A Comprehensive Water Quality Assessment in Dundigal: Analyzing Contaminants and Their Impact

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Abstract. Pollution arising from industrial, agricultural and domestic developments has made the assessment of water quality ever more important given the increasing impact on ecosystem health and human well-being. Directly relevant to the United Nations Sustainable Development Goals, this study relates primarily with SDG 3 (Good Health), SDG 6 (Clean Water and Sanitation) and SDG 11 (Sustainable Cities), plus more generally through safe water access, pollution reduction and sustainable resource management. This investigation assesses the water quality of specific physical, chemical and biological parameters of lakes within Dundigal. In various designated sampling sites key indicators such as pH, Biochemical Oxygen Demand (BOD), turbidity and Total Dissolved Solids (TDS) were measured and analysed using the Digital Water and Soil Analysis Kit (Model 161) by Electronics India. However, large differences were observed in contaminations levels between the sampling sites. Notably, BOD and Turbidity values were beyond acceptable limits which further supported that the lake water in Dundigal which is unsuitable for direct human consumption without proper pre-treatment steps. These results underscore the pressing necessity for optimal and systematic monitoring of local water resources on an ongoing basis. Our work shows how spatially targeted water treatment interventions, combined with pollution control measures can bring large public health gains, and sustainable environmental benefits at modest expense within the region.

Keywords: Water analyzer, SDGs, total dissolved solids, chemical, biological parameters, and physical parameters

1 Introduction

Water standards are a critical factor in ensuring the health and sustainability of ecosystems, as well as the well-being of living things. It also aligns with the United Nations SDGs,

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particularly SDG 6 (Clean Water and Sanitation), SDG 3 (Good Health and Well-being), and SDG 11 (Sustainable Cities and Communities), by contributing to the development of effective water quality monitoring tools essential for ensuring safe, accessible, and sustainably managed sustainably managed water resources. According to SDG 6, safe and clean water is essential for drinking, irrigation, and maintaining biodiversity. The storage structures of water are becoming very polluted by urbanization growth, agricultural, industrial expansion, wastewater, and unregulated waste disposal, which have numerous significant impacts. The contaminants are heavy metals, pathogens, pesticides, and others are detected at very high levels in water structures, viz., lakes, irrigation tanks, surface water, and groundwater, posing severe risks to the environment and public health, SDG 3. Therefore, the state of freshwater lakes and water quality assessment is very crucial [1]. Assessing the quality of water and its distribution of contaminants in the lakes is mandatory for their usage. Examining the pollutants in the lakes by using physical, chemical, and biological factors for maintaining the good quality of lake water is the humblest return on investment for ecosystem sustainability and protecting human health [2]. Water quality monitoring is crucial for identifying unsafe pollutants and ensuring that water is safe for drinking, agricultural, and industrial use. It is still a breath to the ecosystem. Water Quality Monitoring in Agriculture [3] is used to detect water quality issues that can be detected early, which saves economic losses and agricultural activity. The electronic device called Digital Water and Soil Analysis Kit (Model 161) is used to detect the impurities in the water quality for various samples, regular monitoring of water quality contributes positively to long-term health and environmental safety by promoting sustainable practices and protecting SDG 11 against waterborne illnesses.

2 Review of Literature

The literature review emphasises the state of water quality, drawing attention to the impacts of pollution caused by industrial waste, untreated sewage, and agricultural activities. Lingaswamy conducted a study on the quality of groundwater in the Jeedimetla Industrial Area, Hyderabad, analyzing different parameters [4]. Findings showed that contaminant levels exceeded the WHO guidelines for the industrial zone, whereas the levels of contaminants were lower at the outskirts of the zone [5]. The degree of industrial impact of a region on groundwater quality is linked to the degree of untreated industrial wastewater discharge. This indicates that there is a need for water treatment methods to be more effective, particularly to safeguard groundwater resources along with public health taken from the literature [6]. A comparative analysis in Medchal District, Telangana, studying lakes in Dundigal, Nizampet, Bowrampet, and Mallampet. The study provided an evaluation of several physical and chemical parameters of water in the rural and urban areas to determine the quality of water [7]. This study was very helpful in understanding the condition of these lakes, their water quality relative to the developmental pressures they face, and the water quality standards. The water quality of Saroor Nagar and Hussain Sagar Lakes in Hyderabad, Telangana, and she conducted an analysis of 24 water samples for all parameters [8]. It was shown that there is a significant difference in the physicochemical parameters measured in the samples and the accepted standards.

An analysis focused on the deteriorating urban water bodies infrastructure levels in Hyderabad, looking at the impact of swift urbanization on the waters' quality, quantity, and accessibility [9]. From the 231 water bodies under study, 25 were completely dry, and 75 were dry, but still surrounded by water during the wet season because of development. None of the water bodies out of the 231 were fit for human consumption, indicating extreme levels of contamination. Protecting the water bodies from pollution is paramount in preserving groundwater [10] and public health, given the anticipated tripling in demand by 2050, the existing dependence on pumped river water, and the already strained groundwater situation [11-12]. Pavan evaluated the water quality in Hyderabad, concentrating on the Himayath Sagar, Peerzadiguda, and Osman Sagar regions. Peerzaadiguda was the most polluted, with groundwater near the Musi River exhibiting elevated levels of electrical conductivity (EC), alkalinity, Escherichia coli (E. coli), and coliform bacteria, posing serious health risks. Himayath Sagar showed high sodium levels, likely from agricultural runoff, while Osman Sagar, although having high EC, was still acceptably low in TDS, turbidity, chlorine, and sulfate, but had high ion concentration. The results showed the direct need for formulating and enforcing efficient water treatment and management strategies in order to provide safe water for domestic, agricultural, and industrial purposes, excluding drinking.

The Saroornagar Lake in Hyderabad showed that pollution from untreated sewage, indiscriminate domestic laundry, vehicle washing, and industrial activities was primarily to blame for the degradation of the lake's water quality [13-14]. Each measured variable revealed levels exceeding regulatory limits, leading the authors [15], to infer a surplus of biodegradable organics and correspondingly low dissolved oxygen levels symptomatic of severe eutrophication. Contaminant concentrations now preclude the lake's use for domestic, agricultural, or industrial supply without preliminary and extensive treatment. Concurrently, Devi assessed Hyderabad's urban water supply by collecting samples from hostels, canteens, food courts, and hospitals, measuring all parameters. Results indicated tap water remained, in most samples, within the prescribed limits for the minerals tested, and the absence of microbial pathogens classified it within the safest category nationally. The Union Ministry of Consumer Affairs recently tagged it as the second safest potable water in India, according to a 2021 survey coordinated in tandem with the Bureau of Indian Standards. A complementary review led urged the city to keep the drinking-water pipelines visibly apart from the sewer lines and to modernise parts of the ageing network to block corrosive leaks.

3 Methodology

Water samples are collected in 1000 ml bottles that have been carefully cleaned with distilled water to prevent contamination. Those samples are collected, processed and transported to the laboratory. To consider a range of conditions, multiple water samples are collected from different sites in the area of study. They are measured for a variety of factors, including pH, dissolved oxygen, nitrates and heavy metals to determine if the water is safe for drinking supply, irrigation or sustaining ecosystems.

3.1 Study Area

The study area: Dundigal municipality in Medchal-Malkajgiri district, Telangana state, India 3. Geographical Location of Dundigal: Dundigal is located around 17.5361° N latitude, 78.3881° E longitude based on Geographical Information System GIS in Figure 1. The landscape mainly consists of low-rolling plains and isolated small hills that are a typical feature of the Deccan Plateau. Its geology is predominantly basaltic volcanic rocks from the Deccan Traps lava flows, with weathered granites and gneisses of the Archean Shield affecting groundwater storage and surface Runoff patterns. The climate is semi-arid tropical with summer temperatures exceed in 40oC a mild winter (mean low of 15oC) and yearly average precipitation of about 690 mm mainly being during the southwest monsoon period. In this area, we have three lakes chosen for assessment of water quality. Located at 17.60629° N, 78.420245° E, just near the Dundigal border, Dundigal Cheruvu (Lake 1) plays a significant role as a surface water source for local populations. The second lake, in the center at 17.607593° N, 78.391477° E, provides ecological functions and water requirements.

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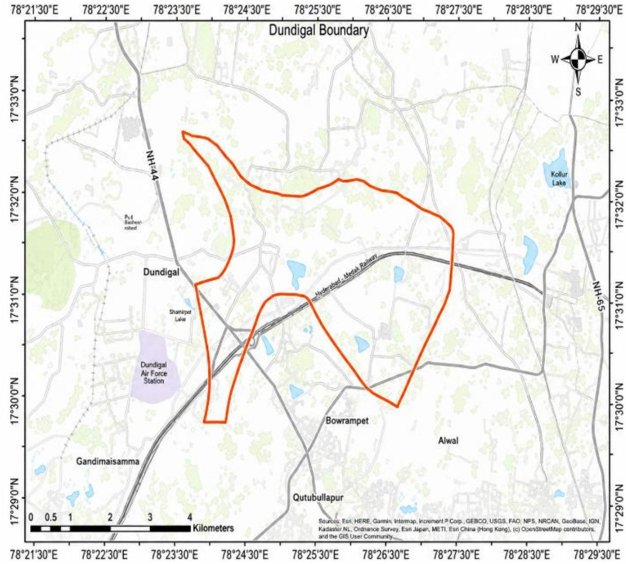

Fig. 1. Dundigal map using GIS

Domarapochampally Lake (Lake 3) Located at (17.620911° N, 78.408663° E), and adds to local biodiversity and historical groundwater recharge. The surrounding soils of the water bodies consist of shallow black cotton soils mixed with red loams due to basaltic weathering which determines its infiltration and retention capacity. Mindat reports that almost all water resources in Dundigal are from groundwater tapped by wells and boreholes extended into weathered and fractured basaltic and granitic formations. org. Lakes, which accumulate seasonal runoff in places, are also being contaminated from urban and even industrial sources as development grows. An in-depth analysis of the physiography, geology, climate and distribution of spatial water bodies goes a long way in performing an integrated holistic assessment of the contaminant sources and sinks along with their impacts which will greatly help to devise mitigation options for a sustainable management of water resources.

3.2 Water Analyzer

A water analyzer is an equipment helps to analyze the quality of water by measuring various chemical, physical and biological indicators. The model 161 Digital Water and Soil Analysis Kit from Electronics India as indicated in Figure 2 is used to examine benchmark standards in water. Water quality analyzers are the specially used instruments or devices that analyze adequately the physical, chemical and biological properties of water to check if it qualifies for its desired purposes. It monitors seven parameters of water quality: temperature, turbidity, pH dissolved oxygen content total dissolved solids concentrations of heavy metals and nitrates. Six independent sensors, each parallelized to one of those parameters returns a raw measurement and subsequently turns these into proportional voltage outputs. In standard engineering, a digital display shows the results read by the main processing unit. The embedded algorithm provides a Water Quality Index and a set of composite health indicators, which enable users to take one reference that appears as an overall measure of risk for human use (drinking, irrigation etc.) or ecological conservation.

Fig. 2. Water analyzer Equipment

3.3 Tests Conducted on the Water Analyzer

These include analyzers that are dependent on turbidity, pH and dissolved oxygen to measure complete sizing of waters. Routine measurement of these parameters supports data informed decisions on where to invest resources in ecological monitoring and treatment control, as well as compliance with public health directives when necessary. These directives are critical to public safety as well as for all industries using water in regulated environments. Accuracy depends upon on-time analyzer maintenance & per-calibration schedules Beyond these regular requirements, physical and biological factors that intermingle with the dissolved oxygen value essentially affect water condition. It is incorporated into water through the process of photosynthesis by autotrophic entities like phytoplankton that are light dependent and require gases, as well as through the process of air diffusion, which is dependent on temperature, movement, and even salinity. Even though some pollutants like organic waste and ammonia tend to lower DO, non-polluted waterways tend to have on average, saturated levels of DO, which is also important for fish, requiring 2 to 5 mg/L, and low levels can become detrimental for aquatic life.

Table 1. BIS permissible limits

Parameters	Units	Permissible limits	Parameters	Units	Permissible limits
PH	-	6.5-8.5	Temp	°C	10-30
TDS	Mg/L	500-2000	BOD	Mg/L	<5
DO	Mg/L	≥5	COD	Mg/L	10-20
Salinity	Mg/L	>600	Turbidity	NTU	5
Chlorides	Mg/L	250-1000	TH	Mg/L	200-600

TDS are the organic and inorganic materials whose concentration is combined and attributed to the process of dissolving in water, such as minerals and salts. These levels, which are typically expressed in parts per million (ppm) or milligrams per litre (mg/L), can affect the density and suitability of water for industrial, agricultural, and drinking purposes. pH: The pH of natural water is often about 7, and because of carbonates, it frequently leans alkaline.

While respiration raises CO_2 at night, reducing pH, photosynthesis lowers it during the day. Temperature, industrial waste, and exposure to the atmosphere are other factors Salinity: Numerous dissolved salts, such as chlorides, carbonates, magnesium, bicarbonates, potassium, phosphates, iron, and manganese, are found in natural waters. The prescribed concentration tolerances- expressed as maximum or minimum cited points- are tabulated in Table 1. The cited water quality parameters included are low and high pH, TDS, the saturated biological and chemical loads (BOD and COD), DO, electrical conductivity, salinity, temperature, and visual turbidity features.

4 Results and Discussions

The three water samples were collected from each of three different lakes, resulting in a total of nine samples. The water quality of these lakes was analyzed based on key parameters to determine their suitability for various purposes. Each sample was observed for various components, viz., pH, TDS, BOD, COD, turbidity, total hardness, and chloride content. These parameters provide valuable insights into the water quality of the lakes in Dundigal. Table 2, show the test results for each lake.

Table 2. Various parameter values of the water samples collected from the Various Lakes

Parameters	**Dundigal Lake 1 Samples**			**Dundigal Lake 2 Samples**			**D-Pochampally lake Samples**		
	1	2	3	1	2	3	1	2	3
TDS (mg/L)	550	500	540	450	500	650	490	420	480
PH	6.5	6.8	6.9	7.2	6.5	5.3	7.8	7	7.5
BOD (mg/L)	4.2	5.0	4.8	7	6.5	8.5	4.2	4.6	3.8
COD (mg/L)	46	40	44	35	45	42	35	38	32
Turbidity (NTU)	11.5	12	10	8	6	9	12	14	10
Total Hardness (mg/L)	182	190	220	180	200	220	185	190	175
Chlorides (mg/L)	110	120	102	100	128	120	110	108	90
DO (mg/L)	7.2	6.8	7.0	7.5	7.8	8.5	8.0	10	7.0
Salinity (ppt)	0.4	0.5	0.6	0.4	0.6	1.0	0.6	0.5	0.3
Temperature (°C)	25.8	26.1	27	25.5	28	25.8	24	26	25.8
Cell constant	1.1	1.0	1.2	1.1	1.6	1.3	1.5	1.3	1.2

The pH levels of water samples from D-Pochampally Lake, Dundigal Lake 1, and Dundigal Lake 2 are within the BIS-acceptable range. Every sample from D-Pochampally Lake and Dundigal Lake 1 is within the BIS range, showing stable pH levels in the water. Though, Dundigal Lake 2, Sample 2 is below the lesser limit of 6.5, demonstrating slightly acidic water, and Samples 1 and 3 are within the range. This implies that Dundigal Lake 2 exhibits some pH variability. According to the BIS (2021), the BIS-permissible range of 500–2000 mg/L is contrasted with the TDS values for Dundigal Lake 1, Dundigal Lake 2, and D-Pochampally Lake. All samples in Dundigal Lake 1 had TDS levels that are close to the lower limit (~500 mg/L), indicating acceptable water quality. Samples 1 and 2 in Dundigal Lake 2 are just within the 500 mg/L limit; however, Sample 3 surpasses it by approximately 700 mg/L. TDS levels of D-Pochampally Lake are just below the limit, ranging from 400 to 500 mg/L. Although the greater TDS in Dundigal Lake 2 (Sample 3) indicates a slightly elevated concentration of dissolved solids that may require more observation, overall, all results are well within the BIS range of safety

All samples for BOD values from Dundigal Lake 1, Dundigal Lake 2, and D- Pochampally Lake have their BOD levels compared to the BIS permitted maximum of 5 mg/L. All three samples in Dundigal Lake 1 have BOD levels between 4 and 6 mg/L. Moderate organic contamination is indicated by values that slightly exceed the allowable limit, while others fall within it. Significant organic pollution is indicated by the higher BOD readings in Dundigal Lake 2, which range from 6 to 8 mg/L and exceed the BIS limit. Similarly, BOD levels in D-Pochampally Lake range from 5 to 7 mg/L, with some readings over the permissible limit. Samples from Dundigal Lake 1, Dundigal Lake 2, and D-Pochampally Lake have their COD values compared to the BIS-permissible range of 10–20 mg/L. Dundigal Lake 1 has COD values between 40 and 50 mg/L, which is significantly higher than the considered acceptable and indicates the presence of high quantities of chemical contaminants. Also, Dundigal Lake 2 has significant chemical contamination, with COD levels ranging from 40 to 50 mg/L. Even while the COD levels in D-Pochampally Lake are rather lower—between 30 and 40 mg/L—they still greatly exceed the BIS limit. Very high COD indicates that some impurities are contaminating the water and degrading its quality as well as damaging aquatic ecosystems (for example, agricultural runoff or industrial waste).

The Turbidity levels recorded in water samples collected from D-Pochampally Lake, Dundigal Lake 1 and Dundigal Lake 2 are represented in above Table. All three lakes have tests exceeding the BIS allowable maximum of 5 NTU, indicating significant turbidity levels. D-Pochampally Lake has a higher turbidity value; Sample 2 exceeds 14 NTU and is relatively larger than the mild turbidity of Dundigal Lakes 1 and number 2. These high levels mean that you have a good deal of sediment or particulate matter in the water and cannot drink directly (without treating it first), as wells are not permanently pure. Raw hardness data for water samples from these same lakes. All of the samples fall within the 200–600 mg/L BIS permissible score for chlorides. While D-Pochampally Lake, which is closer to the upper range, has slightly higher values than Dundigal Lakes 1 and 2, the values are generally similar across the lakes. This implies that even while every sample satisfies the chloride requirements, the water hardness levels need to be monitored in order to maintain their long-term suitability for use in residential or commercial settings. The chloride concentrations in all samples from D- Pochampally Lake, Dundigal Lake 1, and Dundigal Lake 2 are significantly lower than the 250– 1000 mg/L BIS acceptable limit. Dundigal Lake 2 Sample 2 had the greatest concentration, 128 mg/L, while Dundigal Lake 1 and 2 exhibited comparable values. With slightly lower chloride levels than other lakes, D-Pochampally Lake shows no signs of serious contamination.

All lakes have dissolved oxygen levels that are both above and below the BIS minimum requirement of 5 mg/L. Levels at Dundigal Lakes 1 and 2 are consistently about 7-8 mg/L. Sample 2 from D-Pochampally Lake has the greatest dissolved oxygen level, at about 10 mg/L; all of its other samples had levels above 7 mg/L. Water temperatures fall between 10 and 30°C, which is the BIS-acceptable range. While Dundigal Lake 2 Sample 2 has the highest temperature of 28°C, Dundigal Lake 1 displays consistent temperatures of about 25°C. At D-Pochampally Lakes, with temperatures between 23°C in Sample 1 and 26°C in the others, the thermal conditions were conducive for aquatic ecosystems across all lakes. Salinity levels of all three lakes - were far below the 600 ppm BIS (Bureau of Indian

Standards) guideline, which means the water is within safe salinity standards. Dundigal Lake 1 Dundigal Lake 2 D-Pochampally lake D-Pochampally Lake and Dundigal Lake 1 were intermediately salty (0.4–0.6) in all samples, whereas Dundigal Lake 2 showed the highest salinity for Sample 3 (1.0). This shows that no water sample has a salt value higher than what is admissible. The cell constant values range across the lakes, suggesting differences in conductivity calibration needs. However on all samples, Dundigal Lake 1 has consistent and comparatively lower values (1.0), Sample 2 is the lowest cell constant (1.6) with strong strength conduction. D-Pochampally Lake consistently shows slightly higher cell constant values (1.5) across all of its samples. These variances in cell constant highlight the failure of the three lakes to regulate their ionic content of water.

Water quality index (WQI) is a number to communicate the overall characteristic or quality of water by plotting various physical, chemical and biological parameters. The presented method condenses complex water quality levels or values into a single value that either represents the condition of water which is more communicable and easier to understand as compared to keeping track of multiple water qualities at once. The WQI metric usually provides a range of 0–100 for the improved water quality, represented in higher values when reaching satisfactory conditions or lower values when the receiver body is less suitable. As described in Table 3, calculation of the WQI usually comprises parameter selection, normalisation of raw data onto a common scale, weight extraction and aggregation from sub-index values into a final index.

$$WQI = \Sigma \left(\frac{Q_n * W_n}{W_n} \right)$$

Where Qn = Quality rating for the nth parameter, Wn = Unit weight of the nth parameter, (based on guidelines like BIS).

Table 3. Water Quality Index (WQI) Ranges and Classification

WQI Range	**Water Quality**	**Description**
0 – 25	Excellent	Clean, safe for consumption, and most other applications without treatment
26 – 50	Good	Safe for most of uses, requires modest treatment for drinking.
51 – 75	Fair	Moderately contaminated, requires treatment for household or drinking purposes
76 – 100	Poor	Contaminated, unsuitable for consumption, requires massive treatment.
> 100	Contaminated	Dangerous to human health, it requires thorough treatment before use.

For Dundigal Lake 1, the salinity was 0.6 ppt, the temperature was 24°C, the total hardness was 185 mg/L, the chlorides were 110 mg/L, the dissolved oxygen (DO) was 8.0 mg/L, the TDS was 490 mg/L, the BOD was 4.2 mg/L, the COD was 35 mg/L, and the turbidity was 12 NTU. Poor water quality was indicated by the Water Quality Index (WQI), which was found to be 125.98. Its low quality is mostly caused by elevated COD and turbidity. Dundigal Lake 2 salinity was 0.5 ppt, its pH was 7.0, its TDS was 420 mg/L, its BOD was 4.6 mg/L, its COD was 38 mg/L, its turbidity was 14 NTU, its total hardness was 190 mg/L, its chlorides were 108 mg/L, and its DO was 10 mg/L. This lake's water quality was extremely bad, as shown by its WQI of 136.83. Its high WQI was mostly caused by high levels of salinity, turbidity, and COD. For D-Pochampally Lake, the pH was 7.5, TDS was 480 mg/L, BOD was 3.8 mg/L, COD was 32 mg/L, turbidity was 10 NTU, total hardness was 175 mg/L, chlorides were 90 mg/L, DO was 7.0 mg/L, salinity was 0.3 ppt, and temperature was 25.8°C.

The WQI for this lake was 112.05, which still falls under the poor water quality category. Higher turbidity and COD levels contributed to its lower water quality

5 Conclusion

According to the Water Quality Index (WQI), the water quality of all three lakes—Dundigal Lake 1, Dundigal Lake 2, and D-Pochampally Lake—is rated as bad or extremely poor. The decline in these lakes' water quality is mostly caused by high concentrations of pollutants such as COD, turbidity, and salinity. Dundigal Lake 2 likewise has high salinity levels; however, Dundigal Lakes 1 and 2 are most impacted by high COD and turbidity. Despite a minor improvement, D-pochampally Lake's water quality is classified as poor by the WQI due to high levels of turbidity and COD. For safe human consumption and other applications, all these lakes need to undergo extensive treatment to meet drinking water standards, SDG 6. In addition, continuous monitoring and targeted remediation are essential to restore water quality and ensure long-term sustainability. Enhanced quality of water confirms safe drinking water, healthier ecosystems, improved agriculture, and reduced cost of treatment for water, while future scope lies in smart monitoring, AI-based prediction, and sustainable treatment technologies for SDG 6 and global water security.

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The data used in this study were obtained through direct field sampling and laboratory analysis of water samples collected from Dundigal Lake 1, Dundigal Lake 2, and D-Pochampally Lake using the Digital Water and Soil Analysis Kit (Model 161) by Electronics India.

All authors contributed to the conception of the study. Water sample collection, laboratory analysis, and Water Quality Index computation were carried out by the authors. Data interpretation and manuscript preparation were performed collaboratively. All authors read and approved the final manuscript.

The authors declare that they have no conflict of interest.

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