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ECOLOGICAL STUDIES OF THE BHANDAM CHERUVU, WITH REFERENCE TO ITS PHYSICO-CHEMICAL ENVIRONMENT-A CASE STUDY OF RAPID EUTROFICATION

***P. Gowri**

Department of Zoology, Kaktiya Govt. College (Autonomous) Hanamkonda, Warangal-506001(TG).

***Corresponding Author: P. Gowri**

Department of Zoology, Kaktiya Govt. College (Autonomous) Hanamkonda, Warangal-506001(TG).

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ABSTRACT

This study investigates the impact of human activities on the eutrophication process of a lake by examining various physico-chemical parameters of the water, including temperature, pH, electrical conductivity (EC), chemical oxygen demand (COD), biological oxygen demand (BOD), total hardness, magnesium (Mg^{2+}), phosphates, nitrates, carbonates, and bicarbonates. Located near a city, the lake has been observed to be polluted due to multiple anthropogenic sources. The research monitored seasonal variations in these physico-chemical parameters over a one-year period, from June 2023 to May 2024, at four distinct sampling locations across the lake. Notable variations in heavy metal concentrations were detected before and after the immersion of Ganesh idols during the Ganesh Chaturthi festival. Overall, the findings clearly indicate that the lake is eutrophicated, as most of the physico-chemical parameters exhibited high values. This study underscores the lake's status as a eutrophic zone, largely resulting from various human activities.

KEYWORDS: Physico-Chemical Parameters, Seasonal Variation, Eutrophication.

INTRODUCTION

Water is one of the most critical components for sustaining life on Earth. According to Kudesia and Kudesia (1998), approximately 97% of the Earth's water is found in oceans, 2% is locked in ice at the poles, and the remaining 1% is available as fresh water in rivers, streams, lakes, and groundwater, which is essential for human consumption, irrigation, and industrial use. Seasonal variations can significantly impact parameters such as temperature, dissolved oxygen (DO), biological oxygen demand (BOD), and other factors affecting lakes (Patra A.P. 2010; Salanki V.R. 2007). Eutrophication is a global phenomenon characterized by the nutrient enrichment of aquatic ecosystems. It is a natural, albeit slow, process of lake aging that ultimately leads to ecological succession. Lakes possess a complex and delicate ecosystem that lacks a self-cleaning ability, making them susceptible to accumulating pollutants. In recent years, the increasing impact of human activities in and around aquatic systems and their catchment areas has significantly contributed to water quality degradation and the decline of water bodies, resulting in accelerated eutrophication. Substantial amounts of undesirable elements have been introduced, hastening the eutrophication process. Consequently, there have been major changes in the biological and physico-chemical parameters of the water, adversely affecting the quality of the aquatic ecosystem and often transforming clear water into a turbid state (Qin 2009). Bhandam Cheruvu is located near the cities of Hanamkonda and Kazipet in the erstwhile Warangal district. Until 1990, this lake served as a primary source of water for irrigation and fish culture. The lake has become eutrophicated due to the inflow of drainage waters carrying sewage from the city, resulting from various human activities. This investigation examines the seasonal variations of the physico-chemical parameters, noting significant blooms of phytoplankton and zooplankton throughout the study period.

MATERIALS AND METHODS

Samples were collected monthly during the morning hours, specifically before 6:00 A.M., in clean plastic water containers. Concentrated hydrochloric acid (HCl) was added to prevent any alteration of the physico-chemical parameters. The quality of the water is typically assessed based on its physico-chemical and biological characteristics. For this study, a comprehensive analysis of various physico-chemical parameters was conducted, including temperature, pH, electrical conductivity (EC), chemical oxygen demand (COD), biological oxygen demand (BOD), total hardness, calcium (Ca^{2+}), magnesium (Mg^{2+}), phosphates, nitrates, carbonates, bicarbonates, and heavy metals such as iron (Fe), manganese (Mn), copper (Cu), zinc (Zn), and nickel (Ni). This analysis was performed over a one-year period, from June 2023 to May 2024, at four different

sampling locations around the lake, following the standard methods outlined by APHA (2006).

TOPOGRAPHY

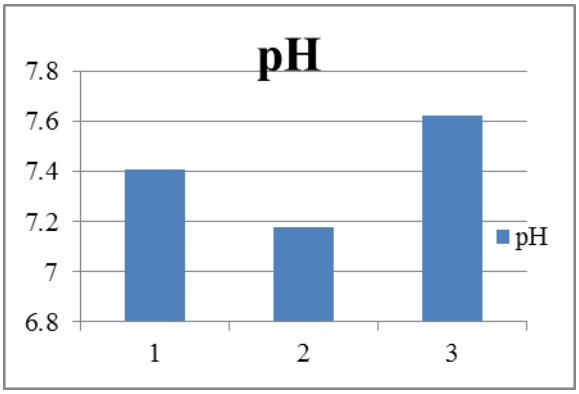
Bhandam Cheruvu is located at a latitude of 17°08'58" and a longitude of 79°32'34" in the erstwhile Warangal district of Telangana State, India. The lake is in close proximity to the city, and it receives a significant amount of domestic waste generated by urban households. Sewage from various sources enters the lake through multiple routes, leading to a decline in water quality and contributing to the ongoing issues of pollution and eutrophication in the ecosystem. This influx of urban waste underscores the need for effective management and conservation strategies to protect this vital water resource.

RESULTS

The annual data for the physico-chemical parameters of Bhandam Cheruvu, an urban lake, covers the period from June 2023 to May 2024. Water samples were collected at 6:00 A.M., prior to sunrise, to minimize diurnal variations in the measurements. Parameters such as pH, temperature, and dissolved oxygen (DO) were measured on-site immediately after sampling. The collected water samples were then transported to the laboratory for further analysis, following the standard methods outlined by APHA (1998). To ensure the integrity of the samples, appropriate preservative techniques were employed, and the water samples were preserved until the analysis was conducted in the laboratory. This systematic approach is essential for accurately assessing the lake's water quality and understanding the impact of urban waste on its ecosystem. An overview of Bhandam Cheruvu's water quality parameters such as the physico-chemical parameters of the lake water over a year-long period, from June 2023 to May 2024, revealed the extent of pollution and its impacts on the lake's ecosystem has. The following Parameters were analyzed during the study and also some of the following parameters were measured. Water temperature has fluctuated between a minimum of 19°C in the post-monsoon period and a maximum of 32°C in the pre-monsoon period. Temperature directly affects all chemical properties of water. The pH values were ranged from a minimum of 7.18 in the pre-monsoon to a maximum of 7.62 in the post-monsoon. The increase in sewage influx has implications for pH levels. The Electrical Conductivity (EC) was averaged 754.4 µS/cm in the post-monsoon and peaked at 1341.2 µS/cm, indicating higher concentrations of salts and ions. The Chemical Oxygen Demand (COD) was Recorded a minimum of 64.2 mg/L in the post-monsoon and a maximum of 74.5 mg/L in the pre-monsoon, suggesting a presence of oxidizable organic matter. The Biochemical Oxygen Demand (BOD) has Fluctuated between 17.25 mg/L in the post-monsoon and 24.8 mg/L in the pre-monsoon, with higher values reflecting significant organic pollution. Chlorides were a minimum of 141.13 mg/L in the post-monsoon and a maximum of 249.3 mg/L in the pre-monsoon. Sulfates were minimum levels were observed at 37 mg/L during the monsoon and maximum levels at 42.69 mg/L in the post-monsoon. Nitrates concentration recorded was 0.82 mg/L in the monsoon and a maximum of 1.30 mg/L in the pre-monsoon. Phosphates concentrations ranged from 0.50 mg/L in the post-monsoon to 0.78 mg/L in the pre-monsoon, indicating pollution levels above warning thresholds. Total Solids (TS) Minimum of 799.38 mg/L recorded during pre-monsoon and maximum of 859.75 mg/L during monsoon. The Total Dissolved Solids (TDS) were minimum of 788.56 mg/L in pre-monsoon and maximum of 850.06 mg/L during the pre-monsoon. Dissolved Oxygen (DO) varied between a minimum of 4.23 mg/L in pre-monsoon and a maximum of 5.44 mg/L in post-monsoon, revealing an inverse relationship with temperature. Total Hardness was the Lowest recorded at 270.44 mg/L in post-monsoon and highest at 370.25 mg/L in pre-monsoon, while calcium and magnesium ions showed similar trends.

Table-I-SEASONAL WISE VARIATIONS IN PHYSICO - CHEMICAL PARAMETERS OF BHANDAM CHERUVU (2023-2024)

SL.no	PARAMETERS	MONSOON	POST MONSOON	PRE MONSOON	MINIMUM	MAXIMUM
1	pH	7.41	7.18	7.62	7.18	7.62
2	EC	1110.19	754.44	1341.25	754.44	1341.25
3	COD	71.00	64.25	74.56	64.25	74.56
4	BOD	17.25	17.25	24.81	17.25	24.81
5	Chlorides	171.63	141.13	249.31	141.13	249.31
6	Sulphates	37.00	42.69	42.94	37.00	42.94
7	Nitrates	0.82	1.23	1.30	0.82	1.30
8	phosphates	0.53	0.69	0.50	0.50	0.69
8	Total solids	859.75	581.44	799.38	581.44	859.75
9	TSS	9.69	9.88	10.38	9.69	10.38
10	TDS	850.06	571.56	788.56	571.56	850.06
11	DO	4.23	5.44	4.59	4.23	5.44
12	Total hardness	281.38	270.44	370.25	270.44	370.25
13	Ca++	62.56	68.56	80.88	62.56	80.88
14	Mg++	23.00	26.69	27.31	23.00	27.31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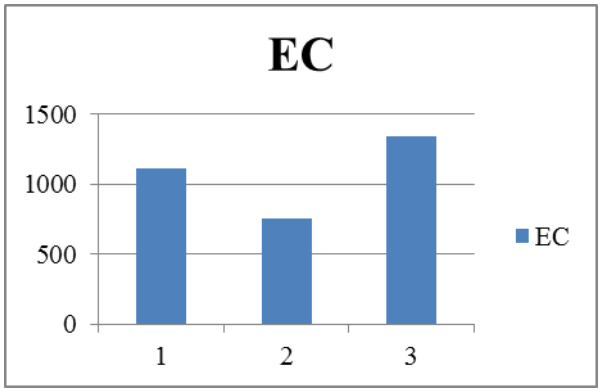
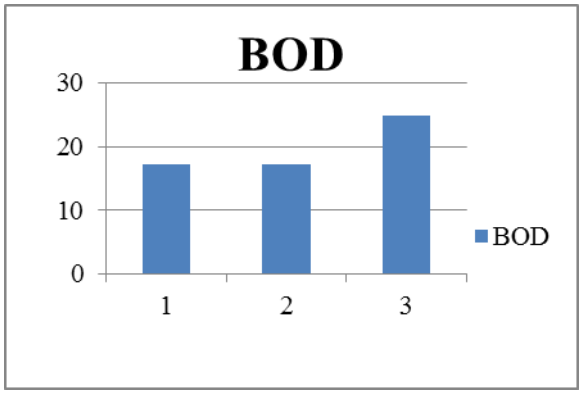
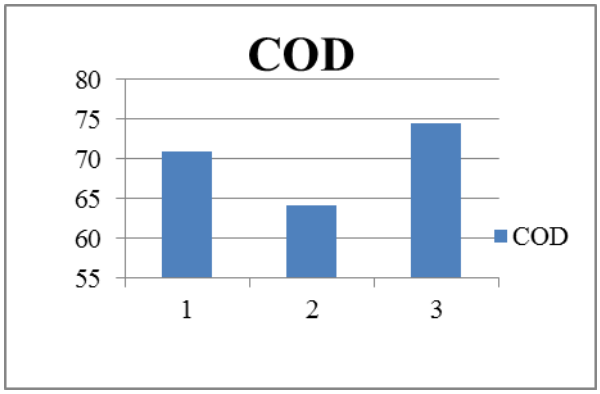
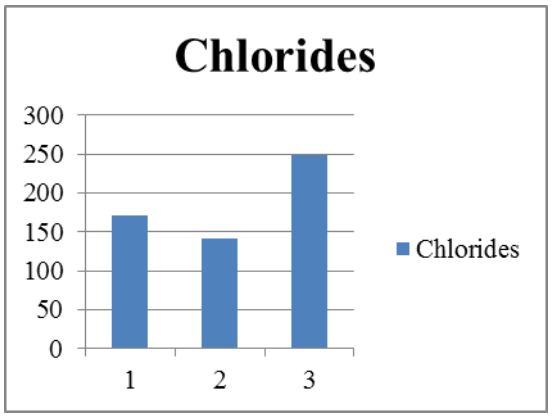
7.8
7.6
7.4
7.2
7
6.8
1
2
3
pH


EC
1500
1000
500
0
1
2
3
EC


BOD
30
20
10
0
1
2
3
BOD


COD
80
75
70
65
60
55
1
2
3
COD


Chlorides
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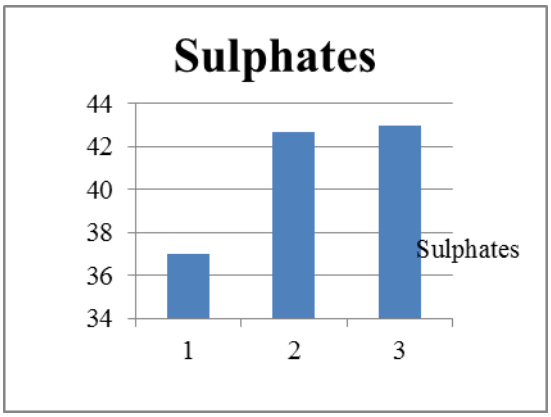
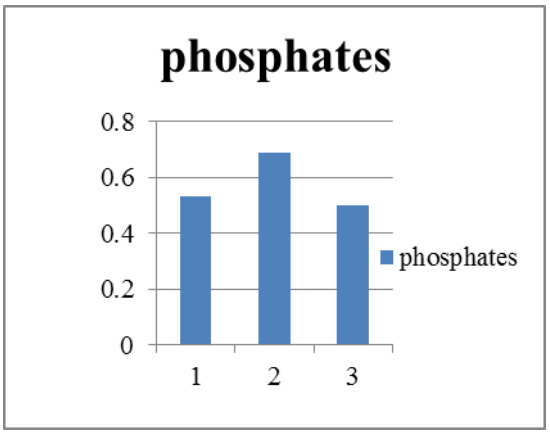
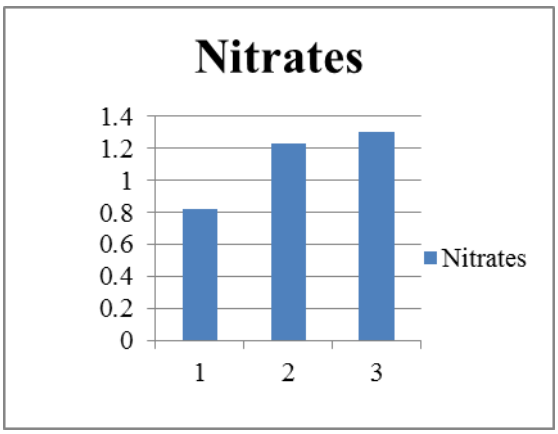
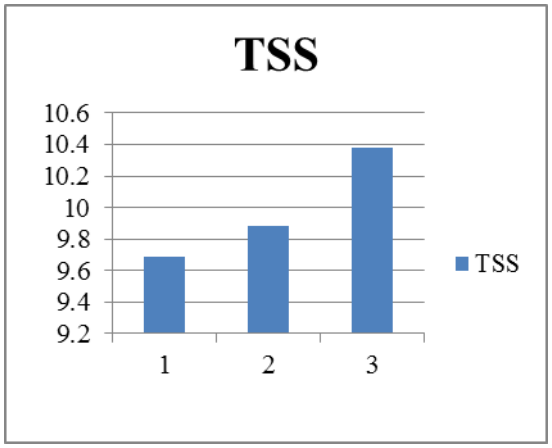
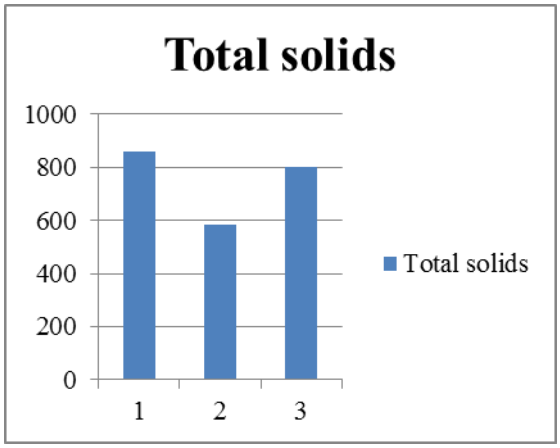
250
200
150
100
50
0
1
2
3
Chlorides

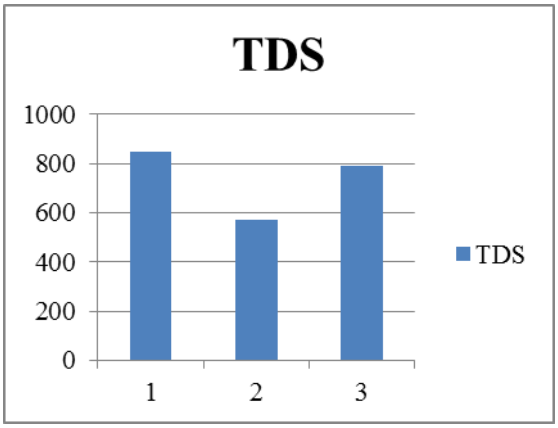

Sulphates
44
42
40
38
36
34
1
2
3
Sulphates

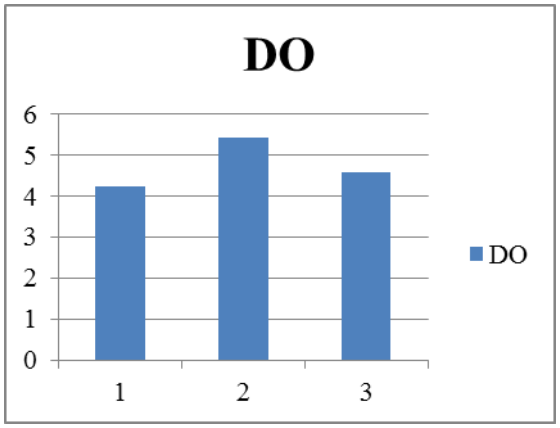

phosphates
0.8
0.6
0.4
0.2
0
1
2
3
phosphates

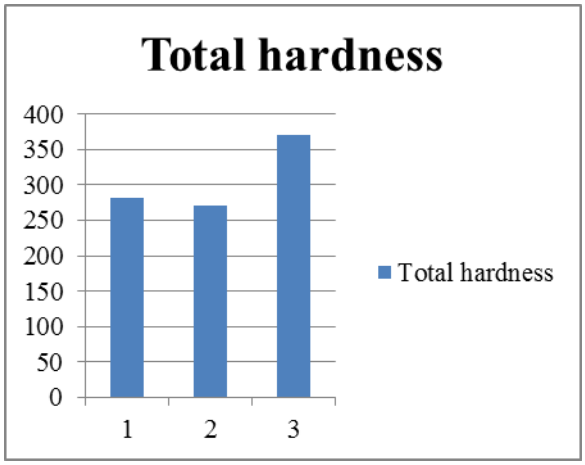

Nitrates
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1
2
3
Nitrates

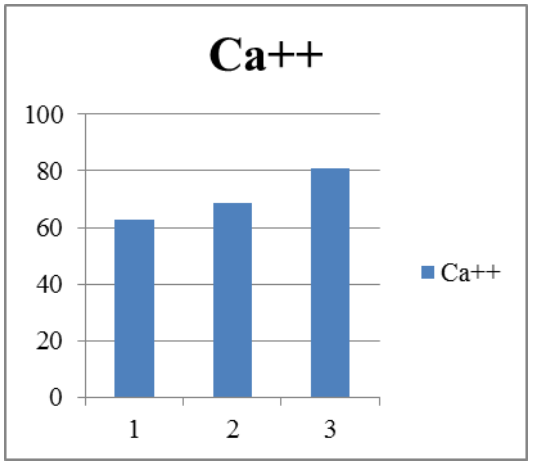

TSS
10.6
10.4
10.2
10
9.8
9.6
9.4
9.2
1
2
3
TSS

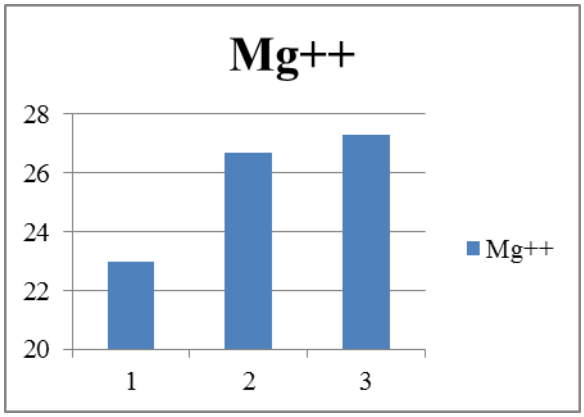

Total solids
1000
800
600
400
200
0
1
2
3
Total solids


TDS
1000
800
600
400
200
0
1
2
3
TDS


DO
6
5
4
3
2
1
0
1
2
3
DO


Total hardness
400
350
300
250
200
150
100
50
0
1
2
3
Total hardness


Ca++
100
80
60
40
20
0
1
2
3
Ca++


Mg++
28
26
24
22
20
1
2
3
Mg++

DISCUSSION

Bhandam Cheruvu, an urban lake in the Warangal district of Telangana, has been subjected to significant ecological changes due to urbanization and improper waste management practices. This study examines the physico-chemical parameters of the lake water over a year-long period, from June 2023 to May 2024, to assess the extent of pollution and its impacts on the lake's ecosystem. This study aims to raise public awareness regarding this man-made environmental crisis and to underscore the urgent need for conservation efforts to restore and protect Bhandam Cheruvu before it reaches a point of irreversible degradation. During the study, the following parameters were measured. The values of each parameters recorded during the study period are represented in the table-I. The water temperature fluctuated between 19^0 c minimum in post- monsoon and the maximum was recorded in pre-monsoon with 32^0 c. The temperature is the basis for all parameters. The pH values ranges from minimum with 7.18 in pre monsoon to the maximum value recorded in post- monsoon with 7.62 is influenced with the increase in sewage from various ways in to the lake. The EC fluctuated yearly average between 754.4 mhos/cm2 which is minimum in the post- monsoon and the maximum EC value with 1341.2mhos/cm2. The high EC values indicate the presence of salts and ions in higher concentration.(Nidhi Bajpai et al.2012). The COD values recorded were minimum in the post- monsoon period with 64.2 mg/lit and the maximum values were recorded in pre-monsoon with 74.5mg/lit. The higher values of COD indicate pollution due to oxidisable organic matter. The BOD is a measure of the degradable organic matter present in water sample. The BOD values fluctuated between minimum with 17.25mg/lit in the post- monsoon and the maximum values recorded in the pre monsoon with 24.8mg/lit. The higher values of BOD are due to high concentrated, dissolved and suspended organic matter in water (Jameel 1998). Similar results were coincided with Avinash and Prabhaker (2009). The chlorides values are recorded minimum with 141.13mg /lit in post- monsoon and the maximum values were recorded in the pre-monsoon with 249.3mg/lit. These observations were supported by the of Sumitra etal.(2007) in lake Pichhola. The sulphates are recorded minimum in monsoon with 37mg/lit and maximum in post- monsoon with 42.69mg/lit. The nitrates are recorded minimum in the monsoon with 0.82mg/lit and maximum with 1.30mg/lit in the pre-monsoon. As a result of the dilution with rain water nitrates are low during monsoon. Generally higher values of nitrates exhibit by polluted organic matter.(Shanti et al. 2002) The phosphates are minimum in post- monsoon with 0.50mg/lit and maximum in pre-monsoon with 0.78mg/lit. The phosphate concentration above 0.5mg/lit indicates pollution (Jain et al., 1996) the total solids are minimum during pre-monsoon with 799.38mg/lit and maximum with 859.75mg/lit in monsoon season. The TDS are recorded minimum in pre-monsoon with 788.56mg/lit and maximum during the pre-monsoon with 850.06mg/lit. Higher values of TDS and TS are due to carbonates, bicarbonates, phosphates, sulphates, salts and ions (Nidhi and Bajpai et al. 2012). The dissolved oxygen was recorded minimum during the pre-monsoon with 4.23md/lit and maximum in post-monsoon with 5.44mg/lit it showed an inverse relationship with temperature which might be due to oxidation of oxygen as reported by Patil and Dongare(2006). The total hardness was minimum in post- monsoon with 270.44mg/lit and maxium during the pre-monsoon with 370.25mg/lit The Ca++ ions are minimum in monsoon with 62.56mg/lit and maximum in pre-monsoon with 80.88mg/lit. The Mg++ ions are minimum in monsoon with 23mg/lit and maximum during pre-monsoon with 27.31mg/lit.

CONCLUSION

The study's findings underscore the alarming state of Bhandam Cheruvu, highlighting its rapid transition towards eutrophication, which is predominantly driven by anthropogenic factors. The lake, situated in close proximity to urban developments including commercial establishments, residential areas, and public amenities has suffered significant ecological deterioration over the past years.

1. Accelerated Eutrophication

Eutrophication, characterized by excessive nutrient enrichment, has led to a marked decline in water quality. The elevated levels of phosphates and nitrates, as identified in the study, are clear indicators of nutrient runoff stemming from urban wastewater. Additionally, the high values of Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD) point to an increase in organic pollution, which further fuels the degradation of water quality. Such conditions can result in harmful algal blooms, which disrupt aquatic life and decrease oxygen availability for fish and other organisms, causing further ecological imbalance.

2. Impact of Urbanization

The encroachment on the lake's natural area has reduced its water retention capacity by nearly half, which poses significant challenges for flood management and groundwater recharge in the surrounding areas. With the lake unable to effectively manage and store rainwater, the risk of flooding during heavy rain events increases, creating further hazards for nearby populations. The surrounding urban infrastructure exacerbates these issues by directing stormwater and sewage directly into the lake, compounding the effects of pollution.

3. Decline in Biodiversity

As water quality deteriorates, the biodiversity within Bhandam Cheruvu is increasingly at risk. Many aquatic species, particularly sensitive organisms such as certain fish and invertebrates, cannot survive in polluted waters. The loss of biodiversity can lead to a collapse of local ecosystems, reducing resilience against environmental changes and impairing the lake's ability to function as a natural resource for the community.

4. Urgent Call for Action

Given these findings, it is imperative to recognize that the current state of Bhandam Cheruvu represents a man-made environmental disaster. The responsibility lies not only with local authorities but also with the community, industry stakeholders, and environmental organizations to enact meaningful changes.

Effective management strategies could include

a. Wastewater Treatment Improvements: Immediate action to improve treatment processes for urban wastewater before it enters the lake is crucial. This could involve constructing new wastewater treatment plants or upgrading existing facilities to meet stricter pollution control standards.

b. Public Awareness Campaigns: Educating the community about the impacts of improper waste disposal and the importance of protecting local water bodies may foster greater public engagement in conservation efforts.

c. Erosion Control and Natural Buffers: Restoration of natural buffers around the lake and implementation of erosion control measures can help reduce runoff from surrounding areas. Preserving and restoring wetland areas can also improve the lake's ability to filter incoming pollutants.

d. Monitoring and Research: Continued monitoring of water quality and biodiversity will be essential for understanding ongoing changes in the lake's ecosystem. Research initiatives can identify effective restoration techniques and inform policy-making.

5. Restoration and Sustainability Efforts

To mitigate the ongoing degradation of Bhandam Cheruvu, it is crucial to implement integrated lake management strategies. Restoration projects not only help in rehabilitating the current state of the lake but also present opportunities for sustainable development, enhancing the quality of life for local residents. Conservation of Bhandam Cheruvu can serve as a model for other urban lakes facing similar challenges, showcasing the importance of proactive environmental stewardship.

In conclusion, Bhandam Cheruvu's situation is a vivid reminder of the interconnectedness between urban development and environmental health. By taking decisive action now, there is potential for restoration, improvement of water quality, and revitalization of the local ecosystem, which can ultimately contribute to the well-being of the surrounding communities. Safeguarding this vital resource is not just an environmental priority, but also a social and economic imperative that will impact future generations.

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