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A Case Study on Blue Algae in Malampuzha Dam

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Abstract: ***Blue-green algae, or cyanobacteria, are photosynthetic bacteria that thrive in nutrient-rich water bodies. Although they contribute to oxygen production and support aquatic ecosystems, their excessive growth can lead to harmful algal blooms that release toxins, endangering humans, animals, and water quality. Exposure to these toxins may occur through drinking. swimming, or inhalation, causing health effects such as skin irritation, gastrointestinal issues, liver damage, and in rare cases, neurological symptoms. Contaminated water spray can also trigger respiratory problems, and fish and shellfish may become unsafe to consume. Additionally, algal blooms can degrade the taste, Odor, and safety of drinking water, complicating treatment processes. A case in point is Vellayaniv Lake in Thiruvananthapuram and Malampuzha dam, which is affected by eutrophication due to nutrient overload and invasive vegetation, resulting in cyanobacterial blooms and ecological decline. Despite ongoing restoration efforts, sustained monitoring, pollution control, and community participation are essential to improve the lake's health and ensure safe water quality. Effective removal methods used in water treatment plants include physical techniques like filtration and flotation, chemical treatments such as chlorination and ozonation, and advanced methods like activated carbon adsorption and membrane filtration. Long-term control also involves biological strategies and reducing nutrient pollution at the source***

Keywords: Cyanobacteria, Harmful algal blooms, Toxins, Eutrophication, Water treatment

I. INTRODUCTION

A. General

Algal blooms seriously affect water quality and ecosystem health due to nutrient enrichment, climate factors, and human activities. This project studies their occurrence, causes, and management in Malampuzha Dam and Vellayani Lake, aiming to support sustainable water management. The study is structured into five sections: Background and Objectives, Literature Review, Methodology, Results and Analysis, and Future Work. It examines bloom dynamics, environmental conditions, species identification, and suitable control measures for both sites.

B. Site Visit

Malampuzha Dam: A detailed inspection of the dam reservoir area should be carried out, including the water inlet and outlet points, as well as regions of stagnant water where algal blooms typically concentrate. These stagnant zones often provide favourable conditions for the rapid growth of algae. The surrounding catchment areas must also be surveyed to identify sources of agricultural runoff, soil erosion, and inflow streams that may carry excess nutrients such as nitrogen and phosphorus into the reservoir. In addition, observations should be collected regarding recreational activities, boating, and tourism around the dam, as these human activities can contribute to pollution and nutrient loading. It is also important to assess the depth profile of the reservoir, flow regimes, and seasonal fluctuations in water levels. Variations in water depth, temperature, and circulation patterns during different seasons can create ideal conditions for algal proliferation. Conducting these assessments will help in understanding the factors influencing algal bloom formation and in developing effective management strategies.

Fig 1 : site visit

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C. Scope

1) Environmental Protection: Uncontrolled algal blooms cause eutrophication, reduce dissolved oxygen, and lead to the death of aquatic life. controlling algae helps maintain ecological balance in water ecosystem.

2) Drinking Water Purification: Excess algae release harmful toxins like Microcystis and cause bad taste, Odor, and discoloration, making water unsafe for consumption.

3) Public Health and Safety: Contaminated water with harmful algae can cause diseases such as diarrhea, liver damage, and other health issues. Algae also promote the growth of harmful bacteria.

4) Agricultural Water Management: Algae-contaminated irrigation water can clog systems, affect soil quality, and reduce crop yield, increasing maintenance costs for farmers.

II. SAMPLE COLLECTION AND CONFORMATION OF ALGAE

A. Sample Collection

Water samples were collected from two different locations within Malampuzha Dam to ensure a representative analysis of the water quality. The purpose of collecting samples from multiple points was to accurately assess the extent of algal contamination and variations in physicochemical characteristics across the reservoir. The sampling was carried out carefully using clean containers to avoid external contamination. These samples were then transported to the laboratory for detailed examination. The main objective of sample collection was to evaluate the presence of blue-green algae (cyanobacteria), analyse water quality parameters, and determine whether the water is safe for drinking and aquatic life.

B. Laboratory Tests Performed

The following tests were conducted:

1) Turbidity Tests

Turbidity indicates the cloudiness of water caused by suspended particles like silt,algae,and microorganisms.
Instrument used: Nephelometer (Turbidity meter)
Unit: NTU (NEPHLOMETRIC TURBIDITY METER)

Result
Measured value :0.3 NTU
Acceptable limit: Up to 5 NTU

2) pH TEST

pH determines whether water is acidic, neutral, or alkaline (scale 0–14).
Instrument Used: Digital pH Meter

Result
Measured pH: 7.26
Acceptable Range: 6.6 – 8.5

3) Dissolved Oxygen (DO)

The amount of oxygen dissolved in water, essential for aquatic life.
Unit:mg/L

Result
Measured DO: 11.5 mg/L
Acceptable Range: 5 – 8 mg/L

4) Chloride Content

Chloride concentration affects taste and indicates possible contamination.
Method: Titration method
Unit:mg/L

Result
Measured Chloride: 283.6 mg/L
Acceptable Limit: 250 mg/L

5) Microscopic Analysis
To identify the presence of harmful algae species.
Result:

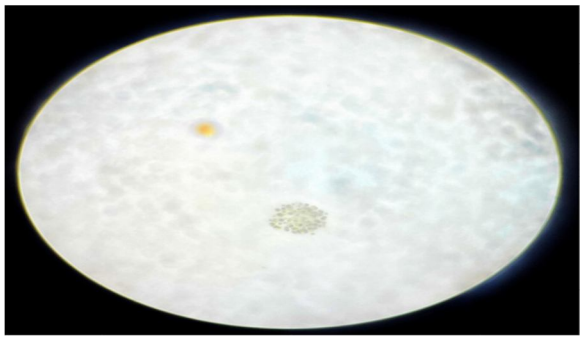

Fig 2 : microscopic view of collected sample

Microscopic examination confirmed the dominance of Microcystis.
Microcystis is a type of blue green algae (cyanobacteria) common in eutrophic water bodies produces bodies produces toxins called microcytins harmful to liver and human health and makes water unsafe for drinking

C. Objectives
The primary objective of harmful algae removal is to reduce or eliminate blue-green algae (cyanobacteria), which rapidly grow in warm, nutrient-rich, and stagnant water. These algal blooms cause water discoloration, foul Odor, and unpleasant taste, making water unsuitable for drinking and recreation. Some cyanobacteria also release toxins that are harmful to humans, animals, and aquatic life. Algal contamination affects overall water quality by altering dissolved oxygen levels, pH balance, and microbiological safety. Exposure to harmful algal blooms can lead to health issues ranging from skin irritation to serious liver, neurological, and gastrointestinal problems. Moreover, excessive algal growth depletes oxygen in water bodies, leading to fish deaths and loss of biodiversity. Therefore, effective algae removal and management are essential to improve water quality, prevent health hazards, restore ecological balance, and ensure the long-term sustainability of fresh water resources. Frequent clogging of algal blooms in the filtration units and other critical components of water treatment plants causes instantaneous operational damage. This damage occurs repeatedly at regular intervals, making maintenance difficult, time-consuming, and costly. In many cases, the affected components cannot be easily repaired and require partial replacement or shutdown of the treatment process.

III. IDENTIFICATION SOURCE OF BLUE ALGAE

A. Agricultural Runoff
Malampuzha Dam is surrounded by an extensive landscape covering an area of approximately 24 km radius, which is predominantly characterized by agricultural land use. This region includes large-scale arecanut plantations, coconut groves, banana plantations, along with paddy fields and mixed cropping systems. Agriculture in this area is heavily dependent on the dam for irrigation water, especially during dry seasons, making the reservoir a critical component of the local agrarian economy.
The intensive cultivation practices in the surrounding farmlands involve the frequent application of chemical fertilizers, organic manure, and pesticides. During periods of heavy rainfall, particularly in the monsoon season, surface runoff from these agricultural lands transports nutrients such as nitrogen and phosphorus into the reservoir. This nutrient enrichment alters the natural water chemistry of the dam.
As a result, the reservoir becomes increasingly susceptible to eutrophication, a process marked by excessive nutrient accumulation that promotes the rapid growth of algae, including blue-green algae (cyanobacteria). Such algal blooms can reduce dissolved oxygen levels, impair water quality, disrupt aquatic ecosystems, and pose risks to irrigation, drinking water supply, fisheries, and recreational use of the reservoir.

Therefore, the vast agricultural zone surrounding Malampuzha Dam plays a significant role in influencing the ecological health of the reservoir. Understanding the relationship between land use patterns, agricultural runoff, and algal growth is essential for developing sustainable watershed management practices and mitigating environmental impacts in the dam region.

1) Runoff Mechanism

- During rainfall, excess fertilizers from farmlands are washed away.
- This runoff enters nearby streams and drainage channels.
- Eventually, these nutrients flow into the dam reservoir.

2) Cause of Algal Growth (Eutrophication)

- Nutrient-rich runoff increases nitrogen and phosphorus levels in the water.
- These nutrients promote rapid growth of algae and aquatic plants.
- This process is known as eutrophication.

3) Environmental Impacts

- Reduced dissolved oxygen levels in water.
- Harm to fish and aquatic organisms.
- Degradation of water quality and clarity.
- Foul Odor, bad taste, and reduced recreational and aesthetic value of the dam.
- Increased cost and difficulty of water treatment for irrigation and drinking purposes.

4) Excess Fish Feed Input

- In fish farming, **artificial feed** is added regularly.
- A significant portion of this feed:
    - Remains **uneaten**
    - Settles at the bottom
- Feed contains **high nitrogen (N) and phosphorus (P)** — key nutrients for algae.

Fig 3 : Rubber farmland

Fig 4 : Banana plant farmland

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Fig 5 : areca palm farmland


Fig 6 : Coconut tree farmland

B. Dairy Farm

In addition to agricultural activities, dairy farming plays an important role in influencing algal growth in the reservoir, as identified through the study. Dairy farms located within the catchment area generate significant quantities of animal waste, including cow dung and urine, which are rich in nutrients such as nitrogen and phosphorus.

When dairy farm waste is improperly managed or discharged into open land and nearby drains, these nutrients are carried into the reservoir through surface runoff, especially during the monsoon season. This nutrient inflow accelerates the process of eutrophication, thereby promoting the excessive growth of blue-green algae (cyanobacteria).

Field observations and water quality analysis indicate that areas closer to dairy farming zones show relatively higher nutrient concentrations, correlating with increased algal density. This confirms that dairy farming, along with agricultural runoff, significantly contributes to nutrient loading and algal bloom formation in Malampuzha Dam.

1) Surface Runoff into Reservoir Inflows

During monsoon or heavy rainfall events, manure and urine deposited in cattle sheds, open yards, and grazing fields are transported via surface runoff into feeder streams and canals. These streams ultimately discharge into the reservoir, introducing elevated concentrations of nitrogen and phosphorus. Dairy manure contains high levels of nitrogen and phosphorus that pose significant water quality risks when transported to surface waters via runoff.

Phosphorus runoff from dairy farms has been linked to elevated nutrient levels and algal proliferation in freshwater systems. Timing of rainfall after manure application significantly affects the magnitude of phosphorus transported into water bodies. Atmospheric ammonia emissions from dairy operations can elevate nitrogen levels in adjacent waters, promoting eutrophic growth. Farm nutrient management practices can significantly reduce nutrient losses and the associated eutrophication risk

2) Nutrient Retention and Accumulation in Reservoirs

Unlike rivers, dam reservoirs have long hydraulic residence times and low flushing rates. These conditions Favor nutrient retention and sedimentation. Nutrients entering the reservoir from dairy farming activities accumulate in bottom sediments, forming an internal nutrient pool that can be remobilized during thermal stratification or water-level fluctuation

3) Algal Bloom Formation in Reservoir Environments

The availability of nitrogen and phosphorus from dairy farm runoff stimulates rapid algal proliferation, particularly during warm seasons with high solar radiation. Reservoirs with stable water columns provide favourable conditions for bloom-forming algae and cyanobacteria. Recurrent blooms are therefore common in reservoirs influenced by livestock-dominated catchments.

4) Oxygen Depletion and Water Quality Degradation

The decay of algal biomass leads to increased microbial respiration, resulting in reduced dissolved oxygen levels, especially in deeper reservoir zones. Hypoxic or anoxic conditions negatively affect fish populations and benthic organisms, while surface scums reduce the aesthetic and recreational value of the reservoir

Fig 7 : Dairy farm

Fig 8 : Dairy farm near the dam

IV. CONCLUSION

This case study concludes that the occurrence of blue-green algal (cyanobacterial) blooms in **Malampuzha Dam** is primarily the result of nutrient enrichment caused by human activities within the catchment area. Agricultural runoff, fish cultivation, and dairy farming significantly increase the inflow of nitrogen and phosphorus into the reservoir, accelerating eutrophication and creating favorable conditions for the dominance of harmful algae such as *Microcystis.*

The study also confirms that excessive algal growth adversely affects water quality by increasing turbidity, producing foul Odor and taste, releasing toxins, and disturbing the natural dissolved oxygen balance. These impacts pose serious risks to public health, aquatic life, irrigation practices, and drinking water supply. Moreover, frequent algal blooms lead to clogging and damage of water treatment plant components, resulting in repeated operational failures, higher maintenance costs, and difficulty in repair.

Although existing water treatment methods can reduce algal presence to some extent, they are not sufficient as standalone solutions. Therefore, effective long-term management of algal blooms in Malampuzha Dam requires controlling nutrient pollution at the source through improved agricultural practices, proper management of fish farming and dairy waste, continuous water quality monitoring, and public awareness. An integrated and sustainable watershed management approach is essential to restore ecological balance and ensure safe and reliable water resources for the future

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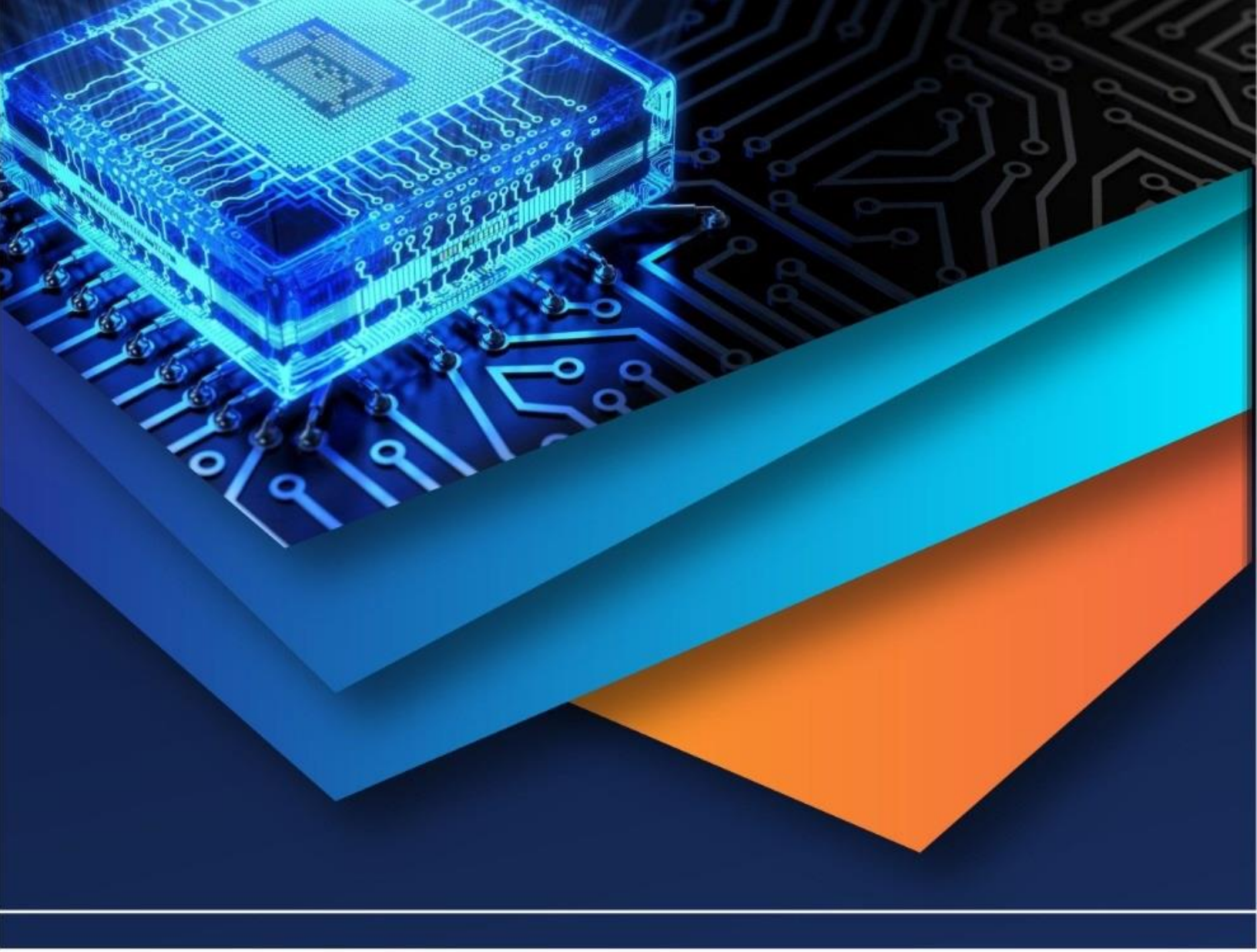

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