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Original Research Paper

Water Quality Index of River Wan at Upstream

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ABSTRACT

River Wan or Wanganga as it is often called, is an important tributary of River Godavari. It is principal source of water for drinking, irrigation and for industries situated in the vicinity in the Beed District of Maharashtra State. Anthropogenic activities are posing serious threat towards pollution of the riverian system. As a result, River Wan is not only serving as water resource, but acts as a sewer for municipal sewage, industrial effluents, and agricultural and urban run off. Because of multiple uses of the river water, river ecology has gained immense importance in recent years. It is, therefore, decided to study the physicochemical characteristics of the river at upstream at selected points. A simple comprehensive weighted arithmetic index method is used to assess overall quality of water for its intended use.

INTRODUCTION

Water is basic precondition for life. Quality and quantity of water at a place plays a vital role in health, wealth and prosperity of the region.

The continual increase in global population associated with socio-economic pressure on freshwater resources, and general lack of sanitation and waste treatment facilities are posing increasing demands on available water. One of the basic principal cause for water scarcity is degradation of water quality (Peter et al. 1999).

Out of the available freshwater, surface water is one of the major sources for diverse needs. Surface water not only serves as source of water, but is also used for convenient disposal of industrial and municipal wastes.

The objective of the present research is to provide information on physicochemical characteristics of River Wan in order to find the impacts of unregulated waste discharge on the quality of river as well as to judge its suitability for human consumption based on the water quality index values.

Water quality index is one of the most effective tools to communicate information on the quality of water to the concerned citizens. It is a parameter for the assessment and management reflecting the composite influence of different water quality parameters (Yisa et al. 2010).

WQI is calculated from the point of view of suitability of surface water for human consumption.

MATERIALS AND METHODS

River Wan is located in north-east part of Maharashtra in Beed district, which lies between lat. 18 52'30" and long. 76 25'30", at an altitude of 550 m above mean sea level. The average annual rainfall in the catchments area is 525 mm. It covers a drainage area of 372 sq. km in the upper Wan, and its tributaries have been availed of in the construction of Wan project at Nagapur. At the downstream of Wan project tributaries of Wan river viz., Padmavati and Bhaupari rivers confluence at 43.7 km and 58 km respectively forming Wan sub basin as a part of Godavari basin with a drainage area of 802.17 sq. km and 767.86 M CFT of water.

The present study is confined to a stretch of 15 km at upstream of Wan project. Three water samples at upstream of Wan project, where outfalls in the forms of municipal sewage, village nala and agricultural runoff are discharged into the river, were collected.

Water samples were collected at monthly intervals for a period of two years. Collected samples were analysed for said parameters using APHA (1995). Care was taken in selecting sampling stations in order to give comprehensive idea of the overall quality of water. As degradation is expected in low flow conditions, peak values of the season were considered for assessing overall water quality.

Calculation of WQI: The Water Quality Index (WQI) was calculated using the Weighted Arithmetic Index method. The quality rating scale for each parameter q_i was calculated by using the expression:

$$q_i = (C_i/S_i) \times 100$$

A quality rating scale (q_i) for each parameter is assigned by dividing its concentration (C_i) in each water sample by its respective standard (S_i) and the result is multiplied by 100.

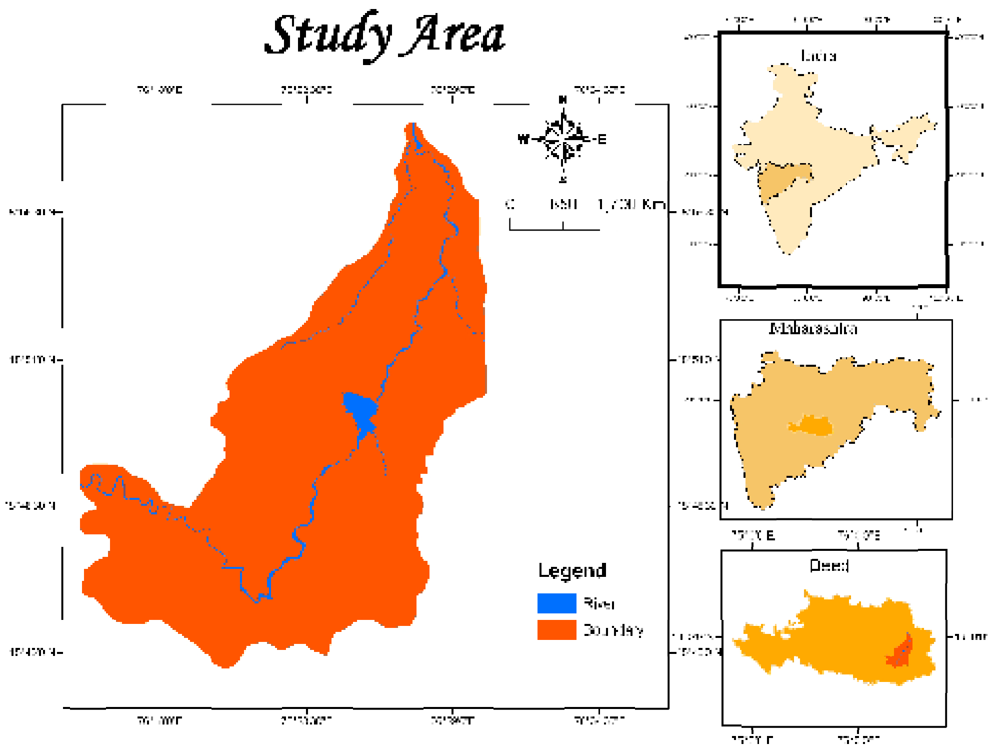

Fig. 1: Map of the study area.

Relative weight (W_i) was calculated by a value inversely proportional to the recommended standard (S_i) of the corresponding parameter:

$W_i = 1/S_i$

The overall Water Quality Index (WQI) was calculated by aggregating the rating (q_i) with unit weight (W_i) linearly:

$WQI = \Sigma W_i q_i$

Generally, WQI were discussed for a specific and intended use of water. In this study the WQI for drinking purposes was considered and permissible WQI for the drinking water is taken as 100:

$$\text{Overall WQI} = \frac{\Sigma q_i w_i}{\Sigma w_i}$$

RESULTS AND DISCUSSION

The physicochemical characteristics of River Wan are presented in Table 1, and results of the study are given in Table 2. The pH is a measure of hydrogen ion concentration and important indicator of water quality and extent of pollution in watershed areas. IS: 10500 prescribes the limiting value of pH between 6.5 and 8.5 for potable waters. The pH values for all the samples ranged between 7 and 8, which were within the standard.

The desirable limit for total dissolved solids as per IS: 10500 is 500 mg/L, whereas the permissible limits in absence of alternate source is 2000 mg/L. Beyond this palatability decreases and may cause gastrointestinal irritation. In the water samples collected from the river TDS varies from 260 to 516 mg/L, which is within the permissible limits.

The total hardness is sum of calcium and magnesium

Table 1: Physico-chemical characteristics of the river at upstream

Sr. No.	Parameter	Average seasonal peak values
1	pH	7.2
2	Turbidity	3.00
3	TDS	516
4	Total Hardness	368
5	Calcium	103.32
6	Magnesium	29.28
7	Sodium	38
8	Potassium	3.8
9	Chloride	84
10	Sulphate	48
11	Electrical Conductivity	825
12	Alkalinity	261
13	Nitrates	3.90
14	Iron	0.52

All units are in mg/L except pH and EC (micromhos/cm)

Table 2: Computation of WQI values in premonsoon at upstream the River Wan.

Sr. No.	Parameter	Std. Permissible Values	W_i	$q_i = \frac{C_i}{S_i} \times 100$	$q_i w_i$
1	pH	7-8.5	0.130	93.6	12.168
2	Turbidity	5.00	0.20	60	12.00
3	TDS	500	0.002	103.20	0.206
4	Total Hardness	200	0.005	184	0.92
5	Calcium	75	0.0133	137.42	1.83
6	Magnesium	30	0.033	96.62	3.19
7	Sodium	20	0.05	190	9.50
8	Potassium	10	0.10	38	3.8
9	Chloride	200	0.005	42	0.21
10	Sulphate	200	0.005	24	0.120
11	Electrical Conductivity	400	0.0025	206.25	0.52
12	Alkalinity	200	0.005	130.50	0.6525
13	Nitrates	45	0.022	8.58	0.188
14	Iron	1.00	1.00	52	52
	Total		1.572		97.304

Overall WQI = $\frac{\Sigma q_i w_i}{\Sigma w_i} = \frac{97.304}{1.572}$ = 61.89 < 100. WQI is less than 100, fit for drinking purpose.

Table 3: Water quality classification based on WQI value.

WQI value	Water quality
< 50	Excellent
50-100	Good-water
100-200	Poor-water
200-300	Very poor water
> 300	Water unsuitable for drinking

Table 4: Sampling stations.

Sample No	Sampling stations
1	Buttenath
2	Pathan-Mandhava
3	Wan-Takli

concentrations expressed as $CaCO_3$ in mg/L. Carbonates and bicarbonates of calcium and magnesium cause temporary hardness while sulphates and chlorides cause permanent hardness. The permissible limit for hardness is 600 mg/L as per IS: 10500. Values beyond this level cause encrustation in water supply and adverse effect on domestic use.

The hardness level in the samples varied from 143 to 368 mg/L indicating that it is below the permissible limits.

The desirable and permissible limits as per IS: 10500 for calcium hardness are 75 mg/L and 200 mg/L. The samples collected were in the range of 40.74 to 103.32 mg/L, which were within the permissible limits.

The desirable and permissible limits as per IS: 10500 for magnesium hardness are 30 mg/L and 100 mg/L. The samples collected were in the range of 8.88 to 29.28 mg/L showing that it is within the permissible limits.

Sodium is also one of the abundant elements in natural waters due to its vast use in agriculture and presence in municipal sewage. The samples of the river have the value of sodium ranging from 8.52 to 38 mg/L, and hence in above the permissible limit. The high concentration of sodium is due to addition of municipal sewage under low flow conditions.

Electrical conductivity is an indicator of salinity hazard. The average peak value is 825 micromhos/cm, above permissible limit. Higher values of conductivity are due to addition of industrial and municipal wastes.

The presence of chlorides in natural waters can be mainly attributed to dissolution of salt deposits in the form of ions, high concentration may indicate pollution by sewage, industrial wastes or saline water. It is the major form of inorganic anions in water. High chloride has a deleterious effect on metallic pipes and structures as well as plants.

The desirable limit for chloride is 250 mg/L as per IS: 10500. The maximum chloride level in the water samples was 84 mg/L, and hence, within the permissible limit.

Sulphates are found appreciably in all natural waters, particularly those with high salt content. Other sources of sulphates may be industrial and domestic sewage, and biological oxidation of organic matter.

The desirable limit for sulphate is 200 mg/L as per IS: 10500. The average sulphate in the water samples was 48 mg/L indicating its level within the permissible limit.

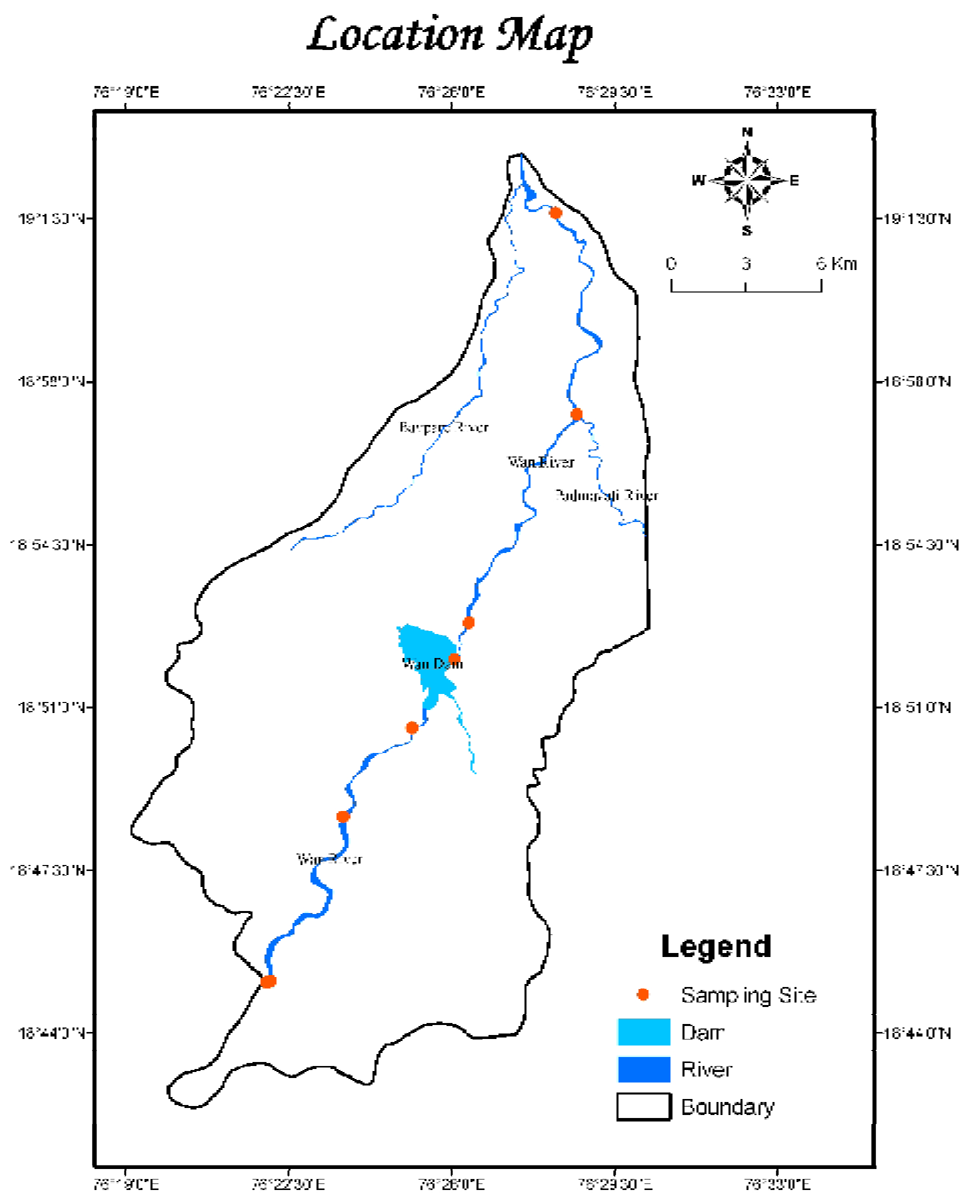

Fig. 2: Location map and sampling sites.

The study of physico-chemical characters of River Wan reveals that the river water can be used for public consumption. The overall WQI of the samples at upstream was 61.89, which is less than 100, the upper limit for drinking water. Application of Water Quality Index (WQI) in this study has been found useful in assessing the overall quality of water. This method appears to be more systematic and gives comparative evaluation of water quality at sampling stations. It is also helpful for public to understand the quality of water as well as being useful tool in many ways in the field of water quality management.

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