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A COMPREHENSIVE ASSESSMENT OF WATER QUALITY IN THE DUNDIGAL AREA: ANALYZING CONTAMINANTS AND POLLUTION SOURCES

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Abstract: *The evaluation of water quality has become increasingly critical due to contamination from industrial, agricultural, and urban activities, as well as the excessive use of groundwater. This study focuses on the physical, chemical, and biological characteristics of Dundigal Lakes, a vital water source in Hyderabad. The objective is to assess the water quality using these parameters to determine its suitability for drinking, irrigation, and industrial purposes. Key water quality indicators such as Total Dissolved Solids (TDS), pH, Biochemical Oxygen Demand (BOD), and turbidity were analyzed. Results revealed variations in pollution levels across different sampling sites, with several parameters—especially BOD and turbidity—exceeding permissible limits. Consequently, the water from Dundigal Lakes is deemed unsafe for human consumption without appropriate treatment. This research underscores the importance of continuous management and monitoring to sustain the quality of this essential resource. Effective water treatment and pollution control strategies, informed by the spatial distribution of contaminants, can promote better public health and ecosystem sustainability.*

Keywords:Physical Parameters, Chemical Parameters, Biological Parameters, Total Dissolved Solids, Dissolved Oxygen, Water Analyzer, Dundigal Lakes

1.INTRODUCTION

Growing populations, urban expansion, and agricultural activities are leading to the overuse of groundwater, resulting in significant environmental pollution and water scarcity. The excessive extraction of groundwater contributes to declining water levels and contamination, necessitating urgent water quality testing to prevent waterborne diseases and ensure safety standards [1]. Water quality assessment is critical in understanding the condition of freshwater resources, which are becoming increasingly scarce [2] .

Evaluating water quality at the basin level involves analyzing various physical, chemical, and biological parameters, enabling the mapping of pollution sources and the spatial distribution of contaminants. High-quality water must meet standards essential for human health and ecosystem sustainability [3] . Water quality monitoring is essential for detecting harmful substances and ensuring safety for drinking, agriculture, and industrial use. It helps protect ecosystems by identifying pollutants, thus preventing damage to aquatic habitats. Economically, early detection of water issues can mitigate financial losses in agriculture and industry, ensuring compliance with legal standards. Ultimately, regular monitoring fosters sustainable water management practices and safeguards communities from waterborne diseases.

2. LITERATURE REVIEW

The literature review from 2012 to 2023 evaluates water quality across Hyderabad, focusing on the impacts of pollution from industrial waste, raw sewage, and agricultural practices. High levels of heavy metals, fluoride, and biological pollutants pose significant health risks. It underscores the urgent need for local governments to implement effective management and treatment plans, alongside routine monitoring and infrastructure upgrades, to combat declining water quality due to urbanization and environmental degradation.

Manchala Lingaswamy et al. (2023) studied groundwater quality in Hyderabad's Jeedimetla Industrial Area, assessing parameters like pH, EC, TDS, hardness, alkalinity, various ions, and heavy metals (As, Cr, Pb, Hg, Cd). Contaminant levels exceeded WHO guidelines within the industrial area but were lower at the periphery, highlighting the impact of untreated or partially treated industrial effluents. The study emphasizes the urgent need for effective wastewater treatment to protect groundwater and public health [4].

Suresh Kumar. R, V. S. S. Sudheer. Ch, Dr. Venkata Ramana. G, and Sri Ramya. N conducted a comparative study on water quality in lakes across Medchal District, Telangana, examining Dundigal, Nizampet, Bowrampet, and

Mallampet lakes. By assessing physical (pH, turbidity) and chemical (COD, BOD) parameters, they provided insights into water quality variations from rural to urban settings, highlighting each lake's compliance with standards amid different developmental pressures [5].

Dr. R. Premsudha and colleagues (2022) assessed water quality in Hussain Sagar and Saroornagar lakes, Hyderabad, analyzing 24 samples for parameters like pH, total hardness, TDS, Ca^{2+}, Mg^{2+}, Cl^{-}, HCO_3, CO_3, DO, BOD, and COD [6]. Results showed variations from permissible limits, underscoring the importance of regular monitoring to ensure water quality.

Potharaju and Aruna (2021) sampled four stations every month for a year (January 2019 to December 2019) in order to investigate the physicochemical parameters of Medchal Lake, Telangana. APHA (2005) methodologies were used to evaluate important parameters such as pH, turbidity, total dissolved solids, hardness, chlorides, phosphates, nitrates, dissolved oxygen, and biological oxygen demand. Although the majority of the metrics were within acceptable bounds, the study found notable variances in a few, suggesting that the water quality was good. The results indicated that the lake's water is fit for human consumption. This study highlights the importance of routine monitoring to preserve environmental health and water quality [7].

K.V. Pavan Kumar (2023) assessed water quality in Hyderabad, focusing on Himayath Sagar, Osman Sagar, and Peerzadiguda. The study identified significant pollution, especially in Peerzadiguda, where groundwater near the Musi River exceeded permissible limits for EC, alkalinity, E. coli, and coliforms, posing severe health risks. Himayath Sagar showed elevated sodium levels linked to agricultural practices, while Osman Sagar exceeded EC limits due to high ion concentrations, though TDS, turbidity, chlorine, and sulfate levels were acceptable. These findings highlight the urgent need for the Greater Hyderabad Municipal Corporation (GHMC) to implement effective treatment and management strategies to ensure safe water for domestic, agricultural, and industrial use [8].

Sumathi Jaganathan and Jayanth Chapla (2023) examined the water quality of Khazipally Lake in Telangana, highlighting contamination from population growth, urbanization, and industrialization, primarily due to nutrient enrichment from nitrogen and phosphorus. This leads to eutrophication, causing oxygen depletion and uncontrolled algal growth. By evaluating parameters like pH, dissolved oxygen, BOD, COD, and nitrates, the authors emphasized the need for regular monitoring to safeguard water quality. They also advocated for raising public awareness and implementing routine analyses to protect the lake's ecosystem and ensure sustainable use [9].

Prachi Vasistha and Rajiv Ganguly (2020) underscore the critical role of water quality assessment amidst growing freshwater scarcity concerns. Their study highlights that evaluating physical, chemical, and biological parameters helps gauge water body health, identify pollution sources, and map contaminant distribution. Basin-level assessments enable precise management strategies, protect ecosystems, and ensure water safety for human use, contributing to sustainable resource management for future needs [10].

3. STUDY AREA

Dundigal, located in the northern part of Hyderabad, India, is a municipality in the Medchal-Malkajgiri district of Telangana. It serves as the headquarters of the Dundigal mandal within the Malkajgiri revenue division. The geographical coordinates of Dundigal are 17.5361° N latitude and 78.3881° E longitude. The study utilizes geological, terrain, and contour maps to analyze the area's rock formations, physical features, elevation changes, and landforms as shown in Figure 1 and Figure 2.

Figure 1 Satellite view of Dundigal region

Figure 2 Terrain view of dundigal

4. METHODOLOGY

Water samples are collected from multiple locations within the study area to capture diverse conditions. Various physical, chemical, and biological parameters—such as pH, dissolved oxygen, nitrates, and heavy metals—are analyzed to assess the water's suitability for drinking, irrigation, and ecosystem

support. The results are then compared to national or international water quality standards to identify any exceedances or potential concerns.

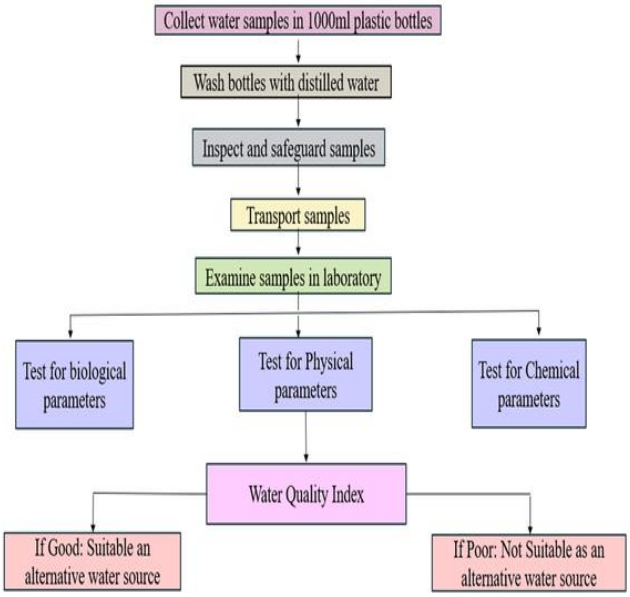

Figure 3 Flow chart of methodology

The above Figure 3 shows chart represents a general procedure for water sample collection and quality testing. It begins with collecting water samples in 1000 ml plastic bottles, which are thoroughly washed with distilled water to avoid contamination. After collection, the samples are inspected, safeguarded, and transported to the laboratory for analysis.

Water analyzer : A water analyzer is a device or system used to measure different parameters in water to evaluate its quality. These analyzers range from portable handheld units to advanced laboratory instruments and are designed to test various physical, chemical, and biological parameters, ensuring that water meets established safety and quality standards.

Figure 4 Water analyzer Equipment

Tests conducted on Water Analyzer

Water analyzers perform multiple tests to evaluate water quality, such as measuring pH, turbidity, and dissolved oxygen levels. These assessments ensure compliance with health and safety standards and provide vital data for environmental monitoring and treatment processes. Regular calibration and maintenance of the analyzers are essential for ensuring accurate results.

- **pH :** Natural water pH usually centers around 7, often leaning alkaline due to carbonates. During the day, photosynthesis reduces CO_2, raising pH, while nighttime respiration increases CO_2, lowering it. Other influences include atmospheric exposure, temperature, and industrial waste. Reverse pH (RpH) is the pH measured after aerating the sample to remove free CO_2, resulting in a typically more alkaline reading.

- **Dissolved oxygen (DO) :** Dissolved oxygen (DO) is a key water quality indicator, influenced by physical and biological factors. It enters water through air diffusion, affected by temperature, movement, and salinity, and from photosynthesis by autotrophs like phytoplankton, which rely on light and available gases. Non-polluted waters typically have saturated DO levels, but pollutants like organic waste and ammonia can deplete DO. Most fish need 2–5 mg/L of DO, with low levels posing risks to aquatic life.

- **Total Dissolved Solids (TDS) :** Total Dissolved Solids (TDS) refer to the combined concentration of organic and inorganic substances dissolved in water, including minerals, salts, and ions. Commonly measured in parts per million (ppm) or milligrams per liter (mg/L), TDS levels can affect water's taste, density, and suitability for drinking, irrigation, and industrial use. High TDS levels influence the water's chemical properties, potentially impacting aquatic life and the solubility of oxygen.

- **Salinity :** Natural waters contain various dissolved salts, including carbonates, bicarbonates, chlorides, magnesium, phosphates, potassium, iron, and manganese. High levels of dissolved solids increase water density, affect osmoregulation in freshwater organisms, and reduce gas solubility, impacting the suitability of water for drinking, irrigation, and industrial uses. This parameter is especially important in analyzing saline lakes, coastal estuaries, and marine environments, typically measured in ppm (mg/L) or ppt (g/L).

- **Temperature :** Solar radiation and atmospheric temperature significantly influence the thermal dynamics of natural water bodies, leading to

convection currents and thermal stratification. The release of heat from various sources can also result in thermal pollution, altering water temperature. Temperature is a crucial factor affecting chemical and biological processes in water; an increase caaccelerate chemical reactions, decrease gas solubility, enhance taste and odor, and boost the metabolic activity of aquatic organisms.

For a number of water quality parameters, such as pH, total dissolved solids (TDS), oxygen demand (OD), salinity, electrical conductivity, temperature, oxidation-reduction potential (ORP), biochemical oxygen demand (BOD), chemical oxygen demand (COD), and turbidity, the Table 1 below displays the BSI standard permissible limits

BSI permissible limits

Table 1 BSI permissible limits

Parameters	Units	Standard permissible limits
pH	-	6.5-8.5
Total dissolvedSolids(TDS)	Mg/L	500-2000
Oxygen demand (OD)	Mg/L	≥5
Salinity	Mg/L	>600
Electrical conductivity	µs/L	200-800
Temperature	°C	10-30
ORP(oxidation-reductionpotential)	mV	200-400
BOD (Biochemicaloxygen demand)	Mg/L	<3
COD (Chemical oxygen demand)	Mg/L	10-20
Turbidity	NTU	5

5. RESULTS AND DISCUSSION

Before using water for different purposes, it's important to analyze its quality. Water usually contains various impurities, including suspended particles, dissolved substances, and microorganisms. The below table summarizes the results of water quality tests conducted on three different samples. Each sample was tested for several key parameters: pH, Total Dissolved Solids (TDS), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), turbidity, total hardness, and chlorides. These parameters help provide a clear understanding of the water quality, and the results are explained below in Table 2.

Table 2 Results of the water samples collected from the lakes

Parameters	Dundigal lake	Domara pochamapally lake	Dundigal cheruvu
PH	7.2	6.8	7.5
TDS (mg/L)	450	500	480
BOD (mg/L)	4.5	5.0	3.8
COD (mg/L)	35	40	32
Turbidity (NTU)	8	12	10
Total Hardness (mg/L)	180	190	175
Chlorides (mg/L)	100	120	90
Dissolved Oxygen (mg/L)	7.5	6.8	7.0
Salinity (ppt)	0.4	0.5	0.3
Temperature (°C)	25.5	26.1	25.8
Cell constant	1.1	1.0	1.2

pH : The pH values of Domara Pochampally Lake, Dundigal Lake, and Dundigal Cheruvu are compared to the safe standards set by the Bureau of Indian Standards (BIS). Dundigal Lake has a pH slightly above 7, Domara Pochampally Lake is around 6.8 (the lowest), and Dundigal Cheruvu is nearly 7.5 (the highest). All three lakes fall within the BIS acceptable range of 6.5 to 8.5, indicating that they are within safe pH levels for water quality as shown in Figure 5.

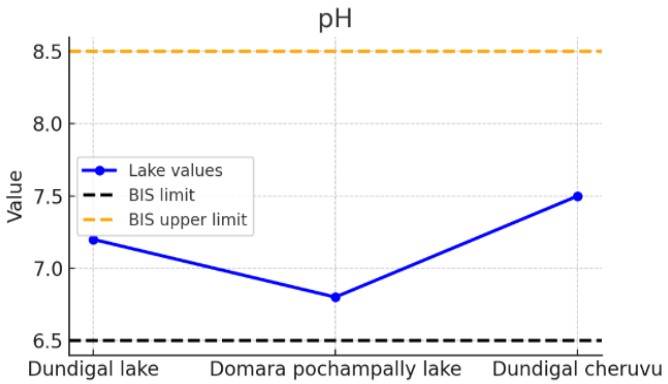

Figure 5 pH Levels of Water Samples Compared to Permissible Limit

Total Dissolved Solids : The Figure 6 Shows TDS levels of Dundigal Lake, Domara Pochampally Lake, and Dundigal Cheruvu are evaluated against the Bureau of Indian Standards (BIS) safe drinking water standard of 500 mg/L. Dundigal Lake has a TDS value of about 450 mg/L, well below the limit. Domara Pochampally Lake meets the maximum threshold at exactly 500 mg/L, while Dundigal Cheruvu's TDS is around 470 mg/L, slightly lower but still close to the limit. The rising TDS levels in Domara Pochampally Lake and Dundigal Cheruvu suggest a need for monitoring to maintain water quality, as elevated TDS can affect the taste and overall quality of drinking water.

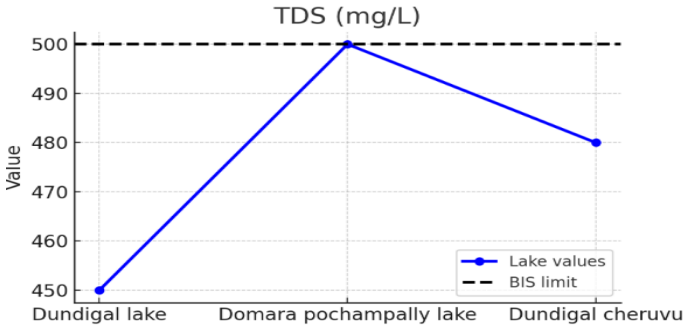

Figure 6 TDS Levels of Water Samples Compared to Permissible Limit

Biochemical Oxygen Demand (BOD): The BOD levels of Domara Pochampally Lake, Dundigal Lake, and Dundigal Cheruvu against the BIS limit of 5.0 mg/L. Domara Pochampally Lake exceeds this limit at exactly 5.0 mg/L, while Dundigal Lake is below it at approximately 4.5 mg/L. Dundigal Cheruvu has the lowest BOD value at around 3.8 mg/L, well under the allowable limit. These results reflect varying degrees of organic contamination in the lakes, with all values remaining within permissible limits as shown in Figure 7.

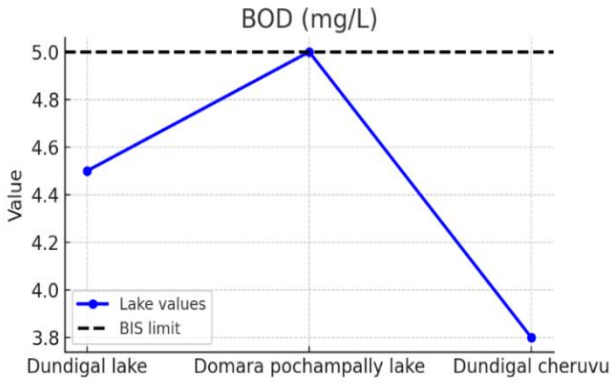

Figure 7 BOD Levels of Water Samples Compared to Permissible Limit

Chemical Oxygen Demand (COD): Chemical Oxygen Demand (COD) values for Dundigal Lake, Domara Pochampally Lake, and Dundigal Cheruvu, with the BIS limit set at 250 mg/L. All lakes have COD levels well below this limit, with Dundigal Lake at approximately 40 mg/L, Domara Pochampally Lake slightly higher at about 50 mg/L, and Dundigal Cheruvu at around 35 mg/L as shown in Figure 8.

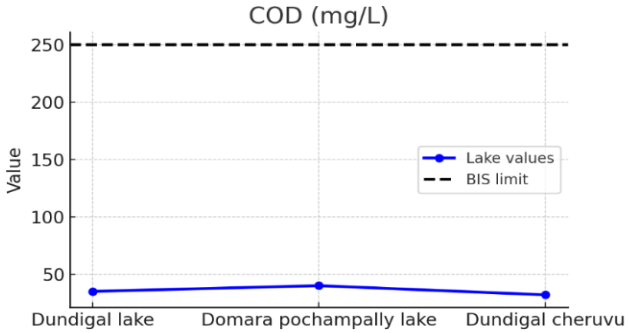

Figure 8 COD Levels of Water Samples Compared to Permissible Limit

Turbidity: The turbidity levels for 3 lakes, measured in NTU, exceed the BIS limit of 5 NTU. Domara Pochampally Lake has the highest turbidity at 12 NTU, followed by Dundigal Cheruvu at 10 NTU, and Dundigal Lake at 8 NTU as shown in Figure 9. High turbidity indicates less clear water, caused by suspended particles, suggesting significant concentrations of suspended materials in all three lakes, which may indicate pollution or sedimentation issues.

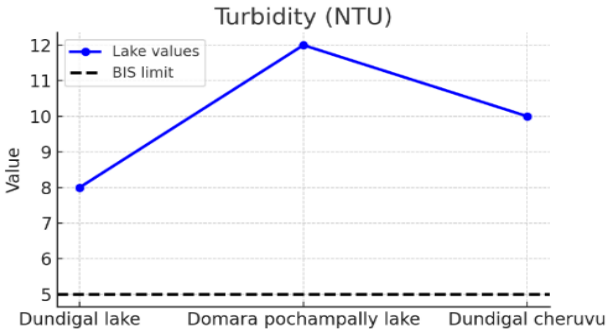

Figure 9 Turbidity Levels of Water Samples Compared to Permissible Limit

Total Hardness: The total hardness values for Dundigal Lake, Domara Pochampally Lake, and Dundigal Cheruvu are measured in mg/L and show stable levels across the lakes, with a slight decrease at Dundigal Cheruvu. All three lakes have hardness levels well below the BIS limit of 300 mg/L, indicating that the water hardness is within acceptable standards as Shown in Figure 10.

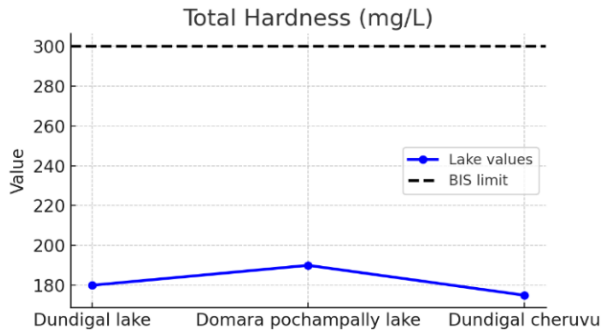

Figure 10 Total Hardness Levels of Water Samples Compared to Permissible Limit

Chlorides: The Figure 11 shows chloride levels in Dundigal Lake, Domara Pochampally Lake, and Dundigal Cheruvu are measured in mg/L and are all below the BIS limit of 250 mg/L. Dundigal Lake and Dundigal Cheruvu have higher chloride levels near 175 mg/L, while Domara Pochampally Lake shows a lower concentration of about 125 mg/L. Overall, none of the lakes approach the upper safety limit, indicating relatively low chloride pollution in these water bodies.

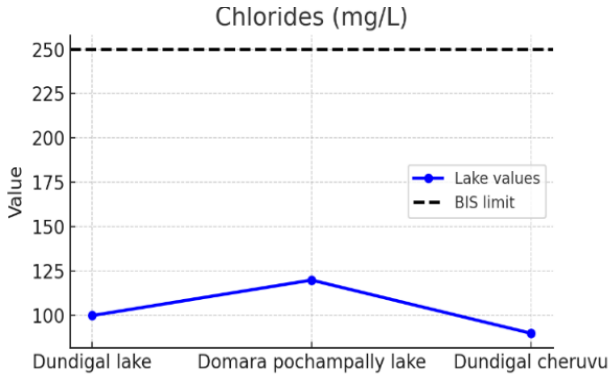

Figure 11 Chlorides Levels of Water Samples Compared to Permissible Limit

Dissolved Oxygen: Dissolved oxygen levels in Dundigal Lake, Domara Pochampally Lake, and Dundigal Cheruvu are all above the BIS minimum limit of 5.0 mg/L, indicating good water quality for aquatic life. Dundigal Lake has the highest level at about 7.5 mg/L, followed by Domara Pochampally Lake at around 7.0 mg/L, while Dundigal Cheruvu's levels are similar to those of Dundigal Lake as shown in Figure 12. These results suggest stable and adequate oxygen levels across the lakes, supporting healthier aquatic ecosystems.

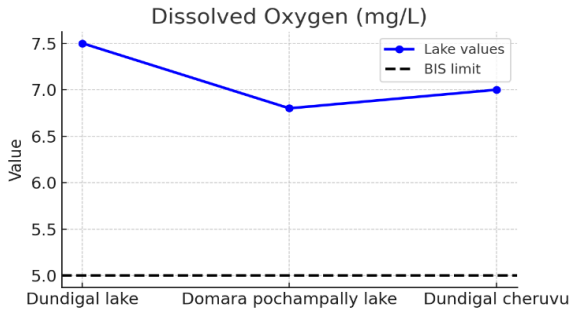

Figure 12 Dissolved Oxygen Levels of Water Samples Compared to Permissible Limit

Temperature: Temperature readings from three lakes show that Dundigal Lake is at approximately 25.6°C, Domara Pochampally Lake is slightly higher at around 26.1°C, and Dundigal Cheruvu has a temperature of about 25.7°C. These measurements highlight the temperature variations among the lakes as Shown in Figure 13.

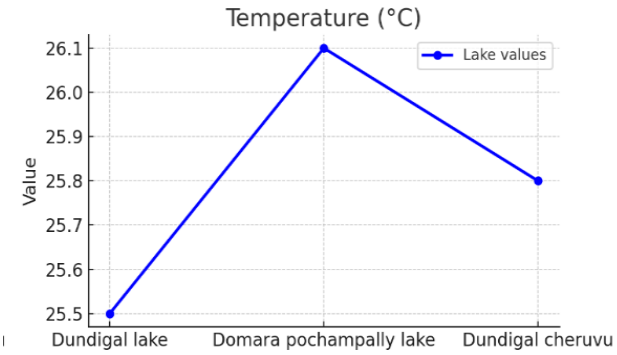

Figure 13 Comparative Water Temperatures of Local Lakes

Sailinity : The Figure 14 Shows salinity levels of the three lakes are as follows: Dundigal Lake at approximately 0.4 ppt, Domara Pochampally Lake at around 0.5 ppt, and Dundigal Cheruvu at about 0.3 ppt. All measurements are well below the Bureau of Indian Standards (BIS) limit of 1.0 ppt, indicating that salinity levels in all three lakes are within acceptable water quality ranges.

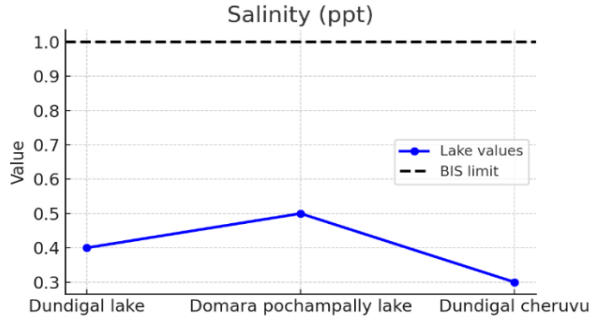

Figure 14 Comparison of Salinity Levels in Dundigal Lakes with BIS Standard

Cell Constant: The cell constant values for the three lakes are as follows: Dundigal Lake at approximately 1.1, Domara Pochampally Lake at 1.0, and Dundigal Cheruvu at 1.2 as shown in Figure 15. This variation indicates differences in the water's conductivity, with Dundigal Cheruvu exhibiting the highest conductivity potential among the three lakes.

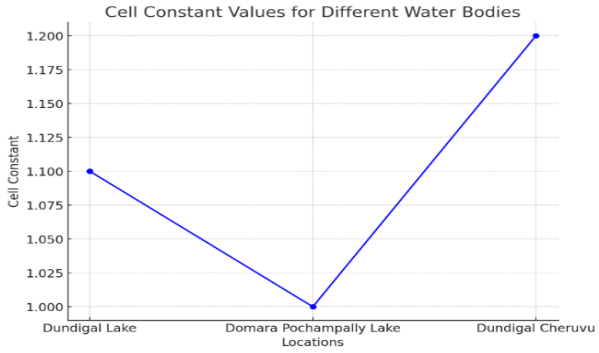

Figure 15 Variation in Cell Constant values Across Dundigal Lakes

Water Quality Index (WQI): Water Quality Index (WQI) is a numerical representation that helps assess the overall quality of water based on various water quality parameters. It simplifies complex data into a single value, making it easier to understand the general condition of the water. The WQI value reflects the suitability of water for various uses such as drinking, swimming, or irrigation. Higher WQI values indicate poorer water quality, while lower values suggest better water quality.The general formula for calculating the Water Quality Index (WQI) is

$$WQI = \frac{\sum(Qn*Wn)}{\sum Wn}$$

Qn is calculated as:

$$Qn = \frac{(Vn-Vid)}{(Sn-Vid)} * 100$$

Where:

- V_n = Measured value for the parameter.
- S_n = Standard permissible value for the parameter (based on guidelines like BIS or WHO).
- V_{id} = Ideal value for the parameter (in most cases for pollutants, this value is 0 or a permissible limit).

WQI for Dundigal Lake:

According to the Water Quality Index (WQI) analysis, Dundigal Lake's water quality level is indicated by an approximate WQI of 83.99. In a similar vein, Domara Pochampally Lake's greater WQI of roughly 97.99 indicates its relative health. Conversely, Dundigal Cheruvu exhibits its unique water quality characteristics with a WQI of roughly 88.88.

Water Quality Index (WQI) Ranges and Classification:

WQI is classified into ranges that show the water quality state, with minor variances based on the region or method. Water with a WQI of 0–25 is typically regarded as being of excellent quality, clean, and acceptable for drinking and most other applications without treatment. Good water quality, safe for most uses yet needing only modest treatment for drinking, is indicated by a WQI of 26 to 50. Fair water is defined as having a WQI of 51 to 75, indicating moderate contamination and requiring treatment for household or drinking uses. With a WQI of 76 to 100, poor water quality is contaminated, unfit for human consumption, and necessitates extensive treatment. When the WQI is greater than 100, it means that the water is extremely contaminated, dangerous to human health, and needs to be thoroughly treated before it can be used.

Results Of water quality in each lake

Dundigal Lake (WQI = 83.99), Domara Pochampally Lake (WQI = 97.99), and Dundigal Cheruvu (WQI = 88.88) are all classified as having "Poor Water Quality" according to the water quality index (WQI) analysis. According to this categorization, these lakes' water is unfit for human consumption and needs to be thoroughly treated before being used.

6.CONCLUSION

In conclusion, water quality testing is essential for assessing the safety of sources like Dundigal Lakes for various uses, including drinking. The Water Quality Index (WQI) indicates that the current conditions of all three lakes—Dundigal Lake, Domara Pochampally Lake, and Dundigal Cheruvu—are unsatisfactory for potable water due to elevated Total Dissolved Solids (TDS), Biochemical Oxygen Demand (BOD), and turbidity levels. These exceed acceptable limits, placing them in the Poor Water Quality category, which necessitates significant treatment before consumption. High TDS affects taste and health, while elevated BOD points to organic pollution that can harm aquatic life. Increased turbidity suggests poor water clarity, which can harbor pathogens. Therefore, treatment methods are essential to reduce TDS, BOD, and turbidity to meet drinking water standards, along with regular monitoring to ensure safe consumption and ecosystem health.

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