A comparative Study of Water Quality Index of River Kali Nadi and River Ganga in Western Uttar Pradesh - Meerut (India)

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Abstract

The main objective of the comparative study was to calculate and evaluate the Water Quality Index (WQI) of two rivers Kali Nadi and river Ganga, which will help in quantifying the extent of pollution and their by assessing its suitability for drinking and agricultural use. The analysis determines the quality trends and prioritizing pollution control efforts and also helps in indentifying the areas of concern. The samples were assessed for physico-chemical parameters namely pH, Electrical DO, Conductivity, BOD, Total Dissolved Solid, Total Hardness, Nitrates, Sulphates, Chlorides, and Calcium. The calculation of the WQI was done using weighted arithmetic index method. The WQI was found to be *92.03*for river Kali Nadi and for River Ganga 85.66 indicating clearly that untreated water from the river kali and Ganga basin is of poor quality and must therefore be treated before use to avoid water related diseases. It also indicates that the quality of water is not good aquatic biota and also not suitable for agricultural activities as well.

Keywords: Water Quality, Water Quality Index, Physico-Chemical Parameters, Weighted Arithmetic Index Method

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Introduction

No other public health or medical innovation comes close to having the importance of a safe clean supply of water. The Quality of water is vital concern for mankind since it is directly linked with human welfare. Without considering its importance and its crisis in near future, most rivers, in recent decades, are being polluted due to excessive silting by deforestation, urbanisation, cultivation, industrialization and various other human activities. Municipal and domestic wastes, industrial effluents and agricultural run-off are the major contributors to riverine pollution. In some areas, the geochemical nature of the land and climatic conditions are also responsible for variation in water quality (Pathak et al., 1992). The increasing urbanization and industrialization has resulted in increased quantities of domestic and industrial effluent being discharged into the aquatic system. Most of the industrial wastes contain heavy metals which may be toxic to the biota of the receiving streams.

Kali Nadi is one of the most heavily polluted rivers in western Uttar Pradesh (India), is a perennial, which flows in the western districts of Uttar Pradesh and exists between the latitudes 29°4" to 30°4" and altitude 77°5" to 77°9". The Kali Nadi originates from the village Antuwara in Muzaffarnagar district and merges into the Ganga River at Kannauj (Farrukhabad district). It travels a distance of 417 km and passes through Meerut, Bulandshahar, Etah, Mainpuri and Farrukhabad districts in Uttar Pradesh (India). It receives discharge of industrial and municipalities of Meerut and nearby districts. The water of this river is clear before the discharge of combined effluents of sugar, distillery and rubber industries. Most of the industrial wastes contain heavy metals which may be toxic to the biota of the receiving streams. The heavy metals in different river water and sediments were analysed by many workers (Menasveta, 1978; William *et al.,* 1978; Timperley, 1979; Sava *et al.,* 1980; Abo-Rady, 1980). The river originates in district Saharanpur at village 'Barabas' near Iqbalpur. Its course runs eastward and after passing through Deoband and Muzaffarnagar and enters district Meerut near village Nangla. The river then flows in the south-west direction at a distance of 9 km from main Meerut city. It is a large water stretch with varying depths at different places. It has a width of 6mts to 15mts and sandy bed puddles.

The Ganga River is the most important river of the Gangetic Alluvium. It originates from a glacial source and drains a vast area in the Himalayas and the plains of Himachal Pradesh, Haryana, Uttar Pradesh, Bihar, etc. The town and cities situated along the Ganges discharge about 1340 million liter of sewage every day in it, thus polluting the river (Ganga Action Plan, 1985). The situation further worsens with discharge of industrial effluents (260 million liter per day), disposal of dead bodies and open-air defecation along its bank. Unseen and un-quantified toxic chemicals enter the river with agricultural and urban run-off. Water from these rivers is used for irrigation, human consumption, fish and fisheries and for industrial application.

A water quality index (WQI) summarizes large amounts of water quality data into simple terms (e.g., excellent, good, bad, etc.) for reporting to managers and the public in a consistent manner (Hulya, 2009). A water quality index provides a single number that expresses overall water quality at a certain location and time, based on several water quality parameters. WQI can be used as a tool in comparing the water quality of different sources and it gives the public a general idea of the possible problems with water in a particular region. The indices are among the most effective ways to communicate the information on water quality trends for the water quality management (Jagadeeswari and Ramesh, 2012). The objective of the study therefore was to compare and calculate the Water Quality Index (WQI) of river Ganga and river kali in order to assess its quality for drinking and other human purposes.

Materials and Methods

Water quality analysis and its mathematical computation is an important tool, which helps in evaluating the nature, and extent of pollution and also the effectiveness of pollution control measures, which already exist. Water analysis determines the quality trends and prioritizing pollution control efforts and also helps in identifying the areas requiring prior restoration. Keeping this in view the water quality analysis of river kali nadi has been undertaken. Physiochemical analyses were carried out for the samples collected from both the rivers. The physical parameters like, color, odour, taste, turbidity may not seem all that important, yet they reflect directly on the quality of water. Similarly chemical parameters i.e., pH, nitrate, arsenic, phosphate, total dissolved solids (TDS), dissolved oxygen (DO), BOD, conductivity, salinity and Sulphate.

Sampling Stations**:** The sampling stations for the sample collection were based on the effluent disposal points and interference of the human population with rivers. The four sampling station in river Kali Nadi and river Ganga are as: For Kali Nadi - Medical college (KN1) and Mawana road (Saini village) (KN2); for river Ganga - Garh road (near Ganga bridge) (G1) and Garh village (farm land) (G2). Important consideration was taken for selecting sampling stations on Ganga river, the Sampling fore river Ganga was done at the site before and the other sampling after the confluence of Kali Nadi into it.

Sampling Methodology: The samples (KN1; KN2;G1;G2) from all the four selected stations from river Kali Nadi and river Ganga were collected in the morning hour's b/w 9.00-10.00am. River water samples (four replicates) were collected from the middle of the river stream, 30 cm below the water surface, in plastic bottles (2 liters) rinsed with diluted HNO_3. One liter of each sample was preserved with 10 ml of 6N HNO_3 (AR grade) and stored at 4°C. All care was taken to protect the sample from any contamination.

Analysis Methodology: The water samples for heavy metals analysis were filtered through whatman filter paper No. 1 and 500 ml of the filtered samples were acidified with 10 ml of 6N HNO3 (AR Grade). The samples were concentrated up to 50mL using evaporation method (Parker, 1972). The evaporation was carried out in a beaker covered with watch glass to minimize loss of metals. The pH of water samples was measured by digital pH meter. Conductivity, salinity, nitrate and Sulphate were measured by methods adapted from Standard methods for the examination of water and wastewater [APHA, 1992].

The mathematical calculation of the WQI was done using weighted arithmetic water quality index which was originally proposed by Horton (1965) and developed by Brown et al (1972).

The weighted arithmetic water quality index ($WQIa$) is in the following form:

$$WQl_A = 'L^1 i{=}iW_i q_i \,/\, \text{If}{=}\text{iW}_f \qquad (1.1)$$

where n is the number of variables or parameters, wi is the relative weight of the i^{th} parameter and qi is the water quality rating of the i^{th} parameter. The unit weight (wi) of the various water quality parameters are inversely proportional to the recommended standards for the corresponding parameters. According to Brown et al (1972), the value of qi is calculated using the following equation:

$$q_t = 100\ [(Vi - Vid)\ /(Si - Vid)] \qquad (1.2)$$

where Vi is the observed value of the i^{th} parameter, Si is the standard permissible value of the i^{th} parameter and Vid is the ideal value of the i^{th} parameter in pure water. Table 1 below shows a classification of water quality, based on its quality index due to Brown et al (1972).

Table 1 Classification of water quality based on weighted arithmetic method WQI	
WQI	STATUS
0 – 25	Excellent
26 – 50	Good
51 – 75	Poor
76 – 100	Very Poor
Above 100	Unsuitable for drinking

Results and Discussion

Table 2 below gives the observed values (v_t) of the nine selected physicochemical parameters of water samples, standard drinking water values (Sj) standards set according to World Health Organization (WHO, 1993), unit weights (w_t), water quality rating (q_t) and w^j.

Table 2: Calculation of Water Quality Index (WQI) of the river kali

S.NO	Parameter	Observe d values *(Vi)*	Standard values (*i)	Unit weights (Wi)	Quality rating *(qi)*	*Wiqi*
1	***Electrical Conductivity (Micro mho/cm)***	107	250	0.0011	42.8	0.04708
2	***Ph***	7.6	6.5-8.5	0 .0336	40.0	1.344
3	***Nitrate (mg/l)***	0 .02	45	0.0052	0.044	0.00022
4	***Sulphate (mg/l)***	8.23	200	0.0254	4.115	0.1045
5	***T.D.S. (mg/l)***	1.458	500	0.00057	0.2916	0.00166
6	***Born(mg/l)***	0.1	0.5	0.572	20	11.4
7	***Calcium (mg/l)***	10.81	200	0.00143	54.05	0.0772
8	***Chlorides (mg/l)***	3.09	250	0.00114	1.236	0.00140
9	***Dissolved Oxygen (mg/l)***	3.2	5	0.0372	118.75	44.175
10	***BOD***	1.16	5	0.0572	23.2	13.22
				$\sum_{i=10}^{10} wi = \mathbf{0.75484}$		$\sum_{i=11}^{11} wi = wiqi{=}69.029$

The water quality index (WQI) of the river kali was calculated by using the weighted arithmetic index formula as :

WQI $_A = \sum_{i=1}^{11} W_i Q_i \; / \sum_{i=11}^{11} wi = wiqi$ = **69.0294/ 0.754= 92.03**

The WQI index of river kali is 92.03

Table 2: Calculation of Water Quality Index (WQI) of the river Ganga

S.NO	Parameter	Observed values (Vi)	Standard values (*i)	Unit weights (Wi)	Quality rating (qi)	Wiqi
1	***Electrical Conductivity (Micro mho/cm)***	34	250	0.0011	13.6	0.01496
2	***Ph***	8.01	6.5-8.5	0 .0336	67.33	2.221
3	***Nitrate (mg/l)***	1.1	45	0.0052	2.44	0.0126
4	***Sulphate (mg/l)***	4.9	200	0.0254	2.45	0.6223
5	***T.D.S. (mg/l)***	1.14	500	0.00057	0.288.	0.000164
6	***Born(mg/l)***	0.12	0.5	0.572	24.0	13.72
7	***Calcium (mg/l)***	11.2	200	0.00143	5.6	0.008008
8	***Chlorides (mg/l)***	3.5	250	0.00114	1.4	0.00159
9	***Dissolved Oxygen (mg/l)***	3.09	5	0.0372	119.895	44.58
10	***BOD***	2.7	5	0.0572	54.0	3.0888
				$\sum_{i=10}^{10} wi = \mathbf{0.75484}$		$\sum_{i=11}^{11} wi = wiqi = 64.25$

The water quality index (WQI) of the river Ganga was calculated by using the weighted arithmetic index formula a :

WQI $_A = \sum_{i=1}^{11} W_i Q_i \; / \sum_{i=11}^{11} wi = wiqi$ = **64.25/ 0.754= 85.21**

The WQI index of river kali is 85.66

On the basis of Water Quality Index given by Brown et al (1971) the observed value of WQI of river kali is 92.03 and for river Ganga is 85.21 which falls in the range of (76-100) on weighted arithmetic index (WQI) and the status quality of water is very poor and it must be treated before use and avoid any possible waterborne diseases. The WQI of river Ganga is higher than river kali, as the sampling site was Garh Road Meerut where water of river kali confluence in it.

Conclusion

The water Quality Index calculated here in the comparative study is a clear indication that the quality of water is very poor and must be recommended that education on water pollution control and effective measures should be intensified. If the water pollution remains in such or if increased, there are maximum chances that various water borne diseases will originate and aquatic biota will vanish within no time.

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