Assessment of Water Quality Index: A Case Study of River Ramganga at Bareilly U.P. India

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Abstract—Ramganga is an important river in Bareilly (U.P). Hence an attempt has been made to study Water Quality Index (WQI) and pollution or changes in the quality of water. Water quality index (WQI) is a useful tool for quick estimation of quality of any water resource. The quality of river water was classified into permissible, slight, moderate and severe on the basis of the pollution strength at three sampling stations of the river for a period of three seasons. Assessment of WQI of River Ramganga includes physico-chemical parameters viz. pH, Biological Oxygen Demand, Dissolved Oxygen, Total Alkalinity, Total Hardness, Total Dissolved Solids, Total Suspended Solids and Chloride that indicate the extent of pollution. The main causes of deterioration in water quality were lack of proper sanitation, unprotected river sites, high anthropogenic activities and direct discharge of industrial effluents.

Keywords: Water Quality Index, Pollution, River Ramganga, DO, BOD, COD.

1 INTRODUCTION

Rivers are the important source of water that plays an important role in development of nation and sustenance of life. However, they are being polluted due to rapid industrialization, urbanization and other developmental activities. Ramganga is an important river in U.P., it originates from the hills of Garhwal and traverses through Kalagarh, Moradabad and Bareilly and finally merges into River Ganga at Farukhabad, covering a distance of about 480 km. Recently great concern has been universally voiced regarding environmental pollution arising as a side effect of rapid industrialization and subsequent urbanization. Today, the main concern with environmental pollution is with its impact on the health of the present generation and the future ones. Untreated domestic waste way into the rivers through sewage, outfalls drains etc.

Water quality index is one of the most effective tools to monitor the surface as well as ground water pollution and can be used efficiently in the implementation of water quality upgrading programmes (Alam 2010). WQI provides the single number that expresses overall quality based on the different parameters. It summarizes large amount of water quality data into simple terms i.e. excellent, good, bad etc. that is easily understandable and usable by public.

Earlier attempts were made to assess the water quality index of river Ramganga in a very small stretches by Pandey and Sharma (1999) and Sinha et al. (2004). Three sites namely Uchagaon, Ramganga bridge and near chaubari village have been selected and the samples were taken for the physico-chemical analysis of water which includes pH, Biological Oxygen Demand, Dissolved Oxygen, Total Alkalinity, Total Hardness, Total Dissolved Solids, Total Suspended Solids and Chloride. The present study was aimed to assess WQI of river Ramganga in Bareilly district.

2 MATERIALS AND METHODS

Water samples were collected for physico-chemical analysis from three sampling stations viz. Uchagaon, Ramganga Bridge and near chaubari village. As per the norms of the APHA, wide mouthed plastic bottles of one liter size was used for collecting the samples and preserved till the parameters were analyzed in laboratory. Water samples were analysed for following physico-chemical and biological parameters viz. pH, Biological Oxygen Demand, Dissolved Oxygen, Total Alkalinity, Total Hardness, Total Dissolved Solids, Total Suspended Solids and Chloride (APHA 1998). Samples for Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD) were collected separately in BOD (glass) bottles.

In this study, calculation of water quality index was based on eight important physico-chemical parameters. The WQI calculated using the different standards of drinking water quality recommended by WHO, BIS and ICMR.

Table:- Standards for different parameters used

S.No.	Parameters	Recommended agency	standard
1.	pH	ICMR/BIS	6.5-8.5
2.	Total Hardness	ICMR/BIS	300
3.	Biological Oxygen Demand	ICMR	5
4.	Dissolved Oxygen	ICMR/BIS	5
5.	Total Dissolved Solids	BIS	500
6.	Total suspended solids	WHO	500
7.	Chlorides	ICMR/BIS	250
8.	Alkalinity	BIS	200

2.1 Water Quality Index determination

Water Quality Index (WQI) was calculated by using the Weighted Arithmetic Index method as described by Cude (2001). Recently, Khwakaram (2012) modified this method in

which different water quality components are multiplied by a weighting factor and are then aggregated using simple arithmetic mean. For assessing the quality of water in this study, first, the quality rating scale (Qi) for each parameter was calculated by using the following equation;

Qi = {[(Vactual – Videal) / (Vstandard – Videal)] * 100}

Where,
Qi = Quality rating of ith parameter for a total of n water quality parameters
Vactual = Actual value of the water quality parameter obtained from analysis
Videal = Ideal value of that water quality parameter can be obtained from the standard Tables.
(Videal for pH = 7 and for other parameters it is equaling to zero, but for DO Videal = 14.6 mg/L)
Vstandard = Recommended standard of the water quality parameter.

Then the relative (unit) weight (Wi) was calculated by a value inversely proportional to the recommended standard (Si) for the corresponding parameter using the following expression;
Wi = I/ Si

where, Wi = Relative (unit) weight for nth parameter
Si= Standard permissible value for nth parameter
I = Proportionality constant.

The Relative (unit) weight (Wi) to various water Quality parameters are inversely proportional to the recommended standards for the corresponding parameters. Finally, the overall WQI was calculated by aggregating the quality rating with the unit weight linearly by using the following equation:
WQI = ΣQiWi / Σ Wi
Where, Qi = Quality rating
Wi = Relative (unit) weight

In this study, the WQI level was categories based on permissibility for human consumption or uses and the maximum permissible scale for WQI for the drinking water was set as 100 score.

Table: 1 Categorization of water quality based on WQI level

Water Quality Index levels	Description
0-25	Excellent
26-50	Good water
51-75	Poor water
76-100	Very Poor water
100>	Unsuitable for Drinking

3 RESULT

The physic-chemical characterization of river Ramganga during the two seasons was observed as briefed Table-2. pH of all collected sample were found basic in nature.

Table: 2 Water quality values at various sampling stations.

Parameter	pH	Total Hardness (mg/l)	BOD (mg/l)	Alkalinity (mg/l)	DO (mg/l)	Total Dissolved Solids (mg/l)	Total Suspended Solids (mg/l)	Chloride (mg/l)
S1	8.6	212.3	5.3	158	6.1	279.3	178.8	20.5
S2	8.1	195	5.5	130	5.9	250.6	190.2	38.2
S3	8.5	215.6	5.4	154.3	5.9	256.6	186.6	29.4

S1: Ucha Gaon village, S2: Ramganga bridge, S3: Choubari village

Table: 3 Calculation of water quality index of Sampling Station 1 (S1)

S.No.	Parameters	Observed Value (Va)	Standard Value (Vs)	Unit weight (Wi)	Quality Rating (Qi)	WiQi
1.	pH	8.6	8.5	0.1176	106.66	12.54
2.	Total hardness	212.3	300	0.0033	70.76	0.233
3.	BOD	5.3	5	0.2	106	21.2
4.	DO	6.1	5	0.2	88.54	17.708
5.	TDS	279.3	500	0.002	55.86	0.11172
6.	TSS	178.8	500	0.002	35.76	0.0715
7.	Chlorides	20.5	250	0.004	8.2	0.0328
8.	Alkalinity	158	200	0.005	79	0.395
				∑Wi=0.5339		∑ WiQi=52.29202
Water Quality Index (WQI) = ∑ WiQi/∑Wi = 97.9434726						

Table: 4 Calculation of water quality index of Sampling Station 2 (S2)

S.No.	Parameters	Observed Value (Va)	Standard Value (Vs)	Unit weight (Wi)	Quality Rating (Qi)	WiQi
1.	pH	8.1	8.5	0.1176	73.33	8.623608
2.	Total hardness	195	300	0.0033	65	0.2145
3.	BOD	5.5	5	0.2	110	22.00
4.	DO	5.9	5	0.2	90.625	18.125
5.	TDS	250.6	500	0.002	50.12	0.10024
6.	TSS	190.2	500	0.002	38.04	0.07608
7.	Chlorides	38.2	250	0.004	15.28	0.06112
8.	Alkalinity	130	200	0.005	65	0.325
				∑Wi=0.5339		∑ WiQi=49.525548
Water Quality Index (WQI) = ∑ WiQi/∑Wi = 92.761843						

Table: 5 calculation of water quality index of Sampling Station 3 (S3)

S.No.	Parameters	Observed Value (Va)	Standard Value (Vs)	Unit weight (Wi)	Quality Rating (Qi)	WiQi
1.	pH	8.5	8.5	0.1176	100	11.76
2.	Total hardness	215.6	300	0.0033	71.867	0.2371611
3.	BOD	5.4	5	0.2	108	21.6
4.	DO	5.9	5	0.2	118	23.6
5.	TDS	256.6	500	0.002	51.32	0.10264
6.	TSS	186.6	500	0.002	37.32	0.07464
7.	Chlorides	29.4	250	0.004	11.76	0.04704
8.	Alkalinity	154.3	200	0.005	77.15	0.38577
				∑Wi=0.5339		∑WiQi= 57.8072511
Water Quality Index (WQI) = ∑ WiQi/∑Wi = 108.273555						

4 DISSCUSSION

According to above WQI values at various sampling stations, there was an increasing trend in WQI values along the downstream, indicated that an increase in pollution load in river. Pollution load increases in river due to effluent discharges by small scale industries, municipal waste etc. along the stretch. Based on the survey of this district, It was observed that the main cause of deterioration in water quality in Ramganga was due to the lack of proper sanitation, unprotected river sites, high anthropogenic activities and direct discharge of industrial effluent.

Among all the physicochemical parameters selected for water quality index calculation, pH is an important parameter which determines the suitability of water for various purposes. The pH level is a measure of the acid content of the water. pH of river water was found highly basic in winter season. The variation can be due to the exposure of river water to atmosphere, biological activities and temperature changes (Bahadur and Chandra 1996; Adebowale et al. 2008). It was observed that the pollutant water directly influenced the pH of river (Gangwar et al. 2012).

Cation of calcium, magnesium, iron and manganese contribute to the hardness of water (Shrivastava and Patil 2002). Although hard water has no effect on health but it is unsuitable for domestic use.

B.O.D is the measure of degradable organic matter present in a water sample and it can be defined as the amount of oxygen required by micro-organisms in stabilizing the biodegradable organic matter under aerobic condition (Gangwar et al. 2012). The aim of B.O.D test is to determine the amount of biochemically oxidisable carbonaceous matter (IS 1991). The observed B.O.D variations are due to the addition of little amount of organic matter.

Dissolved Oxygen is a factor which determines whether the biological changes are brought about by aerobic or anaerobic organisms (Gangwar et al. 2012). The oxygen present in water can be dissolved from air or produced by photosynthetic organisms (Kumar and Bahadur 2009). Oxygen is generally reduced in the water due to respiration of biota, decomposition of organic matter, rise in temperature, oxygen demanding wastes and inorganic reductant such as hydrogen sulphide, ammonia, nitrites, ferrous iron, etc. (Saksena et al. 2008).

The amount and nature of dissolved and undissolved matter occurring in liquid materials vary greatly. Total Dissolved Solids (TDS) analysis has great implications in the control of biological and physical waste water treatment processes. TDS consists of oxygen demanding wastes, disease causing agents, which can cause immense harm to public health (Parmar and Parmar 2010).

TSS can include a wide variety of material, such as silt, decaying plant and animal matter, industrial wastes, and sewage. High concentrations of suspended solids can cause many problems for stream health and aquatic life.

Chlorides are found in practically all natural waters. This is the most common inorganic anion present in water. Man and animals excrete high quantities of chloride, therefore, it indicates sewage contamination (Zhou 2002; Singh et al. 2012).

Alkalinity is influenced with carbonate and bicarbonate and other ions. Shrivastava and Patil (2002) suggested that the alkalinity is directly related to the abundance of phytoplankton which dissociates bicarbonate into carbonates and carbon dioxide. The carbon dioxide, thus, released is used in photosynthesis. The high concentration of sewage and industrial waste may be the cause of high alkalinity.

5 CONCLUSION

On the basis of various parameters analyzed in this investigation, it was concluded that the water quality of river Ramganga is unfit for drinking purposes.WQI may be used as indicator to know the health of river. The discharging of domestic and industrial wastewater and also other anthropogenic activities were the main factors for contaminating Ramganga stream. Hence, there is need for regular monitoring of water quality in order to detect changes in physiochemical parameters of river water at different sites, implementation of remediation measures and public awareness.

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