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A Case Study on Kommativani Cheruvu, Madanapalle, Annamaya District

[1]Sudha Kuruba, [2]C. Anil Kumar Reddy, [3]M. Anilkumar Naik

[1]Environmental Engineer, Andhra Pradesh Pollution Control Board, Kadapa, India
[2]Asst. Environmental Engineer, Andhra Pradesh Pollution Control Board, Kadapa, India
[3]Junior Research Fellow, Andhra Pradesh Pollution Control Board, Kadapa, India
E-mail: [1]sudhakuruba11@gmail.com, [2]anilenviron1@gmail.com, [3]anilkumarnaik177@gmail.com

***Abstract* - Kommativani Cheruvu, located in Madanapalle, is an important traditional water body that supports irrigation, groundwater recharge, and ecological balance. In recent years, the cheruvu has been subjected to environmental stress due to rapid urbanization, agricultural runoff, and discharge of untreated domestic wastewater. This study aims to assess both the water and soil quality of Kommativani Cheruvu through comprehensive physicochemical and environmental analysis. Water samples were collected from multiple locations and analysed for parameters such as pH, Turbidity, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), and Chemical Oxygen Demand (COD). Simultaneously, soil samples from the cheruvu bed and surrounding areas were examined for properties including pH, moisture content, organic matter, and possible contamination by heavy metals. All analyses were carried out following standard procedures recommended by CSIR-NEERI. The results indicate deterioration in water quality, with elevated BOD and COD levels and reduced dissolved oxygen, suggesting significant organic pollution and the onset of eutrophication. Soil analysis revealed variations in pH and increased organic content, indicating accumulation of pollutants and nutrient enrichment in the sediment. The major sources of contamination include domestic sewage inflow, agricultural inputs such as fertilizers and pesticides, and improper disposal of solid waste. The study highlights the urgent need for integrated restoration strategies, including desilting of contaminated sediments, diversion and treatment of wastewater, and implementation of phytoremediation techniques for both soil and water. Regular monitoring and active community participation are essential for sustainable management. The findings provide valuable insights for environmental authorities and policymakers in designing effective conservation and pollution control measures for Kommativani Cheruvu and similar water bodies.**

Keywords: Kommativani Cheruvu, Water Sample Analysis, Soil Sample Analysis, History, Techniques for Restoration Lake.

I. INTRODUCTION

Madanapalle is a historically and culturally significant town in the Rayalaseema region of Andhra Pradesh, known for its moderate climate, agricultural base, and educational institutions. The town has traditionally depended on a network of tanks (cheruvu) for irrigation and water management, which played a crucial role in sustaining local livelihoods in this semi-arid region. These traditional water bodies were designed to harvest rainwater, recharge groundwater, and support agriculture, forming an integral part of the region's ecological and socio-economic framework.

Among these, Kommativani Cheruvu is an important water body in Madanapalle that has historically supported irrigation and contributed to maintaining the local hydrological balance. Over time, however, increasing population, urban expansion, and changes in land use patterns have placed significant stress on this cheruvu. The inflow of untreated domestic wastewater, agricultural runoff containing fertilizers and pesticides, and improper solid waste disposal have led to the gradual deterioration of both water and sediment quality.

The degradation of such traditional water bodies not only affects water availability but also disrupts ecological balance and groundwater recharge processes. In particular, the accumulation of pollutants in the sediment (soil) of the cheruvu can act as a long-term source of contamination, further impacting water quality. Therefore, it is essential to evaluate both water and soil characteristics to understand the overall environmental condition of the Cheruvu.

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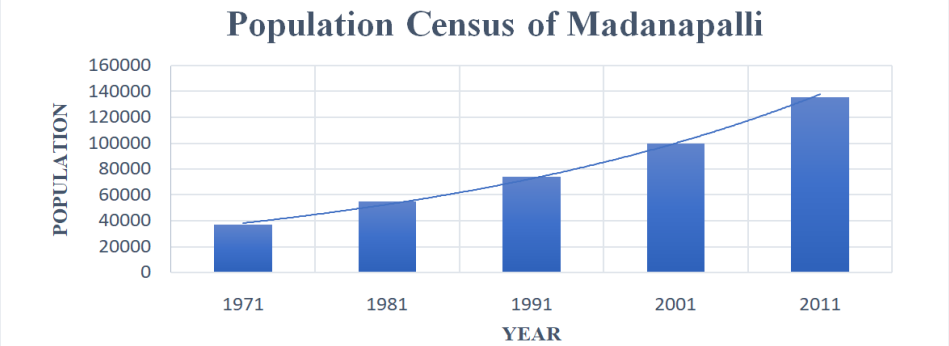

Figure 1: Increasing population of Madanapalli

Table 1: Basic Details of madanapalli

S. No	Description	Values
1	Area	14.20 sq. km
2	Population (2011 Census)	1,35,669
3	Literacy Rate	80.5%
4	No. of Revenue Wards	17
5	Total No. of Households	31,136
6	No. of Election Wards	35
7	No. of Slums	42
8	Slum Population	36,575
9	Water Supply (Boreholes)	3.8 MLD
10	No. of House Service Connections	14,786
11	No. of Public Taps	786

II. HISTORY OF KOMMATIVANI CHERUVU

Kommativani Cheruvu, located in Madanapalle, is part of the traditional tank irrigation system that has historically supported water management in the Rayalaseema region. These tanks were constructed to store monsoon runoff, support agriculture, and recharge groundwater in drought-prone areas.

The name “Kommativani” has cultural and historical significance. It is derived from two terms: “Kommati,” referring to a traditional community (often associated with local trading or occupational groups), and “Vani,” meaning people. Thus, Kommativani can be interpreted as “the water body associated with the Kommati community people.” This indicates that the cheruvu was likely constructed, used, or maintained by this community, reflecting the strong role of local participation in traditional water management systems.

Figure 2: Historical transformation of lake

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2.1 Early Period

During the pre-colonial period, Kommativani Cheruvu was maintained through community-based practices. Local people actively participated in desilting, bund strengthening, and maintenance of feeder channels. The cheruvu functioned efficiently as a sustainable water resource, supporting irrigation, livestock, and groundwater recharge.

2.2 British Period

Under British administration, irrigation systems came under centralized control. While major irrigation works received attention, smaller tanks like Kommativani Cheruvu experienced reduced maintenance. The decline of community involvement led to gradual siltation, reduced storage capacity, and weakening of feeder channels, although the tank continued to serve local needs to some extent.

2.3 Post-Independence / Modern Development

After independence, rapid urbanization and population growth in Madanapalle altered land use patterns around the cheruvu. Encroachment of tank beds and feeder channels, along with increased dependence on borewells, led to neglect of traditional tank systems. Natural inflows were reduced, and maintenance practices declined significantly.

2.4 Present Scenario

In recent years, Kommativani Cheruvu has been affected by anthropogenic activities such as discharge of untreated domestic sewage, agricultural runoff, and solid waste dumping. These factors have resulted in deterioration of both water and soil quality, silt accumulation, and reduced ecological health. However, increasing awareness and involvement of Andhra Pradesh Pollution Control Board (APPCB) in highlighting the need for restoration through scientific management, pollution control, and community participation.

III. STUDY AREA OF KOMMATIVANI CHERUVU

The catchment area is the region that collects rainfall and directs it into the lake. The catchment has been increasing due to rapid urbanization, decreasing the amount of clean rainwater entering the lake.The inlet channel carries both storm water and untreated domestic sewage into the lake. This mixed inflow is the primary source of pollution, increasing organic matter, nutrients, and contaminants in the lake water. Lake Basin is the central portion of stores water. The presence of weeds and lotus growth indicates nutrient enrichment (eutrophication), caused mainly by continuous sewage discharge. Urban Settlement Residential colonies surrounding the lake act as the major pollution source. Domestic wastewater, solid waste, and runoff from these settlements contribute significantly to water quality deterioration. Encroachment and Reduced Buffer Zone as encroachments around the lake boundary, resulting in a reduced buffer zone. This limits natural filtration of pollutants, reduces biodiversity, and increases the risk of direct contamination. Bund (Embankment) bund has been developed as a road, which protects the lake boundary and allows access. However, proper maintenance is essential to prevent erosion and ensure the structural stability of the lake.

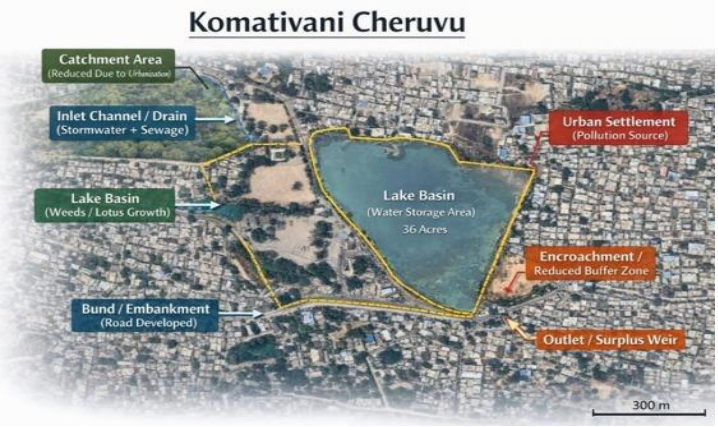

Figure 3: Layout of kommativani cheruvu

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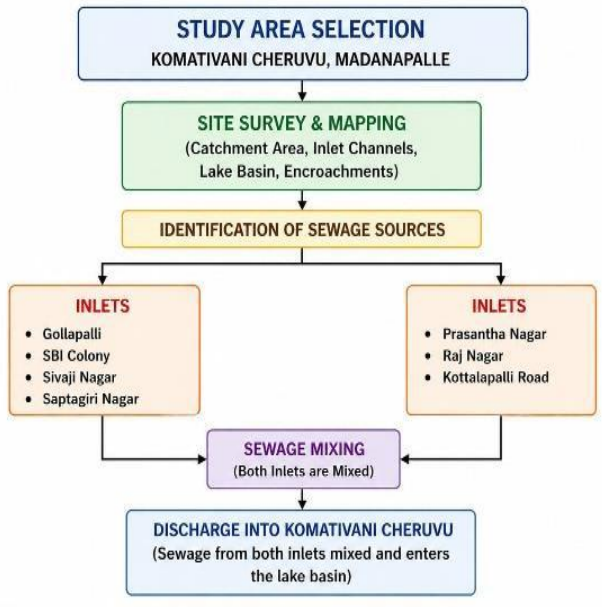

Figure 4: Flow chart of Sewage Drain

IV. ANALYSIS OF COLLECTED SAMPLES

4.1 Test Results of Soil

Soil samples were collected from selected locations around Kommativani Cheruvu following standard sampling procedures. The collected samples were transported to the Department of Civil Engineering Laboratories, Sri Venkateswara University (SV University) for detailed geotechnical. The test results were used to assess the characteristics and contamination level of the soil.

Table 2: Basic soil properties

S. No	Experiment	Result
1	Water Content	2.42%
2	Specific Gravity (G)	2.6
3	Sieve Analysis	56% of sand
4	Liquid Limit (%)	40.72%
5	Plastic Limit (%)	14.07%
6	Plasticity Index	26.65
7	Toughness Index	0.326
8	Flow Index	81.66%
9	Free Swell Index (%)	35%
10	Permeability	1.66×10^{-4} cm/sec
11	Maximum Dry Density (MDD)	2.05 g/cc
12	Optimum Moisture Content (OMC)	11.9%
13	Unconfined Compressive Strength	162 kPa
14	Soil Classification	Poorly Graded Sand

4.2 Test Results of Water Sample

Water samples were collected from two locations of Kommativani Cheruvu following standard APPCB sampling procedures. The samples were collected in clean, sterilized containers, properly labelled, and transported to the M/s. SMS Laboratory, Chennai under preserved conditions. The collected samples were analysed for physicochemical, microbiological, and heavy metal parameters to assess the lake's water quality.

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Table 3: Water sample properties

S. No	Parameter	Results of sample 1	Results of sample 2
1	Escherichia Coli (E-Coli)	<1.8 MPN/100 ml	<1.8 MPN/100ml
2	Faecal Coliforms	<1.8 MPN/100 ml	<1.8MPN/100ml
3	Total Coliforms	920 MPN/100 ml	920MPN/100ml
4	Ammonical Nitrogen as NH_3-N	BLQ(LOQ:1.0) mg/L	BLQ(LOQ:1.0) mg/L
5	BOD at 27°C for 3 days	82 mg/L	86 mg/L
6	Chloride as Cl	421 mg/L	391 mg/L
7	COD	353 mg/L	373 mg/L
8	Dissolved Oxygen as O_2	4.9 mg/L	5.1 mg/L
9	Fluoride as F	0.49 mg/L	0.45 mg/L
10	Oil & Grease	BLQ (LOQ:4.0) mg/L	BLQ (LOQ:4.0) mg/L
11	Phosphate as PO4	6.5 mg/L	7.9 mg/L
12	Sulphate as SO4	135 mg/L	119 mg/L
13	Total Nitrogen as N	10 mg/L	12 mg/L
14	pH at 25°C	7.75	7.85
15	Total Dissolved Solids (TDS) (Inorganic) @ 550°C	1237 mg/L	1248 mg/L
16	Total Suspended Solids (TSS)	18 mg/L	12 mg/L
17	Turbidity	70.3 NTU	68.8 mg/L
18	Lead	0.085 mg/L	0.11 /L

V. METHODOLOGIES / TECHNICS TO RESTORE KOMMATIVANI CHERUVU

5.1 Diversion of Sewage Waste Water

The restoration of Kommativani Cheruvu in Madanapalle requires a systematic approach based on its existing site conditions. As observed, the catchment area has been increase due to urbanization, and the inlet channel carries both stormwater and sewage, leading to deterioration of water quality. Therefore, the first step involves diversion of sewage from the inlet drain and provision of decentralized treatment systems such as constructed wetlands or settling tanks before water enters the lake. The lake basin, which shows weed and lotus growth, requires desilting and removal of excessive vegetation to restore storage capacity and improve water quality.

Encroachments around the buffer zone must be controlled, and a proper buffer strip with vegetation should be developed to prevent direct pollution inflow. The bund, which is currently developed as a road, should be strengthened to avoid erosion and ensure structural stability. The outlet or surplus weir must be maintained properly to regulate excess water during rainfall events. Additionally, rainwater harvesting structures and check dams in the upstream catchment can enhance inflow and groundwater recharge. Continuous monitoring using modern tools and periodic maintenance under the guidance of Andhra Pradesh Pollution Control Board (APPCB) will ensure long-term sustainability.

5.2 Fencing of Kommativani Cheruvu

Fencing is an important protective and preventive measure recommended for the conservation of urban water bodies. 50% waste can be prevented by fencing of Kommativani Cheruvu. Fencing helps in safeguarding lakes from encroachment, unauthorized activities, and direct pollution.

In the case of Kommativani Cheruvu located in Madanapalle, fencing around the lake boundary and buffer zone is essential to prevent solid waste dumping, sewage intrusion, and human interference. Proper fencing ensures that the lake area is clearly demarcated and protected from further degradation. The fencing system can be constructed using chain-link mesh, barbed wire, or concrete posts, depending on site conditions. It should be installed along the periphery of the lake and near inlet zones, especially where there is a high risk of pollution entry. In addition, providing controlled entry points with gates will help in monitoring and maintenance activities. Fencing also supports the development of a green buffer zone, where plantation of grass and trees can be carried out to reduce surface runoff and improve the surrounding environment. This measure plays a key role in long-term lake protection and sustainable management.

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5.3 Solar Aeration for Lake Cleaning

Solar aeration is an eco-friendly technology used to improve water quality in lakes by increasing the dissolved oxygen (DO) levels using solar energy. In water bodies like Kommativani Cheruvu in Madanapalle, where sewage inflow reduces oxygen levels, solar aeration plays a crucial role in restoring ecological balance. The system consists of solar panels, a compressor or pump, and diffusers placed in the lake. Solar panels generate electricity, which powers the aeration system to pump air into the water through diffusers.

Figure 5: Solar Aerator for cleaning of lake

These diffusers release fine air bubbles that increase oxygen transfer into the water. As a result, dissolved oxygen levels rise, helping aquatic organisms survive and promoting the breakdown of organic pollutants. Solar aeration is particularly effective in reducing Biochemical Oxygen Demand (BOD) and controlling foul odors caused by anaerobic conditions. It also helps in minimizing algal blooms and improving overall water clarity. Since the system operates on renewable solar energy, it is cost-effective, requires low maintenance, and is suitable for semi-urban areas. For effective implementation, aerators should be installed near inlet zones where sewage enters the lake, as well as in deeper sections to ensure uniform oxygen distribution. This technology can be combined with other methods such as phytoremediation and sewage diversion for better results.

5.4 Floating wetlands

Sustainable remediation technology recommended for improving water quality in polluted water bodies. As per the strategies follow by Andhra Pradesh Pollution Control Board (APPCB), floating wetlands are used as an in-situ treatment method for lakes receiving domestic sewage and urban runoff. In this system, artificial floating platforms are installed on the water surface, supporting the growth of selected aquatic plants such as Elephant grass, Common Reed, Bulrush Alligator weed, Paspalum Vaginatum, Heliconia plant. The plant roots extend into the water column and act as a bio-filtration medium, absorbing excess nutrients like nitrogen and phosphorus, which are the primary causes of eutrophication. The root zone provides a surface for microbial growth, forming a biofilm that facilitates the degradation of organic pollutants, thereby reducing Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) levels. This process enhances the overall water quality and supports aquatic life.

Floating wetlands are particularly recommended at inlet points of lakes, where untreated sewage enters, as they help in reducing pollutant load before dispersion into the main water body. The system is cost-effective, low-maintenance, and eco-friendly, making it suitable for urban lakes such as Kommativani Cheruvu in Madanapalle.

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Figure 6: Elephant Grass

Figure 7: Common Reed

Figure 8: Alligator Weed

Figure 9: Bulrush

Figure 10: Bulrush

Figure 11: Bulrush

Figure 12: Shows before and after treatment

5.5 Bioremediation

Bioremediation is a biological treatment method that uses naturally occurring microorganisms to degrade and stabilize pollutants present in contaminated water bodies. As practiced and recommended by Andhra Pradesh Pollution Control Board (APPCB), bioremediation is an effective in-situ technique for improving the water quality of sewage-impacted lakes. In this process, selected strains of beneficial bacteria and enzymes are introduced into the water body. These microorganisms consume organic pollutants as their food source and break them down into simpler, non-toxic compounds such as carbon dioxide, water, and biomass. This leads to a significant reduction in Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD), thereby improving dissolved oxygen levels and overall water quality. Bioremediation also helps in reducing foul odors caused by anaerobic decomposition and controls excessive growth of algae by limiting nutrient availability.

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Figure 13: Bioremediation

5.6 Blue Pond Dye (Commonly marketed as DyeMax)

Water shading technology used for improving the aesthetic quality and controlling biological growth in lakes. It is applied in water bodies to reduce excessive sunlight penetration, thereby limiting the growth of algae and aquatic weeds. In polluted lakes such as Kommativani Cheruvu in Madanapalle, nutrient-rich conditions often lead to algal blooms and weed infestation. The application of blue dye forms a thin color layer in the water that blocks specific wavelengths of sunlight, reducing photosynthesis in algae and submerged plants. This helps in Controlling algal blooms, reducing weed growth, improving water appearance (blue color) and minimizing odor problems.

Figure 14: Blue Pond Dye

5.7 Jal Kumbhi (Water Hyacinth) in Lake Management

Jal Kumbhi, scientifically known as Eichhornia Crassipes, is a free-floating aquatic plant commonly found in polluted water bodies. It grows rapidly in nutrient-rich environments and is often seen in lakes receiving sewage inflow. The presence of Jal Kumbhi indicates high nutrient levels (Nitrogen and Phosphorus) and poor water quality. The plant forms dense mats on the water surface, which block sunlight penetration and reduce dissolved oxygen levels. This can lead to deterioration of aquatic life and increase anaerobic conditions, causing foul odors. However, Jal Kumbhi also has some beneficial aspects when properly managed. It has the ability to absorb heavy metals and nutrients, making it useful in phytoremediation. Controlled use of this plant can help in reducing pollution load, but uncontrolled growth can become harmful. As per the suggestions of Andhra Pradesh Pollution Control Board (APPCB), Jal Kumbhi should be regularly removed and managed to prevent excessive growth. Mechanical removal or manual harvesting is recommended to maintain ecological balance. In conclusion, coordinated efforts between municipal authorities, pollution control agencies, and local residents are essential to restore Kommativani Cheruvu. With proper implementation and continuous maintenance, the lake can be revived as a valuable environmental and water resource for Madanapalle.

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5.8 Nanotechnology-Based Restoration

Nanotechnology is an emerging and highly efficient technology used for the restoration of polluted lakes and water bodies. It involves the application of engineered nanomaterials, typically ranging from 1 to 100 nanometers in size, which possess a very high surface area and enhanced reactivity. These unique properties enable nanomaterials to effectively remove a wide range of contaminants, including organic pollutants, nutrients, dissolved salts, heavy metals, and pathogenic microorganisms. In lake restoration, titanium dioxide (TiO_2) nanoparticles are widely used for photocatalytic degradation of organic pollutants under sunlight, thereby improving water quality.

Nano zero-valent iron (nZVI) and iron oxide nanoparticles are effective in removing heavy metals through adsorption, reduction, and immobilization processes. Nanofiltration membranes are employed to remove dissolved impurities, suspended particles, and other contaminants, resulting in improved water clarity. Silver nanoparticles exhibit excellent antimicrobial properties and help control harmful microorganisms present in contaminated water. Nanotechnology offers several advantages, including high treatment efficiency, rapid pollutant removal, minimal chemical consumption, reduced sludge generation, and the ability to treat multiple contaminants simultaneously. When integrated with conventional restoration techniques such as sewage diversion, aeration, constructed wetlands, and phytoremediation, nanotechnology provides a sustainable and effective approach for restoring polluted water bodies. Therefore, it can play a significant role in improving the water quality, ecological balance, and long-term environmental sustainability of Kommativani Cheruvu.

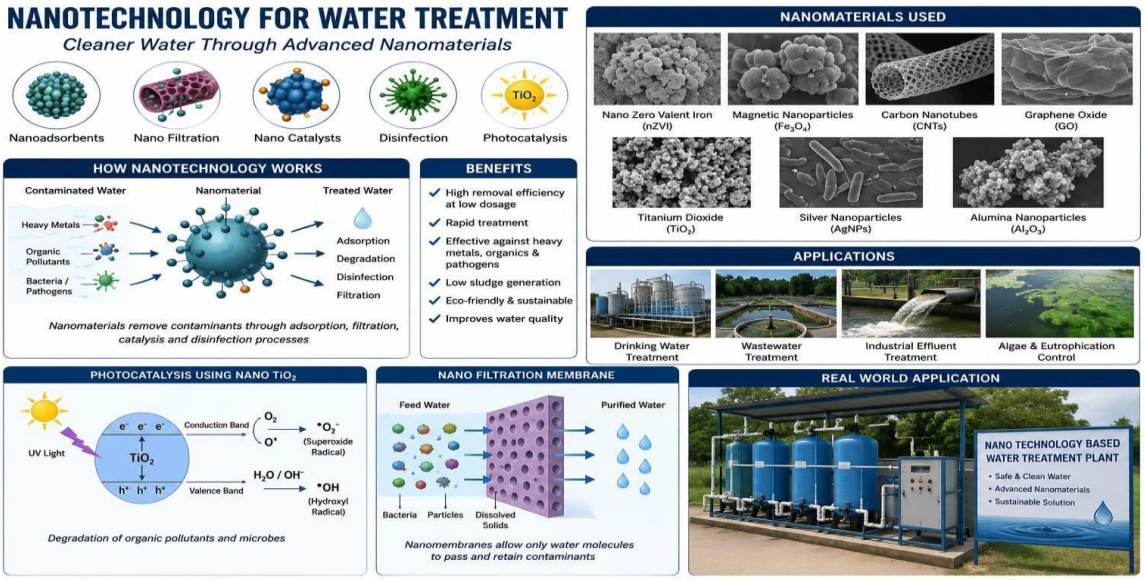

Figure 15: Water treatment using Nano technology

VI. CONCLUSION

The present study evaluated the environmental condition of Kommativani Cheruvu, Madanapalle, through comprehensive analysis of both water and soil quality. The findings indicate that the lake has been adversely affected by untreated domestic sewage, agricultural runoff, and improper solid waste disposal, leading to deterioration of its ecological health. Water quality assessment revealed significant organic pollution, nutrient enrichment, and reduced dissolved oxygen conditions, while soil investigations indicated the accumulation of pollutants within the lake sediments. These observations confirm that the cheruvu is under increasing environmental stress and requires immediate restoration measures.

Based on the field observations and analytical results, an integrated restoration strategy is recommended. Key measures include diversion and treatment of sewage before discharge into the lake, desilting of contaminated sediments, installation of floating wetlands, bioremediation, solar aeration, strengthening of lake protection through fencing, and the application of nanotechnology for enhanced removal of pollutants. These techniques, when implemented together, can effectively improve water quality, restore ecological balance, enhance groundwater recharge, and ensure the long-term sustainability of the lake.

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Overall, the study provides a scientific basis for the restoration and sustainable management of Kommativani Cheruvu. Successful implementation of the proposed measures, supported by regular monitoring, community participation, and coordinated efforts from local authorities and APPCB, can transform the lake into a healthy and valuable water resource for future generations while serving as a model for the restoration of other polluted urban lakes.

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