	S_2
Temperature	Thermometric	-----	-----	20^0C	20^0C
pH	pH metery	7.0 – 8.0	6.5 – 8.5	7.88	8.0
Electrical Conductivity	Conductometry	1400	-------	90	90
Total Dissolved Solid	Filtration Method	1000	500	80	80
Total Hardness	EDTA titration	100	300	133	138
Calcium	EDTA titration	75	75	93	95
Magnesium	EDTA titration	150	30	40	43
Alkalinity	Titration Method	120	200	125	130

TABLE II
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	7.88	8.5	0.117647	58.6666	6.90194
Electrical Conductivity	90	300	0.003333	30.0	0.09999
Total Dissolved Solid	80	500	0.002	16.0	0.032
Total Hardness	133	300	0.003333	44.3333	0.14776
Calcium	93	75	0.01333	124.0	1.65292
Magnesium	40	30	0.03333	133.3333	4.44399
Alkalinity	125	120	0.0083333	104.1666	0.86805
			$\sum W_i = 0.181306$		$\sum W_iQ_i = 14.14665$
Water Quality Index (WQI) = $\sum W_iQ_i / \sum W_i = 78.02637$					

TABLE III
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	8.0	8.5	0.117647	60.6666	7.13724
Electrical Conductivity	90	300	0.003333	30.0	0.09999
Total Dissolved Solid	80	500	0.002	16.0	0.032
Total Hardness	138	300	0.003333	46.0	0.153318
Calcium	95	75	0.01333	126.6666	1.68846
Magnesium	43	30	0.03333	143.3333	4.77729
Alkalinity	130	120	0.0083333	108.3333	0.90277
			$\sum W_i = 0.181306$		$\sum W_iQ_i = 14.791068$
Water Quality Index (WQI) = $\sum W_iQ_i / \sum W_i = 81.58068$					

TABLE IV
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

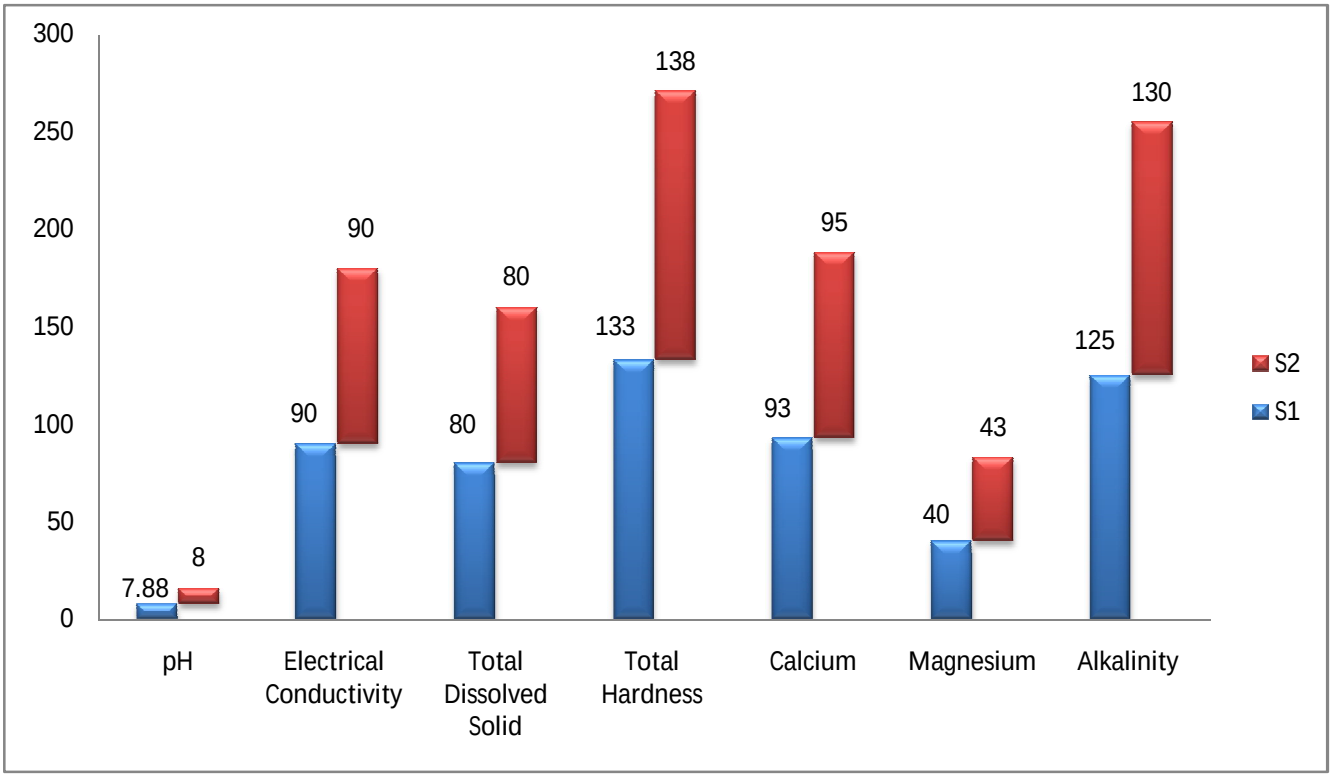

Fig 1: Graphical representation of physico – chemical parameters of Ganga river water

V. CONCLUSION

The above study is an eye opener because the quality of water is very poor (Table IV]) at Rishikesh where it is considered least polluted. The WQI is found to be 78.0 and 81.5 in the samples S_1 (Table II) and S_2 (Table III) respectively. Therefore, the water cannot be recommended for drinking and other domestic purposes without subjecting it to purification. The study suggests that it is a pitiable situation that water at almost its source is not fit for human consumption and as it flows through other major cities it is most likely that water becomes highly polluted rising to the toxic levels. Water quality assessments at other locations can be subject of further investigations.

VI. ACKNOWLEDGEMENT

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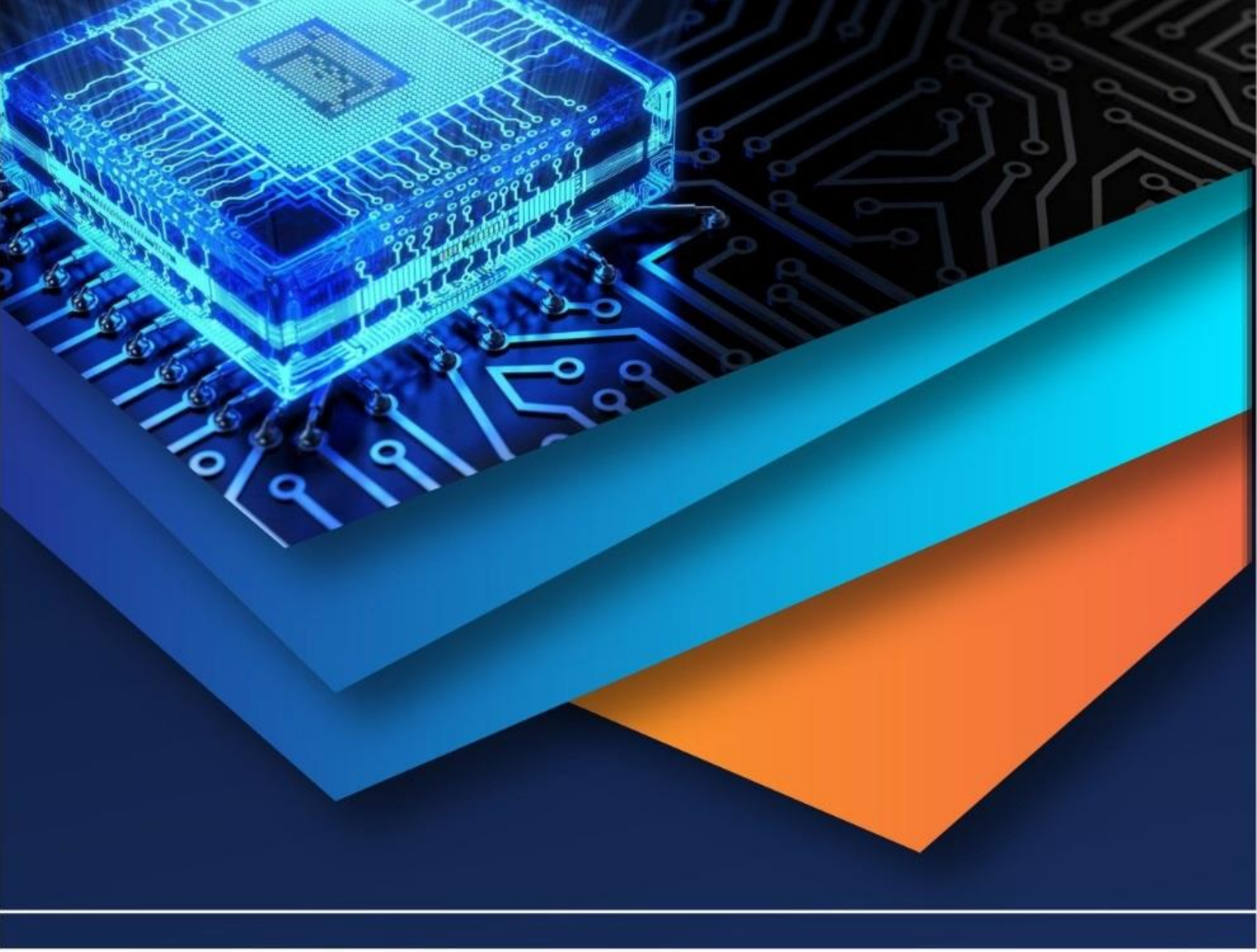

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