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Bio Mapping of Water Quality in the Catchment Area of Arkavathi River - Karihobanahalli Lake, Karnataka, India

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Abstract: ***Surface and groundwater fluid content is controlled by natural features in the drainage network (geographical, topography, meteorological, hydrological, and ecological) and changes with fluctuations in runoff amounts, weather situations, and water levels. As a result, huge natural fluctuations in water quality can be detected even when only a single watercourse is involved. Human impact has an important influence on the environment, such as the outflow of domestic, commercial, municipal, as well as other effluents. As a result, it is vital to monitor the water quality at regular intervals. The Karihobanahalli Lake is one among four major lakes belongs to Arkavathi river basin. Water samples were analysed for critical water quality parameters i.e.; pH (Potentia Hydrogen), 2. BOD (Biochemical Oxygen Demand), 3. COD (Chemical Oxygen Demand), 4. DO (Dissolved Oxygen), and 5. TC (Total Coliform) and the Water quality index are developed. The water quality analysis reveals high BOD value of 24 mg/l, high COD value of 183 mg/l minimum DO value of 2.05 mg/l and Total Coliform concentration of 175000 MPN/ml of water indicating the pollution of lake due to discharge of untreated domestic sewage. for According to the Central Pollution Control Board (CPCB), water quality of Karihobanahalli lakes, indicates that the water is not suitable for drinking purposes, since the WQI class was E. Hence there is a need have interventions remediation measures for restoration of Karihobanahalli Lake. The interventions may be stoppage of direct entry of untreated sewage in to the lake, establishment of STP at strategic locations for treating the untreated sewage and stoppage of discharge of untreated trade effluent from industries.***

Keywords: Water quality, Critical water quality parameter, Pollution control and Methodical remediation of lakes, Water Quality Index

1. Introduction

Human activities have a wide range of consequences on water quality, which can have a major impact on the ecosystem and/or restrict water use. Human faeces pollute water from a single source, although the effects on water quality and the necessary corrective or preventive actions vary [1-2]. In affluent countries, organic load and eutrophication are major concerns. Pollution from various angles, for example, farming waste, such as sewage pollution from un-sewered areas, is very difficult to regulate [3]. On-site measurements, water sample collection and analysis, study and interpretation of logical data, and reporting of findings are thus the primary components of water quality monitoring. Analyses done on a single water sample are only valid for the sample's location and time of collection. A surveillance program's purpose is to acquire sufficient information (by regular or comprehensive sampling and testing) to evaluate geographically and/or temporal changes in water quality [4].

It is vital to keep track of the water's quality of lakes to assess the pollution of ponds, lakes, underground water, river water to regulate the environmental deterioration and potential health threats [5]. To improve the quality of water to make it appropriate for the specific use water treatment is necessary. Specific use may be for irrigation, water recreation, industrial water supply, river flow maintenance and most importantly for drinking. Treating the water to remove the undesirable components and contaminants or to reduce their concentration to fit for the specific use and treating water is a key to health of mankind and allows human being to get benefit either for drinking or domestic uses [6].

Present water quality monitoring study was carried out for Karihobanahalli Lake to monitor water quality as per the standard procedure and providing methodical remediation for improving the water quality or reducing the pollution.

2. Materials and Methods

2.1 Karihobanahalli Zone

Figure 1: Gangondanahalli lake catchment area leads to Karihobanahalli Lake

The study area is Karihobanahalli Lake - a major lake belongs to arkavathi river basin. Figure 1 shows the location of Karihobanahalli Lake. The location, surrounding areas and water inflow details are discussed in the following paras.

The Karihobanahalli lake (Also called Thigalarapalya Lake/ Narasappanahalli lake) is within Sy.no. 40, Karihobanahalli, Sy.No.89, 90, Nelagadaranahalli village, Sy.No.24, Doddabidarakallu village, Yeshwanthapurahobli, Bangalore. Figure 2 shows photographs of lake, outflow of water, google map and survey map related to Karihobanahalli Lake. This Karihobanahalli/ Thigalarapalya Lake come under the BBMP jurisdiction, Dasarahalli Zone. 25 hectares of lake area is covered by water. There is only one outflow from this lake located on the North-Western part close to the Gruhalakshmi housing colony.

a)

b)

c)

d)

Figure 2: a) Photograph of Karihobanahalli lake

b) Flow of dark blue coloured water in the rajakaluve beside M/s Ace Multi Axes Pvt. Ltd., Plot No.532, 10th Main, 4th Phase, Peenya, Bangalore which finally joins Karihobanahalli lake
c) Google map of Karihobanahalli lake
d) Survey map of Karihobanahalli lake

The lake's main intake of water comes from the lake's eastern side, specifically the north-eastern half near the Gruhalakshmi housing development (Kempaiah garden industrial area) and south-Eastern part is near Maruthinagara (Peenya industrial area).

2.2 Sample Collection, Preparation and Analysis

Four samples were collected during winter, summer, monsoon and post monsoon of 2020 for Karihobanahalli

Lake. Collection of 4 samples in each season (total 16) and compared for the water quality standards. Dry weather flow in summer season influences on receiving lake pollution at the maximum level. So, the dry season very important for analysing water quality. Four sampling sites were preferred based on the point source pollution. Grab sampling method has been used for collecting the samples. Sampling sites details related to location were shown in Table 1.

Table 1: Sampling codes and locations details of the lakes

Code	Sites Description	Longitude, Latitude
Sample 1	Karihobanahalli lake	N 13.010967, E 77.486384.

The study involves monitoring of physical, chemical and biological parameters of lake water. All the samples were analysed as per guidelines published by American Public health Association for the inspection of water or wastewater. Importance has been given to five major parameters relevant to water quality i.e.; 1. pH, 2. BOD, 3. COD, 4. DO, and 5. TC. Analysis of lake water samples has been done season-wise like winter, summer, monsoon and post-monsoon [7].

The process implemented in the study has shown in Figure 3 flow chart and the procedure along with steps are mentioned & briefed below.

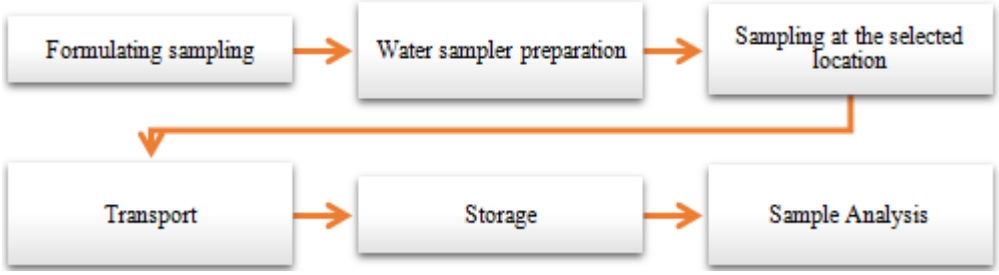

Figure 3: Flowchart of a process implemented in the inspection of water quality in lake water

3. Results and Discussions

3.1 pH Analysis

pH analysis has been done to know the alkalinity and acidic value of the water. Because pH is considered an aesthetic property of water, it is not regulated by the EPA. Considering the range of pH 6.5-8.5 suitable for drinking water the obtained results of the sample shows that water is suitable for drinking purpose [8].

Table 2: pH analysis of Karihobanahalli lake catchment area

Seasons	pH	Drinking Water Standard
Winter	7.55	6.5 – 8.5
Summer	7.35	6.5 – 8.5
Monsoon	6.9375	6.5 – 8.5
Post Monsoon	6.85	6.5 – 8.5

Source: Author

Table 2 shows the pH values of Karihobanahalli Lake. The analysis report reveals that the maximum pH recorded i.e., 7.55 during winter season and minimum pH was 6.85 during post-monsoon season. The water quality in terms of pH indicates that there no pollution in terms of Acidity or Alkalinity and hence for drinking purposes.

3.2 BOD Analysis

In this work, BOD analysis was largely utilized to quantify the quantity of dissolved oxygen required to break down organic compounds present in a water sample through aerobic biochemical activity at 27°C for three days. Indication of high BOD represents organic pollution.

Table 3: BOD analysis of Karihobanahalli Lake

Seasons	BOD in mg/l	Drinking Water Standard in mg/l
Winter	24	2-3
Summer	12.5	2-3
Monsoon	9.2	2-3
Post Monsoon	12.5	2-3

Source: Author

Based on CPCB of India the permissible amount of BOD for drinking water is 2-3 mg/l. Table 3 shows the BOD values of Karihobanahalli Lake. The analysis report reveals that the maximum BOD value of 24 mg/l during the winter and minimum BOD value of 9.2 mg/l during the monsoon. Based on analysis it's also confirms that maximum BOD values have obtained for winter season and minimum BOD values for monsoon season. This high value of BOD indicates discharge of either untreated sewage or partially treated sewage in to the lake from residential area. The findings indicate that the lake's water quality has worsened as a result of untreated/partially treated residential sewage discharged from the surrounding area [9].

3.3 COD Analysis

COD analysis was used to calculate the quantity of oxygen necessary to break down chemically oxidizable organic matter in water samples using a suitable oxidising agent.

Table 4: COD analysis of Karihobanahalli Lake

Seasons	COD in mg/l	Drinking Water Standard in mg/l
Winter	183	250
Summer	136.5	250
Monsoon	100	250
Post Monsoon	101	250

Source: Author

Based on CPCB of India the permissible number of COD for limits for industrial effluence is 250 mg/l. Table 4 shows the COD values of Karihobanahalli Lake. The above table reveals that the maximum COD value of 183 mg/l during the winter and minimum COD value of 100mg/l during the monsoon. Based on analysis it's also confirms that maximum COD values have obtained for winter season and minimum COD values for post monsoon season. The findings reveal that the lake's water quality is contaminated as a result of untreated/partially treated industrial effluent from the surrounding area.

3.4 Dissolved Oxygen (DO) Analysis:

DO was analysed for determining the water quality and to observe the presence of aquatic life in the lake water. It is an essential tool for indicating quality of water also it increases taste of water.

Table 5: DO analysis of Karihobanahalli Lake

Seasons	DO in mg/l	Drinking Water Standard in mg/l
Winter	2.05	6.5 - 8
Summer	3.25	6.5 – 8
Monsoon	3.625	6.5 – 8
Post Monsoon	3.75	6.5 – 8

Source: Author

Concentration of dissolved oxygen has major role in analysing water quality, if the water is having less dissolved oxygen, then aquatic animals may suffocate or die and with increased dissolved oxygen will leads to cause corrosion. Dissolved oxygen concentrations in healthy water should be greater than 6.5-8 mg/L.As shown in Table 5, the DO values of Karihobanahalli Lake. The analysis report reveals that the maximum DO value of 3.75 mg/l during post monsoon and the minimum DO value of 2.05 mg/l during the winter season. Based on analysis it's also confirmed that maximum DO values have obtained for the summer season and minimum DO values the for winter season. The high value of DO during the summer season indicates no entry of sewage and healthiness of water for the survival of aquatic life and the minimum value during winter indicates that the aquatic life cannot survive and eutrophication of lake due to no water/minimum water in the lake [10].

3.5 Total Coliforms (TC)

Total Coliforms or TC analysis was used to measure the level or degree of bacterial pollution and sanitary quality wastewater.

Table 6: TC analysis of Karihobanahalli Lake

Seasons	Drinking-Water	Drinking Water Standard in mg/l
Winter	0	Nil
Summer	175000	Nil
Monsoon	104650	Nil
Post Monsoon	14700	Nil

Source: Author

For drinking water, no total coliform should be detected. Table 6 shows the TC values of Karihobanahalli Lake. The EPA Maximum Contaminant Level (MCL) for coliform bacteria in drinking water is zero (or no) total coliform per 100 ml of water. According to the analysis report that the maximum TC value of 175000 MPN/100 ml during summer and the minimum TC value of Nil MPN/100 ml during the Winter season. Based on analysis it's also confirmed that maximum TC values have been obtained for the winter season and minimum TC values for the post-monsoon season. The findings show that the lake's water quality has worsened as a result of the discharge of untreated/partially treated residential sewage from the surrounding area. During post-monsoon, the dilution from rainwater is helping to reduce bacterial contamination.

3.6 Water Quality Index (WQI)

Table 7: WQI Classes of Karihobanahalli Lake

Sample Code	Location	Water Quality Index Class
Sample 1	Karihobanahalli lake, Bengaluru	E

The water quality index is a major device for determining the quality of drinking water in rural, urban and industrial areas. After summarizing the quality of water completely, results don't indicate extensive variation from zone to zone. The study's focus is to enhance the water quality of Karihobanahalli Lake for irrigation, domestic and other purposes. As per Central Pollution Control Board (CPCB) WQI classes, Karihobanahalli Lake water quality was assessed as bad and is classified as **class E**. Hence as per the class, the water from this lake can be used for controlled waste disposal, industrial cooling and irrigation after tertiary level treatment.

3.7 Methodical Remediation

Water quality inspection results based on WQI class E show that the quality of Karihobanahalli Lake *water is not fit for drinking* purposes. Due to the regular increase in the pollution level of the lakes and rapid urbanization along with industrial waste & domestic waste depleted the quality of water in lakes. So considered an effective technique to control, regulate the lake water quality. Physical, Chemical and Biological, remediation technologies can be adopted as cost-effective method for improving Karihobanahalli lake water.

4. Conclusion

The current analysis serves as the first assessment on the Karihobanahalli Lake. In the current study, water quality Monitoring of Karihobanahalli Lake has been studied along with the seasonal variation too. Here overall suitability of the Karihobanahalli lake water quality is based on WQI classes. The prominent features of several vital physico-chemical parameters of quality water of the Lake of Karihobanahalli Lake are highlighted.

The water quality analysis reveals high BOD value of 24 mg/l, high COD value of 183 mg/l minimum DO value of 3.75 mg/l and Total Coliform concentration of 175000 MPN/ml of water indicating the pollution of lake as a result of the discharge of untreated domestic sewage. According to the CPCB, water quality of Karihobanahalli lakes, indicates that the water is not suitable for drinking purposes, since the WQI **class was E.**

Immediate action plan has to be implemented to assess & augment the lake water quality by essential water quality management plan, which influences sustainable lake restoration. Quality of the water has to be improved by employing numerous parameters like restricting inflow of sewage from residential area and industries and preventing solid waste disposal by residential communities to the lake bed. Along with this, to increase quality of lake water by de-silting the lake bed and avoiding major encroachments for urban developments. Apart from this, Physical, Chemical and Biological treatment up to tertiary level can be considered and suitable remediation technologies can be adopted as cost-effective method for improving overall lake water quality.

Declarations Conflict of interest: The authors declare that they have no Conflict of Interest.

Data Availability – The raw/processed data required to reproduce these findings are available from the corresponding author on reasonable request.

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