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DETERMINATION OF WATER QUALITY INDEX RIVER BHAGIRATHI IN UTTARKASHI, UTTARAKHAND, INDIA

S.K.Pathak[1], Shambhu Prasad[2], Tanmay Pathak[3]
[1, 2]Govt. College Sanwer, Indore (M.P.)
[3]Assistant Manager (Civil) Larsen & Toubro Limited, WDFC CTP 1&2, Jaipur

ABSTRACT

The present paper was intended to calculate water quality index (WQI) of river Bhagirathi. It is one of the tributary of holy river Ganga of India. In order to determine the quality of its water for public use, recreation and other purposes , the eleven parameters like pH, electric conductivity, Total dissolve solids, Total suspended solids, Dissolve oxygen , Biological oxygen demand, Total alkalinity, Total hardness, Chloride, Nitrate and Sulphate were determine. The water quality index calculated from the observed parameters indicate the river Bhagirathi at Uttarakhand during winter was under good water quality condition, while at summer and rainy season of showed poor water quality index. In terms of index number ,offers a useful representation of overall quality of water for public or for any intended use as well as in the pollution mitigate plan and in water quality management.

Keywords:
Water Quality Index, Physico-Chemical Parameters, River Bhagirathi.

INTRODUCTION

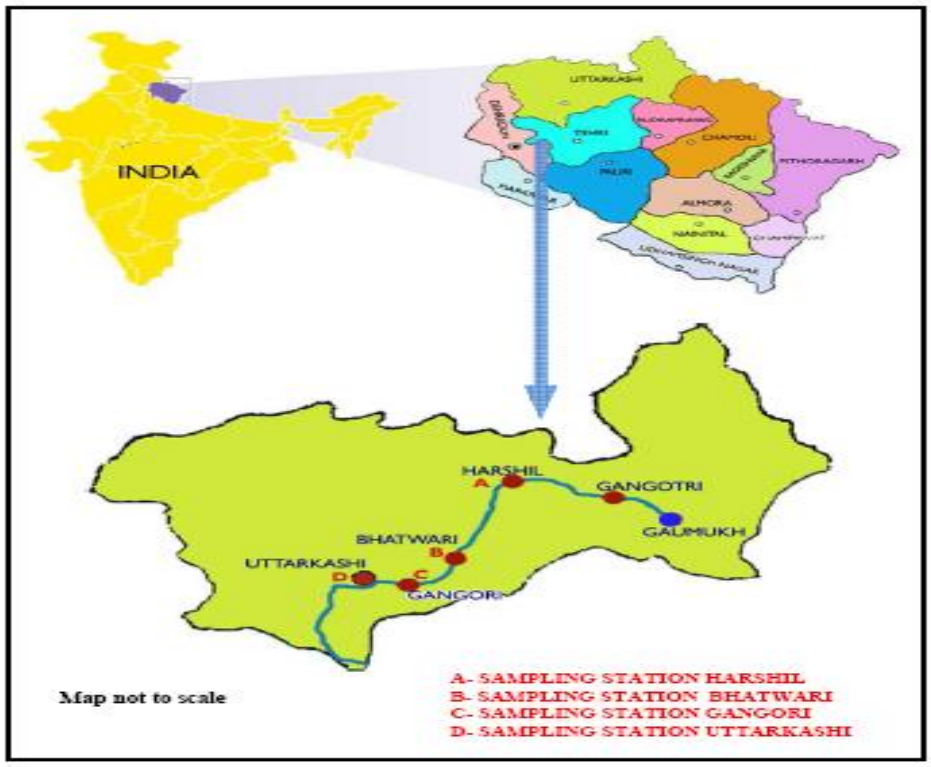
Water is an elixir of life, it is the source of energy, govern the evaluation and function of the universe on the earth. Water is a unique natural resource essential for life and it constantly cycles between the land and the atmosphere. The same water is used for crop and animal production can also be shared with the public and the aquatic and terrestrial ecosystems (Cooper et al., 1998). Increasing problem of deterioration of river water quality to evaluate the production capacity (Mishra et al.,2009).Water resources are of great environmental issues and studied by a wide range of specialists including hydrologists, engineers, ecologists, geologists and geomorphologists (Kumar and Dua,2009). Huge amounts of money and efforts have been made by government during 5 decades to enhance the quality of water for domestic and industrial consumption and reduce its pollution load. One of the most effective ways to communicate information on water quality trends to policy makers and the general public is the indices.

The water quality index (WQI) is a mathematical instrument which provides a single number that expresses overall water quality at a certain location and time, based on several water quality parameters. The objective of this research was evaluate water quality of river Bhagirathi that receives agriculture and domestic drainage water throughout the year. Many researchers of developed countries gives criteria of definition of water quality of natural water bodies (Harkins, 1974; Botton et al. 1978; Lohani, 1981).Similar type of studies have been done in India by Trivedi and Pathak (2007) and Chauhan and Singh, (2010). Chowdhary et al. (2012).

STUDY AREA AND METHODOLOGY

The study area is located in middle Himalaya in Uttarakhand state of India. Uttarkashi is, the district headquarter and is situated between latitude 30^0 22'-31^0 25' north and longititude 77^0 51'-99^0 27' east while the height from sea level is 1180 meters. This area is very rich in biodiversity. For the present study, four sampling station were selected. The total extension (stretch), of these four stations is approximately 76 km. such as Harsil, Bhatwari, Gangori and Uttarkashi.

The water samples were collected from selected sampling stations at an interval of 30 days and pH, electric conductivity, dissolve oxygen were analyzed immediately at the sampling sites using standard equipment. The other parameters like Total dissolve solids, Total suspended solids, biological oxygen demand, Total alkalinity, Total hardness, Chloride, Nitrate and Sulphate were analyzed in the laboratory as per the standard procedures of APHA (1995).



Map 1. Uttarkashi District showing river Bhagirathi (Ganga) and Sampling Stations

WQI COMPUTATION EQUATIONS

For the calculation of water quality index eleven important parameters were chosen. Values used for each parameter were the mean value of the four sites under present investigation. The water quality index has been calculated by using the standards method of drinking water quality. The calculated values were compare with the standard and recommended by the WHO, BIS and ICMR. The weighted arithmetic index method (Brown et al., 1972) has been used for the calculation of water quality index of the water body in the following steps:-

Calculation of Sub Index of Quality Rating (q_n):- The value of q_n is calculated using the following expression.

$q_n = 100[(Vn-Vio]/Sn-Vio)]$ 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 permissible value of the n^{th} parameter. Vio= ideal value of the n^{th} parameter in pure water.

All the ideal values (Vio) are taken as zero for drinking water except for pH=7.0 and DO=14.6mg/L (Tripaty and Sahu, 2005).

Calculation of Unit Weight (Wn):- Calculation of unit weight (Wn) for various water quality parameters are inversely proportional to the recommended standards for the corresponding parameters.

Wn=K/Sn Where: Wn= unit weight for the n^{th} parameters. Sn= standard value for the n^{th} parameters.K=constant for proportionality.

The overall water quality index was calculated by aggregating the quality rating with the unit weight linearly.

WQI=Σ qn Wn/Σ Wn

Table 1: Water Quality Index , status and grading of water quality (Brown et al.,1972)

Water Quality Index Level	water quality status	Grading
0-25	Excellent water quality	A
26-50	Good water quality	B
51-75	Poor water quality	C
76-100	Very poor water quality	D
Above 100	Unsuitable for drinking and fish culture	E

Table 2: Drinking Water standards recommending agencies

Sr.No.	Parameters	Standards	Recommended agencies
1.	pH	6.5-8.5	ICMR / BIS
2.	electric conductivity (umhos/cm2)	300	ICMR
3.	Total dissolve solids(mg/l)	500	ICMR / BIS
4.	Total suspended solids(mg/l)	500	WHO
5.	Dissolve oxygen(mg/l)	5.00	ICMR / BIS
6.	Biological oxygen demand(mg/l)	5.00	ICMR
7.	Total alkalinity(mg/l)	120	ICMR
8.	Total hardness(mg/l)	300	ICMR / BIS
9.	Chloride(mg/l)	250	ICMR
10.	Nitrate(mg/l)	45	ICMR / BIS
11.	Sulphate(mg/l)	150	ICMR / BIS

Table 3: Seasonal Variations of the physicochemical parameters of the Bhagirathi River

Sr.No.	Parameters	Summer Season	Rainy Season	Winter Season
1.	pH	7.71	7.59	7.95
2.	electric conductivity(umhos/cm2)	137.82	313.75	109.59
3.	Total dissolve solids(mg/l)	220.56	483.54	189.64
4.	Total suspended solids(mg/l)	384.95	1208.17	79.42
5.	Dissolve oxygen(mg/l)	7.82	8.04	9.7

6.	Biological oxygen demand(mg/l)	2.35	2.36	1.91
7.	Total alkalinity(mg/l)	75.89	55.61	67.2
8.	Total hardness(mg/l)	85.46	108.79	95.62
9.	Chloride(mg/l)	2.69	10.7	1.875
10.	Nitrate(mg/l)	0.0140	0.0594	0.0331
11.	Sulphate(mg/l)	18.381	23.902	19.461

Table 4: Calculation of Water Quality Index in Summer Season of the Bhagirathi River

Sr. No.	**Parameters**	**Observed values**	**Standard values(Sn)**	**Unit Weight (Wn)**	**Quality rating(qn)**	**Wn qn**
1.	pH	7.71	6.5-8.5	0.2066	47.3333	9.7791
2.	electric conductivity(umhos /cm2)	137.82	300	0.0058	0.4594	0.0027
3.	Total dissolve solids (mg/l)	220.56	500	0.0035	0.4411	0.0015
4.	Total suspended solids (mg/l)	384.95	500	0.0035	0.7699	0.0027
5.	Dissolve oxygen (mg/l)	7.82	5.00	0.3512	70.625	24.8035
6.	Biological oxygen demand (mg/l)	2.35	5.00	0.3512	47.000	16.5064
7.	Total alkalinity(mg/l)	75.89	120	0.0146	0.6324	0.0092
8.	Total hardness(mg/l)	85.46	300	0.0058	0.2849	0.0016
9.	Chloride(mg/l)	2.69	250	0.0070	0.0108	0.00008
10.	Nitrate(mg/l)	0.0140	45	0.0390	0.0003	0.00002
11.	Sulphate (mg/l)	18.381	150	0.0117	0.1225	0.0014
				ΣWn=0.9999	Σqn=167.6796	ΣWnqn=51.1082

Table 5: Calculation of Water Quality Index in Rainy Season of the Bhagirathi River

Sr.No.	**Parameters**	**Observed values**	**Standard values(Sn)**	**Unit Weight (Wn)**	**Quality rating(qn)**	**Wn qn**
1.	pH	7.59	6.5-8.5	0.2066	39.33	8.1256
2.	electric conductivity(umhos/cm2)	313.75	300	0.0058	104.58	0.6066

3.	Total dissolve solids (mg/l)	483.54	500	0.0035	96.71	0.3385
4.	Total suspended solids(mg/l)	120817	500	0.0035	241.634	0.8457
5.	Dissolve oxygen (mg/l)	8.04	5.00	0.3512	68.33	23.9975
6.	Biological oxygen demand(mg/l)	2.36	5.00	0.3512	47.2	16.5766
7.	Total alkalinity(mg/l)	55.61	120	0.0146	46.34	0.6766
8.	Total hardness (mg/l)	108.79	300	0.0058	36.26	0.2103
9.	Chloride(mg/l)	10.7	250	0.0070	4.28	0.0300
10.	Nitrate(mg/l)	0.0594	45	0.0390	0.132	0.0051
11.	Sulphate(mg/l)	23.902	150	0.0117	15.93	0.1864
				ΣWn=0.9999	Σqn=700.72	ΣWnqn=51.5989

Table 6: Calculation of Water Quality Index in Winter Season of the Bhagirathi River

Sr.No.	**Parameters**	**Observed values**	**Standard values(Sn)**	**Unit Weight (Wn)**	**Quality rating(qn)**	**Wn qn**
1.	pH	7.95	6.5-8.5	0.2066	63.3333	13.0845
2.	electric conductivity(umhos/cm2)	109.59	300	0.0058	0.3653	0.0021
3.	Total dissolve solids (mg/l)	189.64	500	0.0035	0.3793	0.0013
4.	Total suspended solids (mg/l)	79.42	500	0.0035	0.1588	0.0006
5.	Dissolve oxygen(mg/l)	9.7	5.00	0.3512	51.0417	17.9258
6.	Biological oxygen demand(mg/l)	1.91	5.00	0.3512	38.2	13.42
7.	Total alkalinity(mg/l)	67.2	120	0.0146	0.56	0.0082
8.	Total hardness (mg/l)	95.62	300	0.0058	0.3187	0.0018
9.	Chloride(mg/l)	1.875	250	0.0070	0.0075	0.00005
10.	Nitrate(mg/l)	0.0331	45	0.0390	0.0007	0.00003
11.	Sulphate(mg/l)	19.461	150	0.0117	0.1297	0.0017
				ΣWn=0.9999	Σqn=154.495	ΣWnqn=44.4461

RESULT AND DISCUSSION

The result obtained from analysis of water sampled of river Bhagirathi are shown in 3, 4, 5, and 6. For the calculation of Water Quality Index the various physico-chemical parameters were selected and observed (Table-3). The pH remained slightly alkaline in nature in every site and the average values for three season were ranged between 7.59 to 7.95. The observation is in conformity with the Sinha (1995).The electrical conductivity and TDS were also found high. Season wise it is high during rainy season. The present investigation indicate that the concentration of Dissolved oxygen fluctuated in between 7.82mg/l and 9.7 mg/l. Bio-chemical oxygen demand (BOD) is the parameter used to assess the pollution of surface and ground water. BOD concentration ranged in between 1.91mg/l and 2.36 mg/l. seasonally, it was high during rainy season and lowered in winter season. A similar observation has been made by Chauhans and Singh (2010).The total alkalinity is the measure of weak acid present in the water and of the cations balanced against them. In the present study the mean value of total alkalinity was recorded in between 55.61mg/l to 75.89 mg/l. The similar range of total alkalinity were recorded by Chandra et al (2011). The average values for three season of total hardness are ranged in between 85.46mg/l to 108.79 mg/l. Chlorides are salts resulting from the combination of the chlorine with sodium. It becomes essential for life (Dikio, 2010).In the present investigation, the higher value for chloride was recorded 10.7mg/l and lower value 1.875mg/l.

For the calculation of Water Quality Index the values of various physicochemical parameters shown in table 3. Season wise Water Quality Index calculations are presented in the tables 5, 6 & 7. The Water Quality Index obtained for the river Bhagirathi in various seasons of study period ie. Rainy season (51.60), winter season (44.45) and summer season (51.11).The Water Quality Index study was done for the various important physic-chemical parameters in different seasons. The result indicates good water quality in winter season and poor water quality in rainy and summer season considering Brown et al. (1972) and it comes under Water Quality grading B in winter season and C during summer and rainy season. Chatterji and Raziuddin (2002), Trivedi and Pathak (2007) and Chauhan and Singh (2010) were also estimate Water Quality Index in their studies on different water bodies.

The rating of water quality shows that the water of the river is not suitable for drinking by human and pollution load is comparatively high during rainy and summer seasons. So highest priority should be given to water quality monitoring and there indigenous technologies should be adopted to make fit for domestic and drinking after treatment. It is advised not to consume water without proper treatment.

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