INVESTIGATION OF LAKES WITH DETAILED RESTORATION PROCEDURE OF SAMPLE LAKES IN BANGALORE

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Abstract — Several man-made lakes can be seen around Bangalore, which were built for recreational, industrial, agricultural, and home water supply needs. The lakes in Bangalore are disappearing day by day as a result of rapid population increase, pollution, and urbanization. Due to their significant socioeconomic value, lakes must be investigated, restored, and safeguarded. The goal of the current study is to investigate and evaluate the physicochemical characteristics of three sample lakes (Ulsoor, Kasavanahalli, and Iblur). The water quality parameters like alkalinity and acidity, calcium and magnesium hardness, dissolved oxygen, biochemical oxygen demand (BOD), pH, electrical conductivity, total hardness, and chloride were studied in the lab using several analytical techniques. The outcomes demonstrated the significance of lake management and restoration. It entails cleaning the lake, pre-treating it, churning and homogenizing the lake water, applying a disinfectant and spark floc, and then fabricating and installing florafts. It was promising that, with the correct filtration, lake water could be used for drinking, irrigation, and residential purposes. The examination of lakes in Bangalore and the thorough restoration procedures of a sample lake in Bangalore are presented in this paper.

Index Terms — Bangalore, Lakes, Parameters, Investigation, Restoration

I. INTRODUCTION

The majority of Bengaluru's lakes were built ages ago as irrigation tanks. Kempegowda built irrigation wells and storage containers in the sixteenth century, connecting them with a cascade system to prevent water wastage. He imagined constructing a metropolis with a winding water supply. As a result of the construction of numerous tanks and the countless canals used to link them, some pristine lakes can now be found in Bangalore. They were created mainly for drinking water and irrigation, with auxiliary uses for things like washing, fishing, and other domestic requirements. Not only have the lakes' freshwater resources positively impacted the microclimate of the city, but they have also refilled groundwater supplies and wells and given generations of fishers a means of subsistence.

Bangalore, India's fifth-largest city and one of the fastest growing, has seen a 39% decadal population increase. The lakes were kept by the locals as a shared resource, and they all enjoyed its benefits. Lakes on high land provided a source of water for cultivation and animal husbandry as well as recharging the groundwater and reducing surface runoff and erosion.

The ecosystem surrounding the water bodies as well as the waters themselves have been impeded by waste that has collected there. Activists have raised this issue with officials in Bangalore city for years.

Despite the small-scale efforts and steps taken by governments as well as non-governmental organizations, a greater proportion of the water bodies remained contaminated. Numerous issues, including urban heat islands, urban floods, and groundwater decline, have been brought on by the loss of lakes.

Large areas of Bangalore, known as the "Silicon Valley of India" and the top exporter of data technology in the nation, had been submerged for three days. The lakes in Bengaluru were full; some of them burst their banks, and the water, seeing little emigration, camped on the streets, in homes, and in parking spaces. Residents in some regions had to be evacuated on tractors. The city additionally suffered from other connected failures. Various regular activities had to be postponed due to the severe traffic disruptions, lost output, and power outages. Some of the causes of the catastrophe were unique to the metropolis. Many of the lakes have been completely filled in, and others have had their size decreased through careful and slow encroachment and clear defining. Additionally, there has been an alteration in the relationship between water systems.

Because of the reduced catchment area and redirected streams, lakes became dry. Around the dry lakes and the dry area of the lakes, residential structures and urban utilities have been built. Low-lying areas were impacted by flash floods and ground water recharge due to the loss of lakes and an increase in impermeable surfaces. The interconnected, which is a significant aspect of the waterways, has been repressed and has lost some of its original qualities. As a result of urbanization, many lakes and ponds are gone, and the ones that remain are contaminated by sewage.

In addition to threatening agricultural activity, greenery, the fishing community, and recreational activities, the disappearance of lakes has resulted in the loss of irrigated fields and drinking water sources. Due to the expansion of water lilies and other aquatic weeds as well as encroachments, even the remaining lakes are no longer suitable as sources of drinking water.

They no longer effectively absorb floodwater, giving rise to the new occurrence known as “urban floods.” Due to the loss

of natural drainage processes and the development of numerous human activities in low-lying areas that were once irrigated by tanks, urban floods are wreaking havoc in cities. Being close to these lakes exposes people and cattle to serious risks and disease vectors.

The goal of lake restoration or lake rejuvenation is to repair degraded or damaged lakes. Because lake contaminants can seriously harm both the environment and human health, lake rehabilitation is crucial. The BBMP (Bruhat Bengaluru Mahanagara Palike), PCB (Pollution Control Board), BWSSB (Bengaluru Water Supply and Sewerage Board), BDA (Bengaluru Development Authority) at Central and State Government, and various departments including Revenue, Fisheries, Minor Irrigation, Forest, Ecology and Environment Department, Citizens, NGOs, etc. are just a few of the para state agencies connected with governance in Bengaluru.

The regional hydrological cycle depends on the presence of water bodies. Flood control, wastewater treatment, drinking water generation, and so forth are major services. The wetlands offer a low-cost method of treating the wastewater of the community. Nowadays, pollution, hydrological changes, conversion to non-wetland uses, encroachment of drainage through land filling, and overexploitation of their natural resources pose substantial threats to the majority of urban wetlands. Due to a concentration of development activity, Bengaluru is undergoing unprecedentedly rapid urbanization.

Lake cleaning, pre-treatment, churning and homogenization, application of spark floc and disinfection, manufacture and installation of florafts are all steps in the rejuvenation process. There are 105 lakes in the city, according to recent research on lakes called “Wetlands”. Only four lakes were found to appear to be in fair shape, but 25 lakes were discovered to be in a very bad condition, completely covered with macrophytes or dumped with solid or liquid wastes, with little to no water.

The examination of lakes in Bangalore as well as the thorough rehabilitation process of representative Bangalore lakes are the subjects of this paper. Ulsoor Lake, Kasavanahalli Lake, and Iblur Lake are the three lakes taken as samples. There were numerous tests performed, including those for alkalinity, acidity, pH, BOD, DO, hardness. The findings showed that the lake needed to be repaired so that it could be used for socioeconomic purposes.

II. STUDY AREA

A. ULSOOR LAKE

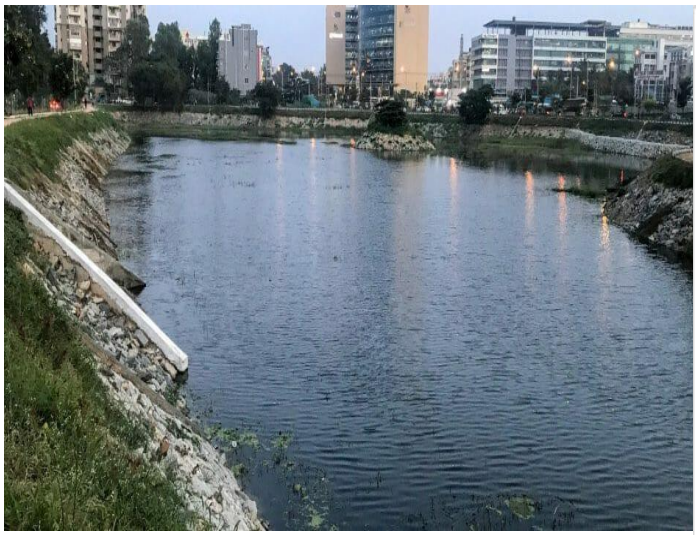
Ulsoor Lake, also known as Halasuru Lake, is one of Bangalore's biggest lakes and is located on the eastern outskirts of the city. Its name derives from the neighborhood where it is situated, Halasuru, which is close to MG Road. It is spread out across 50 hectares and has several islands (123.6 acres).

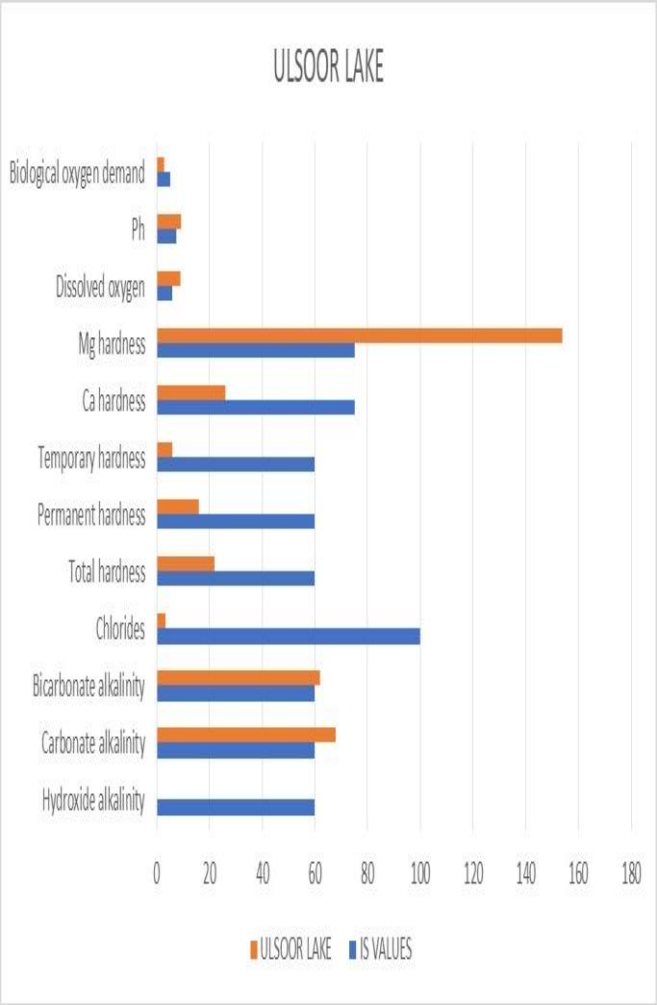
B. KASAVANAHALLI LAKE

Kasavanahalli Lake is a 1.3 mile (3,000-step) route located near Haralur, Bangalore and it is acts as an organic connections to the city's web of freshwater wetland habitats.

C. IBLUR LAKE

Originally spread over 18.6 acres, Iblur lakeis located in the Bommanahalli zone of Bruhat Bengaluru Mahanagara Palike (BBMP).





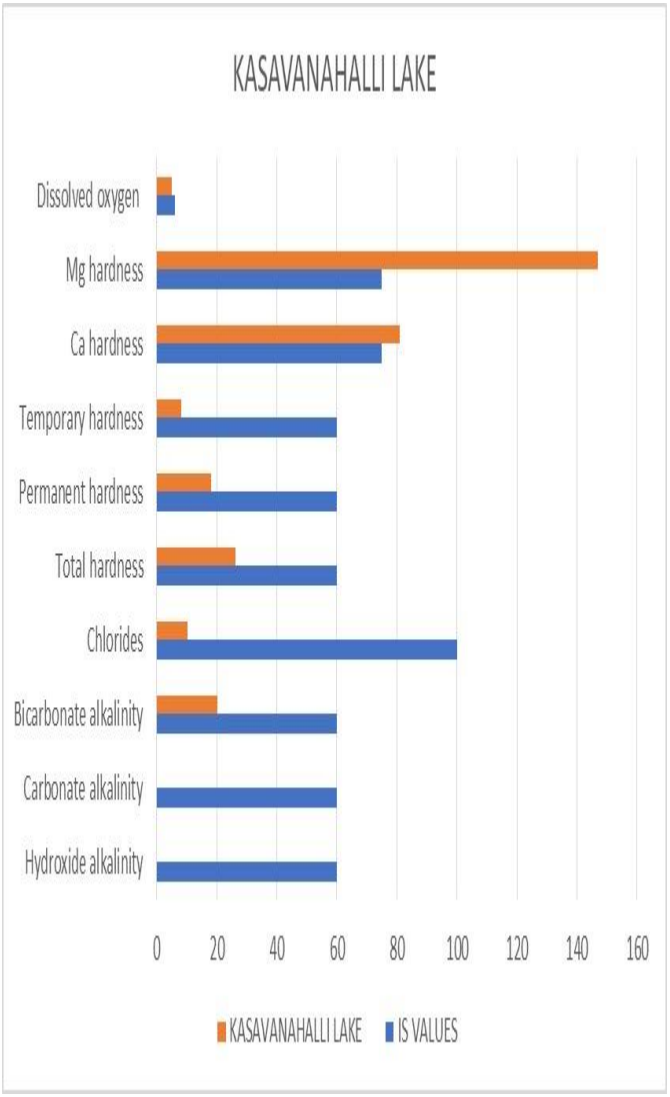
III. EXAMINATION OF LAKE WATER

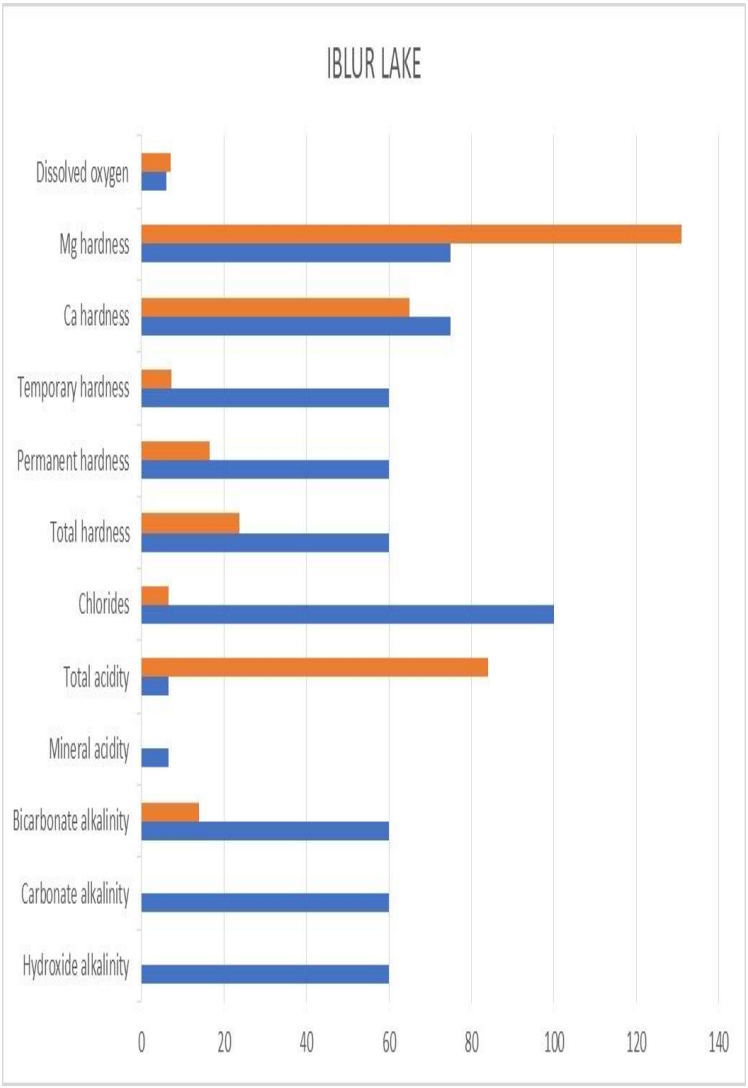
A. ULSOOR LAKE

SL NO.	EXPERIMENT	ULSOOR LAKE
1)	ALKALINITY	
a	Hydroxide alkalinity	0
b	Carbonate alkalinity	68 in mg/L
c	Bicarbonate alkalinity	62 in mg/L
2)	ACIDITY	
a	Mineral acidity	0
b	Total acidity	0
3)	CHLORIDES IN WATER	
a	Chlorides	31.99 mg/L
4)	TOTAL HARDNESS	
a	Total hardness	220 mg/L
b	Permanent hardness	160 mg/L
c	Temporary hardness	60 mg/L
5)	CALCIUM AND MAGNESIUM HARDNESS	
a	Ca hardness	26 mg/L
b	Mg hardness	194 mg/L
6)	DISSOLVED OXYGEN	
a	DO	8.9 in mg/L
7)	ELECTRICAL CONDUCTIVITY	
a	Conductivity	0.3 in mg/L
8)	pH	9.18 in mg/L
9)	BIOLOGICAL OXYGEN DEMAND	
a	BOD	2.8 in mg/L

B. KASAVANAHALLI LAKE

SL NO.	EXPERIMENT	KASAVANAHALLI LAKE
1)	ALKALINITY	
a	Hydroxide alkalinity	0
b	Carbonate alkalinity	0
c	Bicarbonate alkalinity	202 mg/L
2)	ACIDITY	
a	Mineral acidity	0
b	Total acidity	66 mg/L
3)	CHLORIDES IN WATER	
a	Chlorides	101.96 mg/L
4)	TOTAL HARDNESS	
a	Total hardness	261 mg/L
b	Permanent hardness	180 mg/L
c	Temporary hardness	81 mg/L
5)	CALCIUM AND MAGNESIUM HARDNESS	
a	Ca hardness	81 mg/L
b	Mg hardness	147 mg/L
6)	DISSOLVED OXYGEN	
a	DO	4.9 mg/L
7)	ELECTRICAL CONDUCTIVITY	
a	Conductivity	0.6 mg/L
8)	pH	7.9 mg/L
9)	BIOLOGICAL OXYGEN DEMAND	
a	BOD	7.8 mg/L





C. IBLUR LAKE

SL NO.	EXPERIMENT	IBLUR LAKE
1)	ALKALINITY	
a	Hydroxide alkalinity	0
b	Carbonate alkalinity	0
c	Bicarbonate alkalinity	140 mg/L
2)	ACIDITY	
a	Mineral acidity	0
b	Total acidity	84 mg/L
3)	CHLORIDES IN WATER	
a	Chlorides	65.97 mg/L
4)	TOTAL HARDNESS	
a	Total hardness	238 mg/L
b	Permanent hardness	166 mg/L
c	Temporary hardness	72 mg/L
5)	CALCIUM AND MAGNESIUM HARDNESS	
a	Ca hardness	65 mg/L
b	Mg hardness	171 mg/L
6)	DISSOLVED OXYGEN	
a	DO	7.1 mg/L
7)	ELECTRICAL CONDUCTIVITY	
a	Conductivity	0.4 mg/L
8)	pH	6.57 mg/L
9)	BIOLOGICAL OXYGEN DEMAND	
a	BOD	3.9 mg/L

IV. RESTORATION METHODS

In the past, lakes have occasionally been eliminated so that the land might be used for agriculture, or they have simply not been managed and have silted up. Where lakes have been drained in the past, restoration involves enhancing their structure and functionality. Water can be stored by restoration (for flood control) and provided for a variety of uses, including water supply, irrigation, fishing, tourism, etc. Also, it serves as a carbon sink and offers crucial habitats for many different kinds of plants and animals, including waders. By storing vast volumes of water and releasing it when needed, a lake's proper operation can lessen the effects of floods and droughts. The majority of the time, lake restoration relates to techniques employed within the lake, but it can also apply to actions conducted outside the lake, such as a reduction in external nitrogen loading through enhanced wastewater treatment. Purification of the lake, pre-treatment, churning and homogeneity of the lake water, use of a spark floc, disinfection, fabrication and floraft launch are all part of the process. These are the several techniques for restoring ponds and lakes:

• Wastewater treatment has frequently been replaced by wastewater deviation.

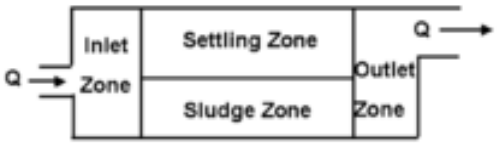
• The removal of surface sediment can help eutrophic lakes and other regions that have been contaminated by harmful substances recover. The removal of superficial sediment can also be accomplished by covering the silt with an inert substance, uprooting macrophytes, and expelling them from reservoirs and streams where they have interfered with the turbines.
• Draining hypolimnetic water—Hypolimnetic withdrawal is a strategy for restoring lakes that involves removing anoxic water from the lake's bottom together with low DO, high P, high ammonia, hydrogen sulphide, and metals.
• Flocculation of phosphorus: Adding a coagulant chemical (like phosphorous) to the water promotes the joining of particles, resulting in bigger aggregates that are simpler to separate.
• Water circulation can be employed to collapse the thermocline. This could stop the development of anaerobic zones and, as a result, the release of phosphorus from sediment. Aeration of lake sediment has also been utilized to prevent anaerobic conditions in extremely contaminated rivers and streams. Eutrophication will decline due to lower nutrient concentrations if retention time in a lake or reservoir is shortened while maintaining the same annual intake of nutrients.
• Using impoundments or wetlands.
• Using trees on the coastline to provide shade.
• Biocontrol strategies
• Biomanipulation

IVA. REMOVAL OF SURFACE SEDIMENT

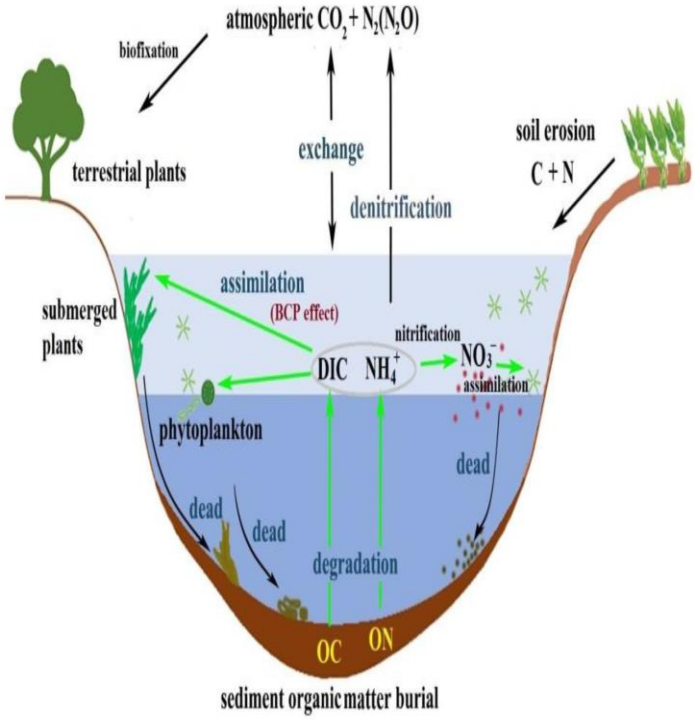
Sedimentation is a physical water treatment procedure that removes suspended solids from water using gravity. Solid particles entrained by moving water turbulence can be organically removed by sedimentation in lakes and seas. Settling basins are pools designed to remove entrained solids through sedimentation. Clarifiers are tanks designed with mechanical methods to remove solids deposited by sedimentation on a continuous basis. Clarification has no effect on dissolved organisms. The process of depositing sediment is known as sedimentation.

- Although sedimentation may occur in tanks of other forms, removal of accumulated solids is facilitated by conveyor belts in rectangular tanks or scrapers rotating around the center axis of circular tanks.

- The settling basin's surface area becomes the most important element in sedimentation rate. Every continuous flow settling basin is split into four sections: the inlet zone, the settling zone, the sludge zone, and the outlet zone.



- At very high particle concentrations, the settling particles can collide and form when reaching the floor of the sedimentation tanks. As a result, further settling will occur only in the modify matrix as the sedimentation rate decreases.



IVB. FLOCCULATION OF PHOSPHORUS

Flocculation is a water treatment process in which solids combine to create larger clusters, or flocs, which are then removed from the water. This procedure can occur naturally or with the assistance of chemical agents. It is a widespread method of stormwater treatment, wastewater treatment, and drinking water purification.

- The removal of suspended solids is one of the requirements for treated water exiting wastewater treatment facilities.
- Small solid particles change the colour of water and transport impurities into natural water sources such as waterways and the ocean.
- Phosphorus content in wastewater must also be limited because phosphorus release into rivers encourages algae development.
- Uncontrolled phosphorus discharges have been linked to mass die-offs of fish and other aquatic life.
- Some industrial applications produce high levels of phosphorus in their wastewater, which may necessitate pre-treatment before being discharged to wastewater treatment facilities.

IVC. BIOMANIPULATION

Biomanipulation was initially based on the idea that by reducing the number of planktivorous fish, the proportion of large cladoceran zooplankton increases, and its consumption during the summer season can reduce certain species of algae that grow in plankton and reduce water turbidity.

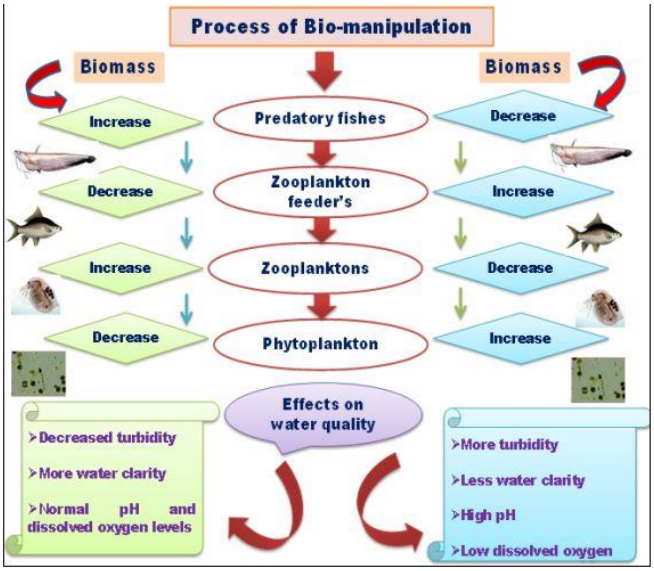
People have been using this technique for decades. Eutrophication reduces the variety of the fish population, potentially threatening fishermen's livelihoods. Humans have purposefully introduced predator species into the aquatic ecosystem to control and improve water quality through a biological process. Biomanipulation is a tried-and-true technology with numerous successful uses in different lakes. It is critical for the clarity of water in waterways. The habitat for the fish population and aquatic biodiversity has been recovered.

1) ADVANTAGES

1. Natural Process Introduced by Humans
2. Reduces Turbidity
3. No requirement for chemicals
4. Improves fisheries
5. Maintain nutrient cycling
6. Supports biodiversity

2) DISADVANTAGES

1.Rotenone Application
2.Management of Lakes
3.Poisoning of Water Bodies
4.Lack of Awareness
5. Expensive Treatment



IVD. BIOLOGICAL

The biological wastewater treatment method, also known as the conventional method, is a popular and extensively used treatment method. It considers biodegradation bleaching with the help of various microorganisms, fungus, bacteria, yeasts, and algae. This is a simple and inexpensive procedure that combines aerobic and anaerobic processes. However, there are some significant constraints to this process:

- Complete colour removal is not possible
- Xenobiotic dyes with complex chemical structures have been found to be resistant to degradation
- Biological methods require a large land area, are diurnal, and take longer to operate
- The process offers little flexibility in design and operation.

The degradation process can occur in the presence of oxygen (aerobic treatment) or in the lack of oxygen (anaerobic treatment). (anaerobic treatment). Both of these naturally occurring effluent treatment principles result in basic differences in the technical and economic processes involved.

Anaerobic microorganisms can only function in the lack of oxygen. Anaerobic processes are distinguished by their low energy needs and small quantity of excess sludge produced. Anaerobic processes generate an excess of energy because biogas is created during the degradation process.

Biogas is composed primarily of methane and carbon dioxide, with residues of hydrogen sulfide, nitrogen, and oxygen. Biogas is primarily used to generate energy in internal combustion engines or furnaces.

IVE. USING TREES ON COASTLINE

Coastal vegetation has the ability to reduce wave runup and protect coastal communities from extreme flooding and land loss as a natural barrier to the shorelines.

Eucalyptus trees are grown all along sewage ponds because they absorb excess wastewater quickly and release pure water vapour into the atmosphere, as well as adding a lot of oxygen to the atmosphere.

- Shoreline and overhanging foliage provide habitat for microbes, stream insects, and other food sources for fish and other aquatic life.
- The shading impact of vegetation also helps keep water temperatures cool, which is essential for salmon to reproduce and thrive.
- Fallen trees and branches in waterways can also provide pools and hiding places for juvenile fish and other aquatic life.
- Shoreline flora also acts as a natural biofilter, aiding in the reduction of pollution in surface runoff and shallow groundwater. Nitrogen and phosphorous are taken up by plants from fertilizers and animal manure.
- This aids in the prevention of algal blooms, which consume oxygen in the water (when they die naturally) and are important for the health of fish and other aquatic organisms.

V. CONCLUSION

We have examined the causes of the most recent floods in Bangalore, the situations of several sample lakes (ULSOOR LAKE, KASAVANAHALLI LAKE, and IBLUR LAKE), and suggested restoration techniques in this article. It has been decided that these sample lakes must be repaired before lake water can be used again. After being restored, the lakes can be used for a variety of socioeconomic purposes. By removing the raja kulves, this may also aid in preventing future lake flooding.

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