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An Investive Study on Water Quality Parameters of Lakhanvaram Lake Water and its Suitability for Drinking

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Abstract

Lakes throughout the globe have been gravely altered or degraded at a pace much more significant than their restoration. Water quality safety is crucial in maintaining lakes' ecosystem service functions. The current study focuses on determining physicochemical parameters such as temperature, pH, EC, hardness, chlorides, alkalinity, DO, BOD, COD, phosphate, and sulphate in water samples from Lakhanvaram Lake over one year to analyse variations. To better understand the water quality changes in Lakhanvaram Lake and to identify the driving factors of water quality changes over time, this study evaluated and presented the water quality of Lakhanvaram Lake using 10 parameters. The results showed that trophic level index (TLI), trophic state index (TSI), and eutrophication index (EI) have to be evaluated to quantify the risk of eutrophication. These indices showed that the lake water was hyper-eutrophic in summer, with TLI, TSI, and EI values of 60.1, 63.0, and 66.6, respectively. This study revealed that controlling agriculture drainage is crucial for lake water quality management. The study generated critical data for managing water quality plans to control the risk.

***Key words*:** Lakhanvaram lake, Water quality, Physical, Physico-chemical, Biological properties of water, Agriculture-stressed, Nutrients

Lake ecosystems comprise these water bodies' physical, chemical and biological properties and may contain fresh or salt water. They may be narrow, deep, permanent, or temporary [1]. Lakes are ideal for researching ecosystem dynamics for interactions between biological, chemical, and physical methods that are frequently quantitatively or qualitatively different from those on land or in the air [1]. Many organisms require fresh water for survival, and humans commonly rely on lakes for various 'goods and services' such as drinking water, waste management, fishing, agricultural irrigation, industrial activity, and enjoyment. With economic growth and population increase, a lot of industrial and agricultural wastewater and domestic sewage inflow into the Lake cause the deterioration of lake water quality. In addition, the lake water quality is also affected by climate change and hydrodynamic conditions [2], causing the control of lake water pollution to face many difficulties.

Freshwater is a limited but essential constituent of Earth's hydrosphere. It is necessary for the survival of humans, for maintaining ecosystem functions, for the existence of plants and animals, and for the development and sustainment of the economy [3]. Most Indian lakes are contaminated with elevated levels of natural contamination, low oxygen accessibility for aquatic life forms and microbes, protozoa, and infections, which have fecal-starting points and cause diseases—fertilizers, pollutants, and sediments cause most lake pollution problems brought into the lakes. Soil particles contain more than 90% of the organic nitrogen and phosphorus derived from upland agriculture operations [4]. In recent years, extensive fertilizer and pesticide use and significant soil erosion rates have exacerbated the problem. High nitrogen and phosphate concentrations are the primary causes of algae growth, resulting in the deterioration of lake water quality. Algae have a much higher growth potential than any land-based plant system, and they react swiftly to nitrogen inputs that act as fertilizers. Monitoring water quality by measuring microbial abundance is critical for avoiding health hazards [5].

With the rise of metropolitan areas and an expanding population, the demand for clean water is greater than ever. The growing population, on the other hand, has the potential to damage water quality not just in the area where they live but also in the production of the food and industrial items they consume. Improved technological improvements, such as fertilizer that aids in crop growth, as well as industrial processes, can all have an impact on water quality. Fertilizer discharge can increase the naturally occurring nutrient levels in the water and impair the water quality through a series of biological responses to the increase in nutrient levels [6]. The primary purpose of this study is to examine the quality of Lakhanvaram Lake water over two to three years and its feasibility for use for drinking purposes and human consumption.

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MATERIALS AND METHODS

The water samples were collected through random selection levels and tight stoppers without introducing air. The water quality parameters are directly related to the safety of the drinking water for human use. These parameters provide important information about the health of a water body. The Lakhanvaram water samples were collected monthly from Sept 2022 to Aug 2023. These water samples were analyzed for their physicochemical properties viz., pH, TDS carbonates, bicarbonates, chlorides, calcium, magnesium, sodium, potassium, ammonical nitrogen, nitrate nitrogen, phosphates, total hardness, total alkalinity, dissolved oxygen (BO), using standard procedure [7], Methods of analysis AOAC [8] and Tandon [9]. These parameters were compared with the limits of the Bureau of Indian Standards (BIS) and the World Health Organization (WHO) to determine their suitability for drinking and human consumption.

RESULTS AND DISCUSSION

Several studies have been conducted over two years to assess the water quality of Lakhanvaram Lake, using monthly interval sampling and analysis for various physico-chemical, and biological parameters. Changes in water quality in light of its usefulness for human consumption have been studied. This research paper has documented important factors contributing to the depletion and degradation of Lakhanvaram lake water quality.

Lake water samples for 12 months are presented in (Table 1). The results indicated that the pH value varied between 6.75 and 8.10. These were falling within the permissible limit. EC values were in the range of 0.145 to 0.775 dS/m. The high EC values of Lakhanvaram Lake water are due to the high amount of dissolved inorganic substances in ionized form [10]. The turbidity for all the Lakhanvaram Lake water samples is below the WHO standards, ranging from 0.5 to 0.75 NTU. The total dissolved solids (TDS) values ranged from 92.8 to 816.0 mg/l. In drinking water, the value shows a very high combined content of inorganic substances.

The total hardness ranged from 25 to 175 mg/l. This shows that Lakhanvaram Lake water samples were within the permissible limits of Bureau of Indian Standards (BIS) and WHO standards. The total alkalinity values were also ranged from 25.0 to 175.0 mg/l. These values were within the permissible limits of BIS and WHO.

Table 1 Analysis report of Lakhanvaram Lake water samples for the period from 2022 to 2023

Particulars of water characteristics	Sept 2022	Oct 2022	Nov 2022	Dec 2022	Jan 2023	Feb 2023	Mar 2023	Apr 2023	May 2023	Jun 2023	Jul 2023	Aug 2023
pH	8.10	7.22	7.35	7.91	6.75	7.25	7.42	7.13	7.02	7.12	6.25	7.32
TDS (PPM) or mg/Lit	92.8	96.0	102.4	105.6	103.68	89.6	131.5	118.4	156.8	816.0	73.6	496.0
Carbonates	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bicarbonates	0.50	0.40	0.50	0.60	0.60	0.50	0.70	0.8	0.90	3.50	0.50	3.50
	(30.5)	(24.4)	(30.5)	(30.6)	(30.6)	(30.5)	(42.7)	(48.8)	(54.9)	(213.5)	(30.5)	(213.5)
Chlorides	1.60	1.20	1.60	2.00	1.20	1.20	1.60	1.60	2.00	5.60	1.60	2.80
Calcium	0.325	0.34	0.325	0.455	0.455	0.65	0.325	0.39	0.325	2.28	0.26	1.755
Magnesium	0.175	0.182	0.175	0.245	0.245	0.35	0.175	0.21	0.176	1.23	0.14	0.945
Phosphates	0.192	0.29	0.192	0.288	0.173	0.192	0.259	0.290	0.192	1.15	0.290	0.277
Total hardness	25.0	26.0	25.0	35.0	35.0	50.0	25.0	30.0	25.0	175.0	20.0	135.0
Dissolved oxygen	5.750	5.850	5.850	5.675	5.992	5.985	5.834	5.795	5.725	4.20	5.815	5.650

The calcium and Magnesium values in the tested Lakhanvaram Lake water ranged from 16.0 to 112.0 mg/l. It plays a significant role in the hardness of water. The sodium value in Lakhanvaram Lake water ranged from 5.98 to 15.66 mg/l. Lakhanvaram Lake water samples over some time have a permissible limit of sodium (200 mg/l). The sodium values range from 5.98 to 15.66 mg/l. The excess sodium may also be stored in old plants [11]. The potassium value ranged from 0.192 to 3.98 mg/l. All the samples have an acceptable limit of potassium (30 mg/l).

The chloride contents in Lakhanvaram Lake water were tested over 12 months with a monthly interval of 42.54 and 198.5 mg/l. Water samples were within the permissible limits of BIS and WHO Standards at all the sampling periods. At concentrations above 250 mg/l, the water acquires a salty taste, which harms the human body [12].

The phosphates (PO_4) content in these four tested samples ranged between 0.00 and 0.15mg/l, and the Lakhanvaram Lake water samples tested were within the permissible limits of BIS and WHO Standards. The sulphates (SO_4) content in Lakhanvaram Lake water tested ranged between 9.8 and 343.0 mg/l, and Lakhanvaram Lake water at different periods was within the permissible limits of BIS and WHO Standards. Shrirang Vrushali and Chatterjee Kaustav [13] stated that a high sulphate concentration may cause gastric irritation.

The dissolved oxygen (DO) values in Lakhanvaram Lake water at different periods ranged from 4.20 to 5.992 mg/l. All the water samples at different collection periods with monthly intervals have a permissible limit (4.20 to 6.0 mg/l) of DO. Lakhanvaram Lake water samples over a monthly period of 12 months with a monthly interval have a permissible limit (4.0 mg/l) of DO. The blue-green Algae content in Lakhanvaram Lake water was tested for 12 months with a monthly interval ranging between 0.50 and 2.20 µg/Lit. These twelve-monthly interval water samples tested were within the permissible limits of BIS and WHO Standards.

During dry summer months periods starting from March to June, water parameters like pH, TDS, chlorides, bicarbonates and cations like sodium and calcium will be high, and in monsoon periods from July to August and also September months because of rainfall, the above parameters will be lowered. However, the rainy season will increase parameters like nitrate nitrogen, chlorides, and sulphates. Dissolved oxygen is vital to supporting the aquatic life in that particular water body. DO will fluctuate daily and is affected by many factors. Oxygen is more easily dissolved in cold water, so colder water will have a higher DO, and warmer water will have a

lower DO. Therefore, from April, May and June in the summer months, the temperature, pH, and DO will be higher, and in November, December and January, the above parameters will be lower.

In many areas, increased water temperatures will cause eutrophication and excess algal growth, reducing drinking water quality. The quality of drinking water sources may also be compromised by increased sediment or nutrient inputs due to extreme storm events. Major water pollutants include microbes, nutrients, heavy metals, organic chemicals, oil and sediments; heat, which raises the temperature of the receiving water, can also be a pollutant. Pollutants typically cause significant water quality degradation during the winter season.

The reduction in pollutant levels was due to restrictive measures to limit anthropogenic activities and the closure of several large and small-scale industries. It provided a unique opportunity to assess the impacts of several wastewater sources on groundwater quality, and the results might help formulate new water quality policies for the region. However, formulating a water quality policy is a long-term process as the instant effects of present and past emergencies on the water quality can also be adverse.

Phosphorus in any lake or any stream at the point where it enters the Lake should not exceed 0.05 mg/l. The excessive phosphorus levels during very wet years and very high inflow periods need to be lowered for reduction in algal blooms and improvement in water quality, as well as for reduction in DO level depressions in the Lake and supplies of nutrients to macrophytes. In a lake, the dissolved oxygen concentration should not fall below 5 mg/l or at least six mg/l during 16 hours of any 24 hours.

The results of this study showed that the analyzed data was compared with Bureau of Indian Standards (BIS) and World Health Organization (WHO) Standards. The analysis of the water quality parameters of Lakhanvaram Lake water showed that pH, TDS, Chloride ion, Total hardness, Calcium and Magnesium, BOD and COD values are well within desirable and permissible limits of Bureau of Indian Standards (BIS) and World Health Organization (WHO) Standards. In conclusion, from the results of the present study, it may be said that the Lakhanvaram Lake water is suitable for domestic usage, such as washing clothes, cleaning utensils, and bathing. However, drinking water needs treatment to minimize contamination, especially alkalinity, through a suitable system [14-17].

CONCLUSION

The present investigation reviewed that due to impurities in Lakhanvaram Lake, many parameters were increased during summer and diluted during the rainy season. This change would affect the aquatic environment as an increase in nitrogen content would naturally result in eutrophication, leading to a decrease in the oxygen content. Lack of oxygen can kill fish, and lack of fish enables malaria-hosting mosquitoes as mosquitoes are natural food for fish. Without oxygen at the bottom, beneficial bacteria and insects cannot biodegrade the organic sediment at the bed level of the Lake. Purification methods should exist from filtration processes that should be carried out before introducing any foreign material into the water body. Proper bioremediation techniques should also be used to improve water quality. The suggested measures to improve the lake water quality include a total ban on the activities that cause pollution. The effects of climate change need to be considered in tandem with atmospheric pollution policies. Carbon removal technologies at power stations utilize amines, which could increase ammonia releases, enhancing N deposition and, hence, both eutrophication and acidification. Idol immersion significantly impacts water quality and fish in lakes, particularly concerning heavy metals. Heavy metal concentrations in lake water and muscles of many fishes increased after immersion of idols compared with the maximum permissible concentrations for human intake. Humans are exposed to these accumulated metals in fish by ingestion. They can impose higher risks on human health because fish are found virtually everywhere in the aquatic environment, and they play a significant ecological role in the aquatic food webs because they carry energy from lower to higher trophic levels. It is further recommended that an accurate assessment of the water demand for human consumption and the minimum water based on the ecological requirements of floodplains should be undertaken at regular intervals to harness the benefits accrued through their natural function. Discharge of untreated domestic sewage and industrial effluents, washing clothes, vehicles, and animals, and immersion in enduring festivals contributed to the pollution of Lake. The present investigation on Lakhanvaram Lake water reveals that nutrient loading has exceeded the eutrophic condition, leading to a hypereutrophic status. Land use change and longer growing seasons could increase the use of fertilizers with subsequent leaching to watercourses, rivers and lakes, increasing the risk of eutrophication and loss of biodiversity.

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