

IMPACT OF RELIGIOUS ACTIVITIES ON WATER QUALITY: A SIGNIFICANT ASSESSMENT AT KUDALA SANGAMA

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Abstract - India is the country of rich cultural heritage and festivals. People here celebrate festivals with great enthusiasm. The religious activities are deeply rooted in India's cultural heritage. The present study was carried out to assess the impact of religious rituals on water quality of surface water body flowing near Kudala sangama of Bagalkot district in Karnataka. Kudala sangama is emerging as a famous pilgrimage place and a tourist spot. The study was aimed to determine the present water quality status at Kudala Sangama. Water sampling was carried out at 4 selected locations for analysis. Physico-chemical parameters like pH, Electrical Conductivity, Total dissolved solids, Turbidity, Total Hardness, Total Alkalinity, Dissolved Oxygen, Biochemical Oxygen Demand, Chemical oxygen Demand, Sulfates and Phosphates were analyzed in the laboratory. The water quality status was assessed by using WQI tool. On a comparison, values of all the physico-chemical parameters are found high in the water sample taken close to the temple. WQI revealed the water quality of the main temple site poor as a result of religious activities at the site.

Key Words: Water quality index, WQI, Kudala Sangama, Water quality assessment, Physico-chemical assessment

1. INTRODUCTION

Importance of water, in maintaining a healthy as well as a prosperous nation in healthy environment is understood from the existence of the civilization on this globe. Water resources are primarily accustomed satisfying the daily desires of living world in and around them, but unfortunately today water quality of these water resources is under severe environmental stress and under threat due to various types of anthropogenic activities and the condition is more pathetic in lentic water bodies.

Among various types of anthropogenic actions, religious activities like immersion of Idols, flour, oil, soap, ash, detergents, floral offerings, mass bathing, dumping dead bodies in water are also the important causes that affect the water quality of a water body. The holy water bodies in India, have their immense value in terms of religious aspect, as people of India are associated emotionally and spiritually with these water bodies. The religious activities are deeply rooted in India's cultural heritage; millions of people take holy bath and perform religious activities and also they drink the river water as a holy water regularly on occasions like solar eclipse and new moon day irrespective of thinking about the water quality of the aquatic bodies.

In the north region of Karnataka, the rivers are affected less by urbanization and industrialization on a comparison. In this region, rivers have not shown remarkable pollution load. In the meanwhile, Kudala sangama, located on the bank of river confluence, is emerging as the important, popular pilgrimage for Lingayat sector of Hindu religion. Because of increasing popularity of the temple, the number of devotees and number of holy, religious, traditional activities are increasing rapidly. As a result of increasing religious activities on the bank, enormous pollution in the river is expected. Therefore the monitoring of river water quality in the present days is important and relevant to prevent the river water from deterioration in future.

2. MATERIALS AND METHODS

2.1 Study Area

For Lingayats of Hindu religion, Kudala Sangama in India is an important center of pilgrimage. It is about 15 km away from the Almatti Dam in Karnataka state. The Krishna and Malaprabha rivers merge here and flow east towards Srisaile (another pilgrim center) of Andhra Pradesh. The Aikya Mantapa or the holy Samadhi (Holy Tomb) of Basavanna, the founder of the Lingayat sect of Hindu religion along with Linga, which is believed to be self-born (Swayambhu), is here. The Kudala Sangama Development Board takes care of the maintenance and development. The village is about 19 km away from Hungund of Bagalkot district. Close by is the holy pilgrim centre and the renowned temple of Sangameshwara, on the river bank, at the confluence of the Krishna and the Malaprabha rivers. On the east, across the river Krishna, stands the Neelamma's temple. She was the consort of Basaveshvara. Kudala sangama is located in the geographical coordinates 16°12'13"N, 76°3'36"E.

2.2 Sampling and Analysis

The study area for the Kudala Sangama water quality assessment was taken along river stretch of 10 kilometers, depending upon the site conditions, the importance of the site and most importantly the access to those sites for sampling purpose. For the water sampling of the river in Kudala sangama, total 4 locations were fixed along the stretch as shown in the **figure 1**. **Table 1** gives the details of sampling locations. First sampling site was near Turadagi village which is located 3km before the main temple place. Second sampling site was at the main temple place whose quality has to be importantly assessed. Third sampling site

was near to Yemmihatti village which is located after the main temple place. Fourth sampling site was near to the Kengalkadapatti village which is a sampling site on Malaprabha river. Water characterization is done by sample collection and analysis. The water samples were collected for three times in February a start of summer season, and samples were analyzed in the laboratory for different physicochemical parameters. Water samples were collected in stopper fitted polyethylene bottles of 3L capacity and refrigerated at 4°C in order to be analyzed as soon as possible.

Table -1: Details of sampling location

Location	Notation	Coordinates of the location
Near Turadagi	S1	16.230757N, 76.058626E
Near Main temple at Kudala sangama	S2	16.208011N, 76.066608E
Near Yemmihatti	S3	16.194741N, 76.098366E
Near Kengalkadapatti	S4	16.180316N, 76.045151E



Figure -1: Map of the study area showing sampling locations

The analysis of all the samples for determination of physicochemical parameters is done as per the Central Pollution Control Board (CPCB) guidelines. The water quality parameters pH, Electrical Conductivity, Total dissolved solids, Turbidity, Total Hardness, Total Alkalinity, Dissolved Oxygen, Biochemical Oxygen Demand, Chemical oxygen Demand, Sulfates and Phosphates are analyzed in the laboratory. The methods adopted for analysis of above mention parameters are listed below in the **table 2**.

Table -2: Methods adopted for analysis of different water quality parameters.

Parameter	Methods/ Instruments adopted
pH	pH meter pH700
EC	EC meter con700
TDS	TDS analyzer CM183
Turbidity	Portable turbidimeter Hach2100 IS
Total Hardness	EDTA Titrimetric method
Total Alkalinity	Titrimetric method
DO	Winkler’s method
BOD	Winkler’s method
COD	Closed reflux method
Sulfate	Turbidimetric method
Phosphate	Stannous chloride method

2.3 Water Quality Index

Water Quality Index (WQI) is an efficacious method for assessing the suitability of water quality. It is also a beneficial tool for communicating the information on overall quality of the water to the concerned citizens and policy makers. WQI denotes large amounts of water quality data into simple terms for reporting to managers and the public in a consistent manner. The objective of water quality index is to reduce the complexity of the water quality data into information that can be understood easily by the public.

This study is an attempt to determine the water quality status of the river water near Kudala Sangama. In the formulation of WQI, the importance of various parameters depends on the intended use of water; here, water quality parameters are studied from the point of view of suitability for human consumption. The ‘standards’ (permissible values of various parameters) for the drinking water used in this study are those recommended by the BIS. When the BIS standards were not available, drinking water standards from ICMR, WHO, EPA and from different technical papers were applied. A general WQI approach is based on the most common factors, which are described in the following steps.

1. Parameter Selection: For the purpose of WQI calculation, eleven water quality parameters have been selected which are: pH, Electrical Conductivity, Total dissolved solids, Turbidity, Total Hardness, Total Alkalinity, Dissolved Oxygen, Biochemical Oxygen Demand, Chemical oxygen Demand, Sulfates and Phosphates.

2. Assigning weightage for each parameter: Each of the parameters has been assigned a weight (A_{wi}) ranging from 1 to 4 depending on the collective expert opinions taken from different previous studies. A relative weight of 1 was considered as the least significant and 4 as the most significant.

The relative weight (Rw_i) was calculated by using the following equation.

$$Rw_i = Aw_i / [\sum Aw_i] \text{ ----- (1)}$$

3. Determination of Quality Function for each parameter considered as the Sub-Index: Subindices transform to non-dimensional scale values from the variables of its different units (ppm, saturation percentage, counts/volume etc.).

$$Q_i = [C_i / S_i] 100 \text{ ----- (2)}$$

While, the quality rating for pH or DO (Q_{pH} , DO) was calculated on the basis of,

$$Q_{pH, DO} = [(C_i - V_i)/(S_i - V_i)] 100 \text{ ----- (3)}$$

where, Q_i = the quality rating, C_i = value of the water quality parameter obtained from the laboratory analysis, S_i = value of the water quality parameter obtained from recommended WHO/BIS standard of corresponding parameter, V_i = the ideal value which is considered as 7.0 for pH and 14.6 for DO. Equations (2) and (3) ensures that $Q_i = 0$ when a pollutant is totally absent in the water sample and $Q_i = 100$ when the value of this parameter is just equal to its permissible value. Thus the higher the value of Q_i is, the more polluted is the water.

4. Sub-Indices Aggregation with Mathematical Expression: This is frequently utilized through arithmetic or geometric averages. Finally, for computing the WQI, the sub indices (SI_i) were first calculated for each parameter, and then used to compute the WQI as in the following equations:

$$SI_i = Rw * Q_i \text{ ----- (4)}$$

$$WQI = \sum SI_i \text{ ----- (5)}$$

4. Results and discussion

The water samples were collected in February a start of summer season at 4 different locations, and samples were analyzed in the laboratory for different physicochemical parameters. The average values of results are shown in table 3.

The pH measurement reflects a change in the quality of the source. It was observed that although there is slight variation in pH, but it is within the prescribed limits. The results of pH varied from 7.2 to 8.3. The pH indicates that the water samples are almost neutral to sub-alkaline in nature.

In water sample of main temple site (S2), the EC value is exceeding the permissible value. The EC value is an index that represents the concentration of soluble salts in water.

A high concentration of dissolved solids greatly affects the taste of the drinking water. The observed values of TDS

nowhere exceeded the prescribed limits. The values of TDS are also quite high comparatively in the sample.

The alkalinity of water is its capacity to neutralize acid. The amount of a strong acid needed to neutralize the alkalinity is called the total alkalinity. The observed values of alkalinity nowhere exceeded the prescribed limits. High value of alkalinity is recorded in S2 sample because of the activities near the main temple site which puts certain amounts of alkaline ions into the river system.

Table 3: Average concentrations of different water quality parameters at different locations

Sl. No.	Parameters	Sampling Locations			
		S1	S2	S3	S4
1	pH	8.3	7.2	8.0	8.1
2	EC (μ S/cm)	158.8	435	273	150.3
3	TDS (mg/L)	98.7	316.8	190.2	97.4
4	Turbidity (NTU)	6.6	33	17.9	11.2
5	Total Hardness (mg/L as $CaCO_3$)	56.8	221	183.1	137
6	Total Alkalinity (mg/L as $CaCO_3$)	60.9	315	208	156.6
7	DO (mg/L)	7.7	6.7	7.2	7.1
8	BOD (mg/L)	5.9	7.5	6.1	6.0
9	COD (mg/L)	9	21	16	13
10	Sulfate (mg/L)	21	67	56	47
11	Phosphate (mg/L)	0.43	3.56	2.73	2.33

This is an essential parameter considered in drinking water for satisfying potability. As water moves through soil and rock, it dissolves very small amounts of minerals and holds them in solution. The observed Total hardness values vary from 56.8 to 221mg/L. The high value is recorded in S2 sample however the values are below the prescribed limits.

DO is the dissolved gaseous form of oxygen. It is essential for respiration of fish and other aquatic organisms. When the water is polluted with large amount of organic matter, a lot of dissolved oxygen would be rapidly consumed in the biological aerobic decay which would affect the water quality; the decreased dissolved oxygen in water would affect the aquatic lives. In S2 sample, the DO value is recorded 6.7mg/L. BOD values indicate a possibility of Organic pollution effect on the water body. The high value of BOD 7.5 mg/L is found in S2 sample. In the samples of S2, S3 and S4, COD values are greater than permissible limits.

Sulfate is naturally existed in surface water as SO_4^{2-} . Biological oxidation of reduced Sulphur species to sulfate increases its concentration in the water body. The values of Sulfate concentrations have nowhere reached the critical values. The higher value 67mg/L is found in S2 sample.

As Phosphorus concentration in the water increases, the growth of aquatic vegetation increases and decreases the dissolved oxygen in the water. The results of total phosphate are also within the permissible limits. The higher value 3.56mg/L is found in S2 sample.

Table 4: Calculated values of WQI and water quality status for different locations

	WQI	Status
S1	59.51	Good
S2	129.43	Poor
S3	93.17	Good
S4	73.80	Good

The WQI calculation reveals that the quality of River water at Kudala sangama area is different at different sampling stations. Water quality index and water quality status for different sampling sites are depicted in the **table 4**. The WQI is used to aggregate diverse parameters and their dimensions into a single score, displaying a view of the water quality of River water. It was observed from the computed WQI that the values ranged from 59.51 to 129.43. The quality of water was found poor in the sample S2 which is a sample taken near main temple. The WQI found less in S1 which is sample taken before the reach of river to the temple site. The WQI at S3 and S4 found less than S2 sample after the dilution of the pollutants.

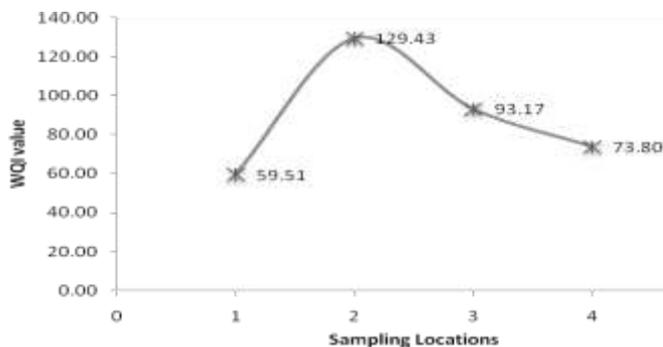


Figure 4.1: Graphical representation of WQI

5. Conclusions

Based on the analysis of results, we can conclude that the water quality of the main temple site is poor as a result of religious activities at the site. On a comparison, values of all the physico-chemical parameters are found high in the sample of temple site where as the pollution in the first sample of Turadagi village taken before the main temple site recorded very less. The exercise of WQI reveals the same. This study indicates the deterioration of water quality at the main temple site as a result of holy, religious and traditional activities.

However, at the temple site, maintenance work is carried out by Kudala Sangama Development Board. Often, the removal of solid wastes floating on the surface water is carried out by the labours. Rotation of this activity has to be increased from the Board. This is the time to take up the necessary actions to protect the water body.

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