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A Lake as a Living Paradise for Habitats Lingambudhi Lake

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Abstract

The research illustrates the cumulative study of morphology of lake, existence of bio diversity in lake which leads the way to explore the integrated water body network and has the scope to implement the recreational activities. In the eyes of the people Lingambudhi Lake considered as the forest which mimics the Ranganatittu Bird Sanctuary with sigh seeing bird migration and Small Island in the middle of the lake. This makes research interesting to walk around the nature to be adventurous and also retreating, where people can experience the way to wanderlust in the time being. Mysore categories as upcoming tier 2 city due to urbanization there is decrease in green spaces o which is much needed and wanted to breathe for living beings and sustain. It's very important to secure and conserve the existing lake and forests. As urban designers Building the living community to live without vandalizing the vegetation and landscape is very challenging. There is depleting of water bodies due to the gentrification of the city. Lake conservation is one of the major resources for the urban environment to keep up the sustainability of the city neighborhoods so in this research paper its suggests the strategies to secure the ecology of lake, protect the biodiversity and promoting the tourism for the public. Strategies/guidelines are discussed in this research paper.

Keywords: Ecosystem, biodiversity, blue green network, sustainable lake conservation.

Introduction

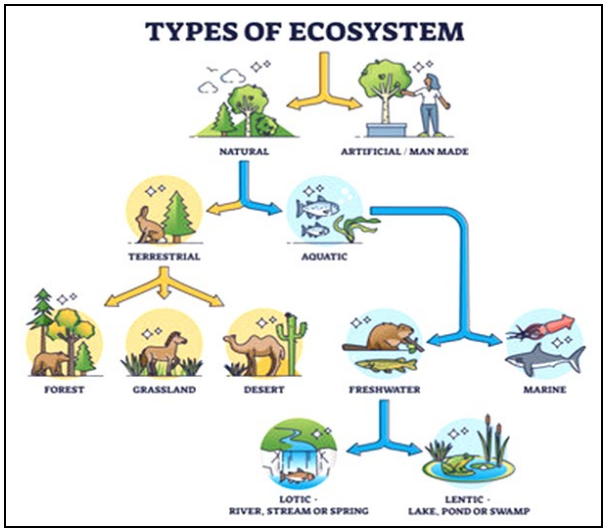
1. Concepts

a) Ecosystem of the Lake

An ecosystem is a community of living organisms and their physical environment, where the organisms interact with each other and their environment

An ecosystem is a dynamic community of living organisms that interact with each other and their non-living environment.

Ecosystems are the building blocks of life on Earth. These dynamic systems, found on land, in water, and even in the air, are characterized by a complex web of interactions that sustains all members within them. While every system has a unique structure, they together contribute to maintaining the balance of nature. There are many different types of ecosystems, each with its own unique set of organisms and interactions.



Source: *Google*

Fig 1: Classification of the ecosystem

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Ecosystems are Important for a Number of Reasons

- **Biodiversity:** Biodiversity is all the different kinds of life you'll find in one area—the variety of animals, plants, fungi, and even microorganisms like bacteria that make up our natural world. Each of these species and organisms work together in ecosystems, like an intricate web, to maintain balance and support life.

Source: *Google*

Fig 2: World map showing bio diversity

- **Habitat**

A habitat is the natural environment where an organism, such as a plant or animal, lives and finds the resources it needs to survive. It includes the physical and biological factors that support the organism's survival and reproduction

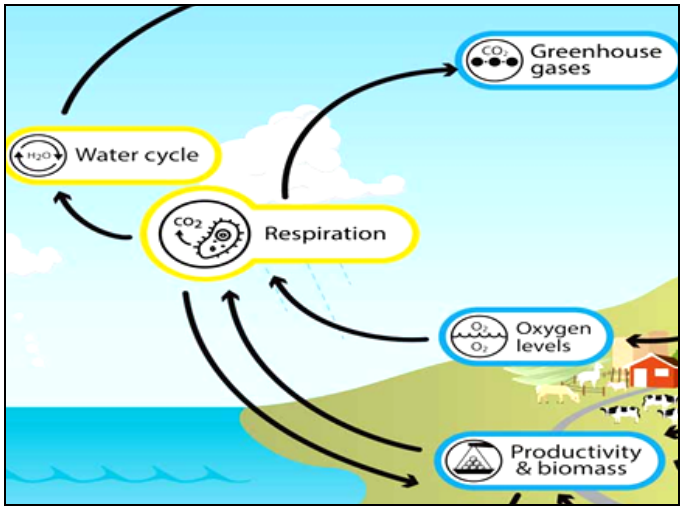
Source: *Google*

Fig 3: Types of habitat

- **Oxygen Levels**

Oxygen levels in ecosystems vary depending on the environment and the organisms that live there:

Atmosphere-The Earth's atmosphere is about 21% oxygen by volume. The balance of oxygen and carbon dioxide in the atmosphere is maintained by plants releasing oxygen during photosynthesis and animals and plants releasing carbon dioxide during respiration

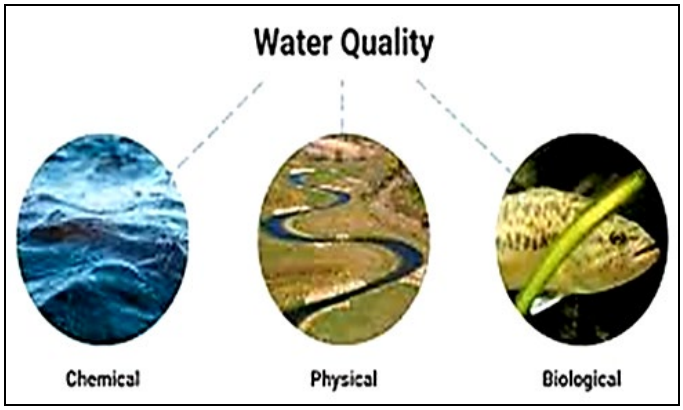


Source: *Google*

Fig 4: Oxygen levels of habitat

- **Water Clarity**

Water quality in an ecosystem" refers to the condition of water within an environment, measured by factors like dissolved oxygen, pH, temperature, nutrient levels, and presence of pollutants, which significantly impacts the health and diversity of aquatic life within that ecosystem, essentially determining its overall ecological balance; poor water quality can harm aquatic organisms, disrupt food chains, and limit the ecosystem's ability to function properly



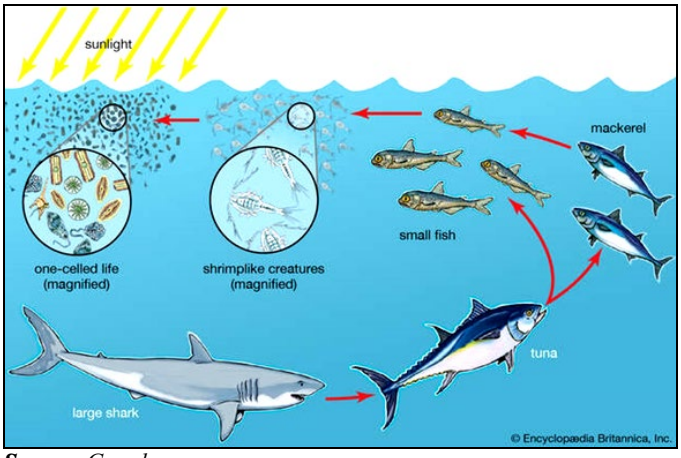
Source: *Google*

Fig 5: Types of water quality in ecosystem

b) Aquatic Ecosystem

An aquatic ecosystem is a biological community of organisms that live in water and interact with each other. Aquatic ecosystems include freshwater and marine ecosystems, and can be found in lakes, rivers, oceans, wetlands, and other bodies of waterAn aquatic ecosystem refers to the life-sustaining in and around various water bodies. It includes every water-based environment on earth where life thrives and living aquatic organisms constantly interact with both the physical and chemical features of nature.

The aquatic ecosystem is a self-sufficient system to sustain life-producing oxygen, has a water purification system, and other means for life to thrive in it. In addition to this, the main function of the aquatic ecosystem is also to support human well-being. This is because it supports fisheries and fulfils water needs for human life.



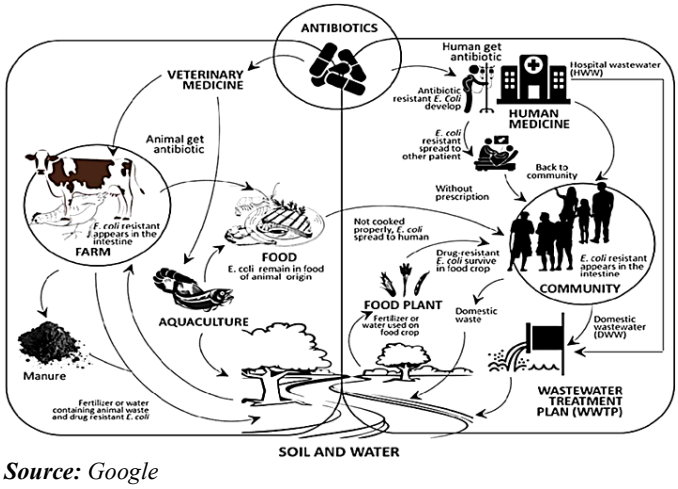
Source: *Google*

Fig 6: Habitat in aquatic ecosystem

Features of an Aquatic Ecosystem

The aquatic ecosystem is directly or indirectly involved in maintaining the natural flow of the environment. Here are some salient features of the aquatic ecosystem.

Wide Range of Habitats: The aquatic ecosystem offers a wide range of natural water-based habitats. These habitats can be found in various types of water bodies all around the globe.
Rich Biodiversity: Aquatic ecosystems are known to have a very rich yet unexplored biodiversity.



Source: *Google*

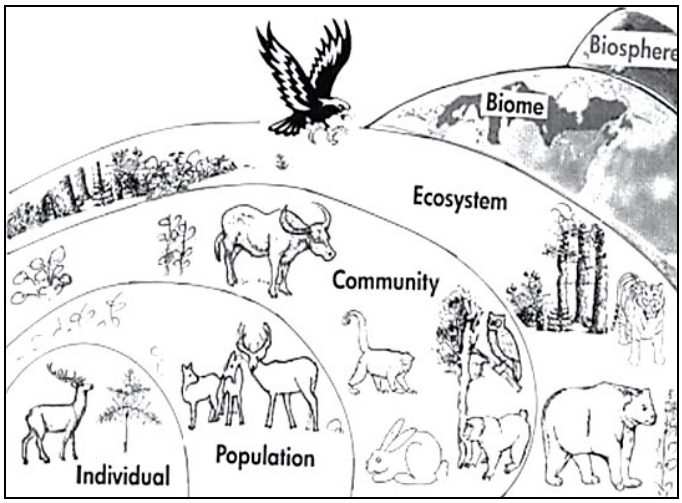
Fig 7: Wide range of soil and water habitats

Among the parts of the aquatic ecosystem that humans have been able to explore, the water bodies offer varying aquatic life at every location.
Essential Resources: From digging up salt in the oceans to extracting various types of sand from rivers, the aquatic ecosystem offers resources essential for human use.
Rare Food Webs: The aquatic ecosystem extends some of the rarest food webs, which are rich in protein and nutrients and beneficial for the consumption of mankind.

The Functions of Aquatic Ecosystem

Enhanced Nutrient Cycling: Aquatic ecosystems facilitate rapid and efficient nutrient recycling, supporting a diverse range of life forms.

Flood Mitigation: These ecosystems act as natural buffers, mitigating floods and protecting human settlements from inundation.



Source: *Google*

Fig 8: Hierarchy of ecosystem

Groundwater Recharge: Aquatic ecosystems play a crucial role in replenishing groundwater reserves sustainably, ensuring consistent water availability
Water Purification: By filtering pollutants and contaminants, aquatic ecosystems naturally purify water, making it suitable for drinking and other human uses

Types of Aquatic Ecosystem

Freshwater Ecosystems

These ecosystems have a salt concentration of less than 1% and include lakes, rivers, ponds, streams, springs, bogs, and wetlands. Freshwater ecosystems can be classified by factors such as temperature, light penetration, nutrients, and vegetation.

Source: *Google*

Fig 9: Fresh water stream

Marine Ecosystems

These ecosystems have a high salt content and include oceans, seas, intertidal zones, reefs, and seabeds. Marine ecosystems are home to a wide variety of aquatic species, including sharks, shellfish, tube worms, crabs, and large ocean fishes.

Source: *Google*

Fig 10: Marine habitat

Source: *Google*

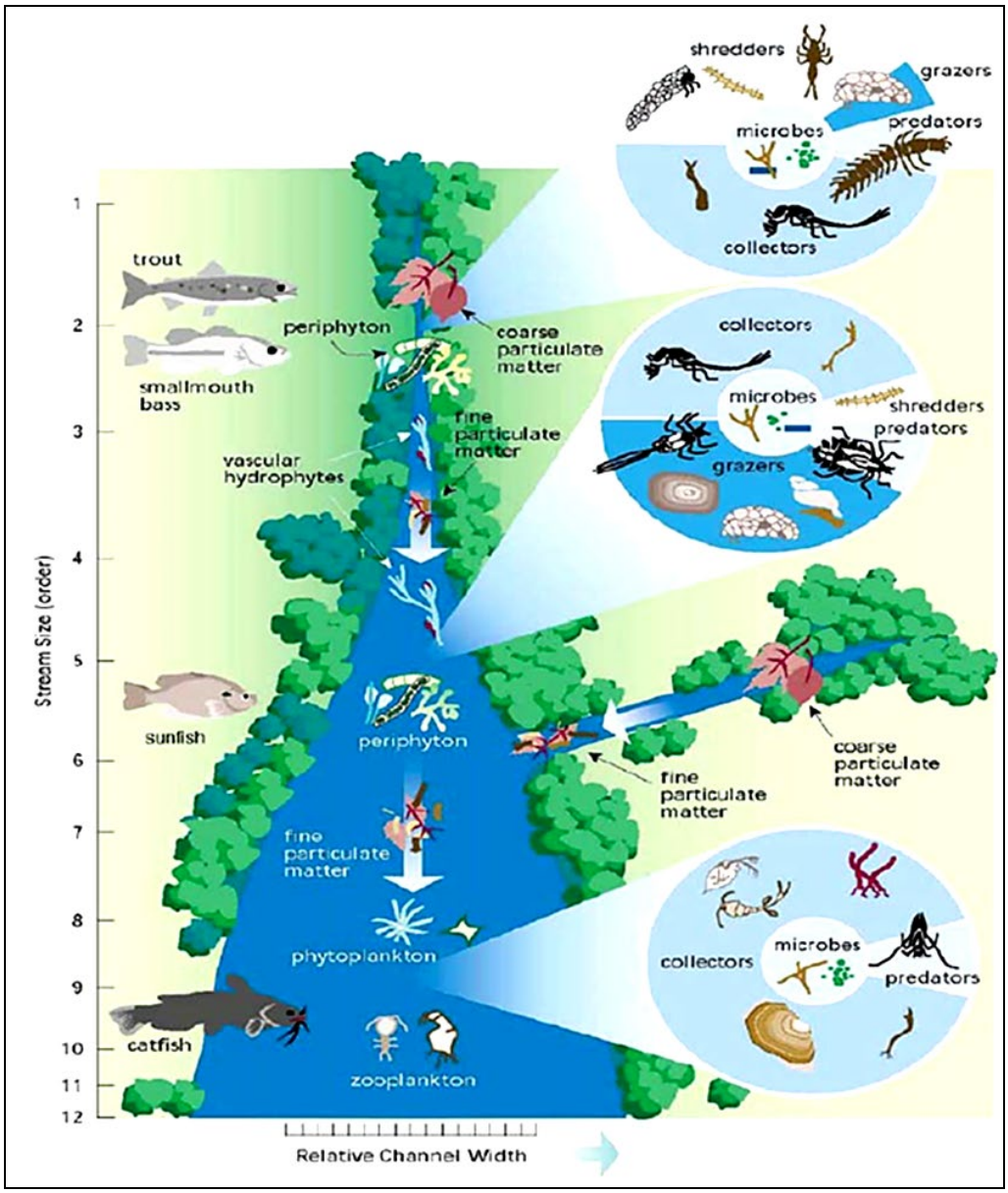
Fig 11: Wetland Ecosystem

Wetlands

These are marshy areas that are sometimes covered in water and are home to a wide variety of plants and animals, including dragonflies, damselflies, birds, and fishes

Lotic Ecosystems

These ecosystems are home to water bodies with a water flow in one direction, such as streams and rivers. The nature and nutrient value of the ecosystem is constantly changing as the water changes.

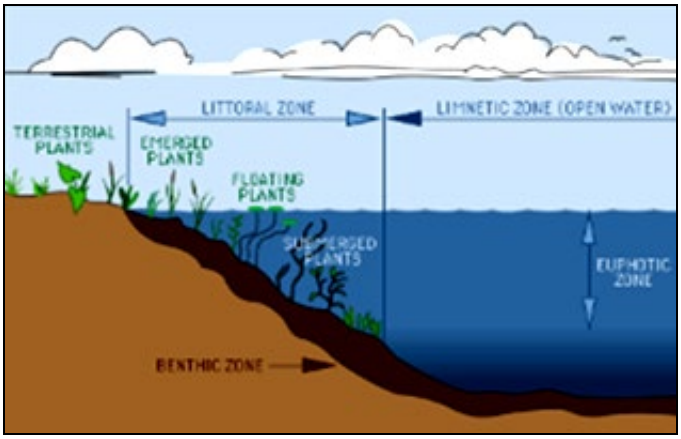


Source: *Nutrient Effects on Spring Flora and Fauna (2006)*

Fig 12: Lotic ecosystem showing various organisms

Lentic Ecosystems

These ecosystems are home to stationary or relatively stagnant water, such as ponds, lakes, bogs, and pools. They are home to crabs, algae, shrimps, amphibians, and plants with both roots and floating leaves.



Source: *Eco shape building with future*

Fig 13: Section of lentic ecosystem

The littoral zone is the near shore area where sunlight penetrates all the way to the sediment and allows aquatic plants (macrophytes) to grow. The littoral community is considered the most diverse and abundant biological community in lakes

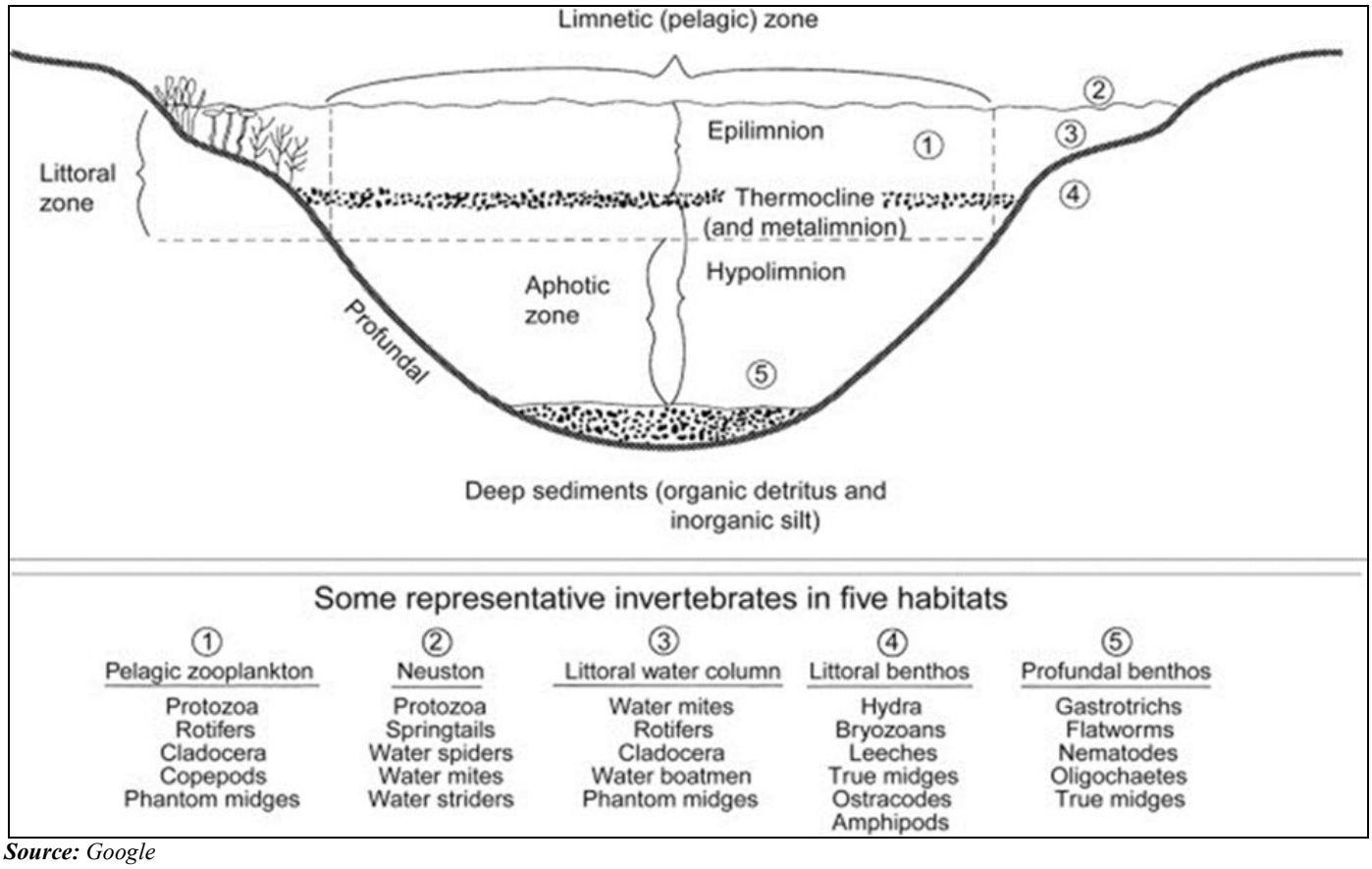
The euphotic zone of the lake is the layer from the surface down to the depth at which light levels become too low for photosynthesis. Light intensity usually decreases exponentially with depth, due to absorption and attenuation by phytoplankton, suspended particles and dissolved organic matter. The limit for photosynthesis is the depth where around 1% of the incident light intensity at the water surface is still available.

The limnetic zone is the open water area where light does not generally penetrate all the way to the bottom.

The benthic zone is the surface layer of the bottom, with sediments abundant with organisms. This upper layer may be mixed by the activity of the benthic organisms that live there, often to a depth of 2-5 cm in rich organic sediments.

The zonation can be seen to be largely determined by the light extinction curve in the water column. If the light extinction coefficient increases, e.g. due to increased sediment resuspension or to massive algal blooms, the spatial delineation of the major ecological zones will also change: the littoral zone will shrink and the euphotic layer will narrow. Populations of macrophytes, phytoplankton and zooplankton will follow these changes in their distribution. Also fish and benthic life will be affected because the flux of organic matter (food) to the sediment will change.

Characteristics of a Lentic Aquatic System: (fig. 14)



Source: *Google*

Fig 14: Chemical composition of different zones

Lentic ecosystems are characterized by still water and include ponds, lakes, marshes, swamps, and ditches. They are different from lotic systems, which are characterized by flowing water, such as rivers and streams. Here are some characteristics of lentic ecosystems:

Size: Lentic ecosystems can range in size from small, temporary pools to large lakes, such as Lake Baikal.

Zonation: Lentic ecosystems have two-dimensional zonation:

Horizontal: Changes in water depth due to the slope and length of the shore
Vertical: Changes in light, water temperature, and nutrient and oxygen concentrations in deeper water

Abiotic Conditions
Different zones in lentic ecosystems have different abiotic conditions, which support species that are adapted to those conditions.
Succession: Over time, lakes and bays can become enriched with nutrients and fill in with organic sediments. This process is called succession.
Diurnal Circulation: In tropical and subtropical regions, nutrients and oxygen circulate during the day. During the night, oxygen-rich water sinks and nutrient-rich water rises.
Oxygen Concentration: The concentration of oxygen in lentic ecosystems is high due to mixing and turbulence. A low concentration of oxygen usually indicates organic pollution

2. Introduction

Lingambudhi Lake is one of the largest and oldest Perennial freshwater lake of the Mysore city which widen over 260 acres and does not get full drought up in the hot summers and flourished with the serenity of water and lush green during the Monsoons. A home for several bird community and water reptiles residing place, butterflies follows everywhere within the lake. As for humans it's a major relaxation and tranquil spot all weekdays and weekends after their daily stressed life. A broad connectivity of lake is enhancing all biodiversity in the heart of heritage city.

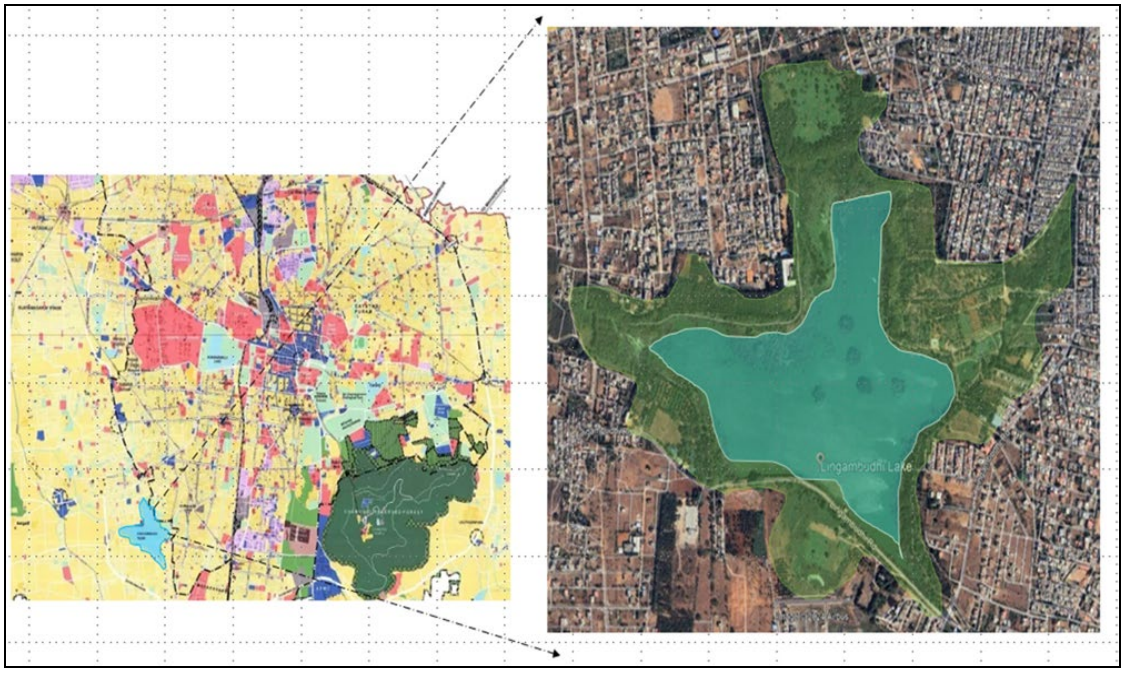
3. Background Study of the Study Precinct

History
Lingambudhi Lake situated in the basin of River Cauvery. Before 1828 until the late 1980s, Lingambudhi Lake was an old village lake in the rural surroundings of the city of Mysore.
The lake was served as multipurpose uses such as, a source of drinking water, irrigation, and fish produce; as a site for washing clothes and cattle; and as a place of religious worship for the people of Lingambudhi Palya, According to history the lake was excavated in 1828 AD by Lingajammani, a queen of Krishna raja Wodeyar III, wodeyar dynasty.
On 28th of August 2003, the Forest Department's proposal of 2001, had finally declared the Lingambudhi Lake and its environment as a protected forest area and had transferred the ownership to the Forest Department.

Source: *Google*

Fig 15: Views of Lingambudi Lake

4. Topography



Source: *Generated and compiled by the author through Google earth pro and site visit*

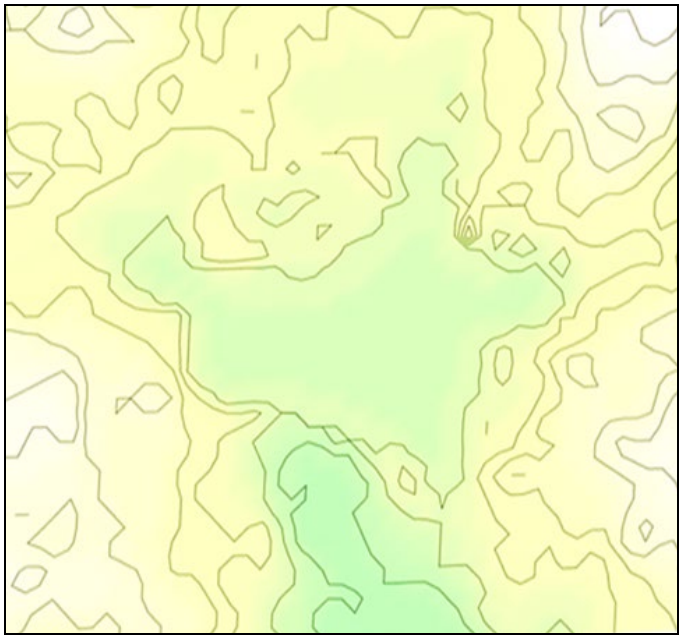
Fig 16: Mysore City master plan 2030

Fig 17: Lake Precinct

One and half decade back Lingambudhi Lake was in the outskirts of Mysore City, but now it is engulfed on all the sides by the extending city dwellings. The lake is geographically located at 12º 16' 20" N and 76º 31'E to the southwest of Mysore city at an altitude of 730m above mean sea level. From the city centre, the lake is situated at a distance of 7 km. (fig 16)

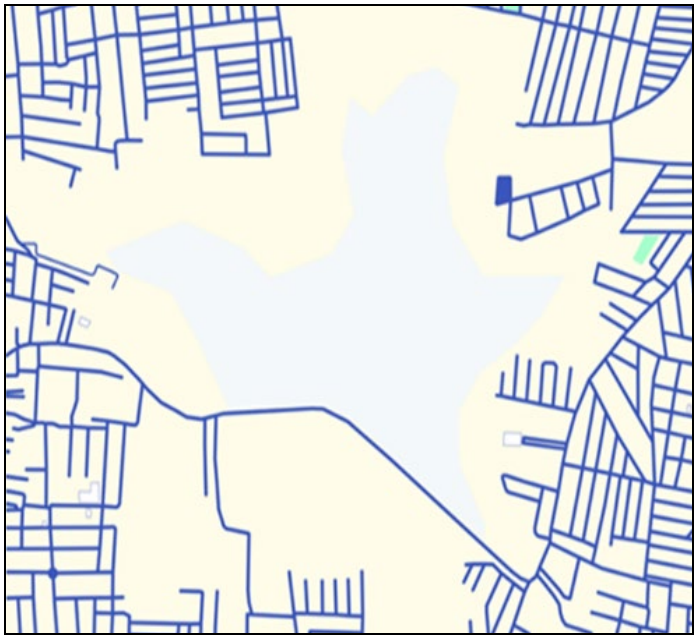
It has a catchment area of 45 Sq. Km. Tropical dry deciduous, secondary scrub and semi-arid grass land is the habitat covering the area followed by irrigated fields during good rainy season.

5. Morphology of the Lake



Source: *Generated by the author through cad mapper*

Fig 18: Topography of Lake Precinct



Source: *Generated by the author through cad mapper*

Fig 19: Street layout map of Lake Precinct

The road connects the residential areas on the south eastern side with the village of Lingambudhi Palya situated on the south western side of the lake. (Fig 17) From this vantage point ducks on tank, arboreal birds and warblers could be viewed on either side of the bund.

Recently laid new walkways all-round the lake, opened up the secondary scrub and forest for nature watchers and are most suitable for watching arboreal and water birds; and butterflies. Entry is restricted: 06.00 – 09.30 am & 04.30-06.30 pm, average users

Soil Condition

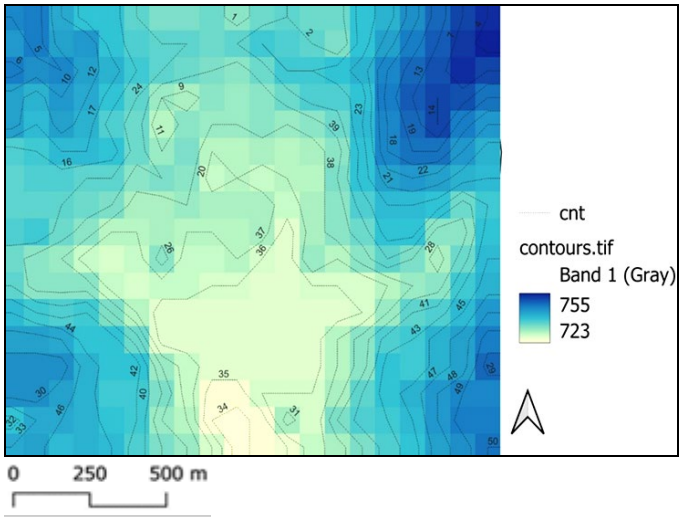
Fine-textured soils, such as clay and clay-loam soils, have a larger porosity compared to coarse-textured soils like sand. As a result, they can hold more water than sandy soils.

All types of soils carried and deposited by water are known as alluvial deposits

Geography

The area is adorned with trees such as gulmohar, silver oaks, climbers and creepers. Visitors can be seen going for morning and evening walks around the lake

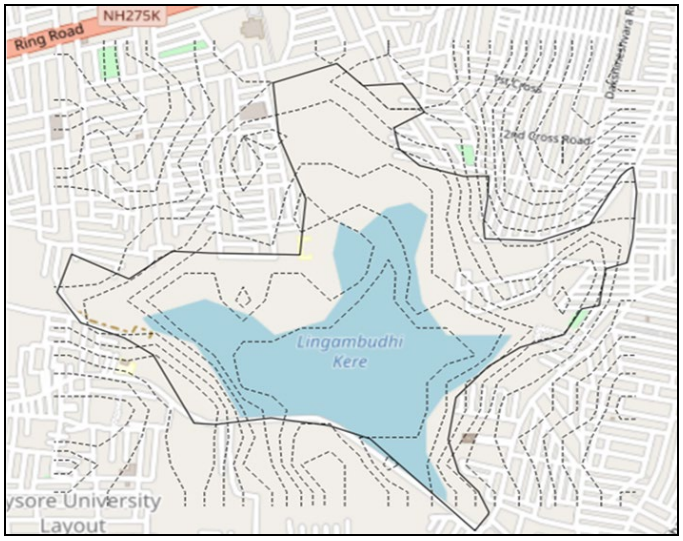
This map helps to understand the lowest and the highest contour level.



Source: *Generated and compiled by the author through QGIS*

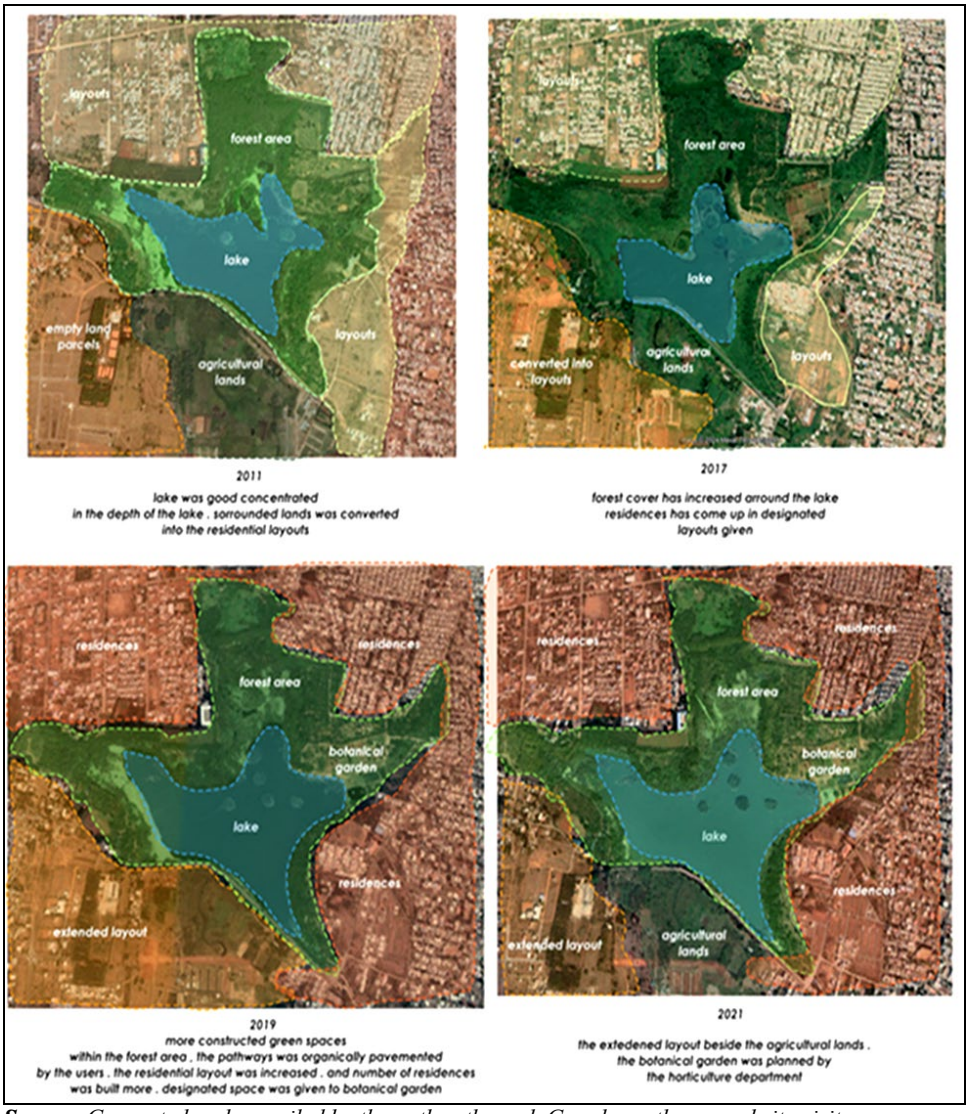
Fig 20: Contours of Lake Precinct

Overlaying the layers will give the analysis of the context of the lake precinct



Source: *Generated and compiled by the author through QGIS*

Fig 21: Over laying the contours over Street layout map of Lake Precinct



Source: *Generated and compiled by the author through Google earth pro and site visit*

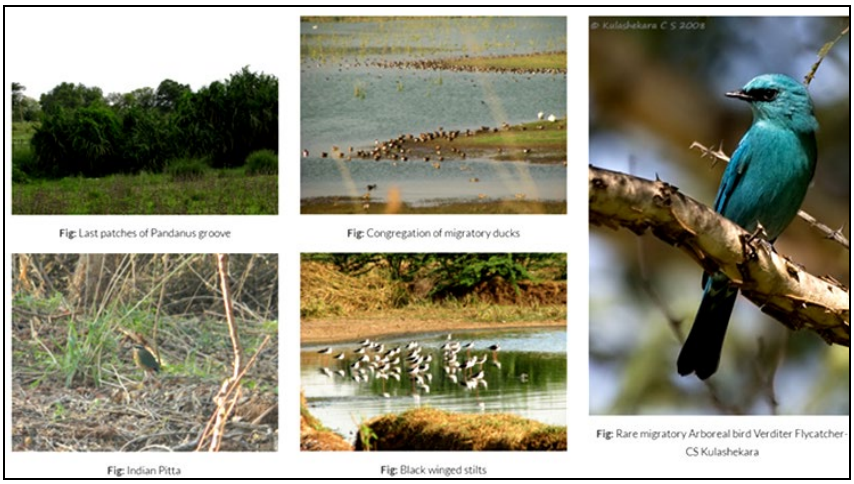
Fig 22: Timeline of Lake Precinct and its development

Showing the land use transformation of the 4 different years which indicates the decrease of green cover around the lake precinct. Due to the extension of residential layouts the along the ring road, the lake surroundings has been effected in the urban ecosystem of the lake.

6. Biodiversity of Lake

The bird data has declined from 2000 to 2010 in both the both population and species occurrence. Totally 213 species of birds (fig 18) From January, 2000 – January, 2010 – a span of a decade is listed below. Totally 172 species are considered for change in the occurrence and population study out of

recorded 213 species, excluding the 41 species (Local and Migratory) recorded less than three times. Changes of 79 species, 46% of 172 common birds consisting of resident, local and regular migratory are conspicuous. Lingambudhi Lake environment undergone man made changes in habitat structure and food abundance, influencing the density and diversity. (Fig 19)



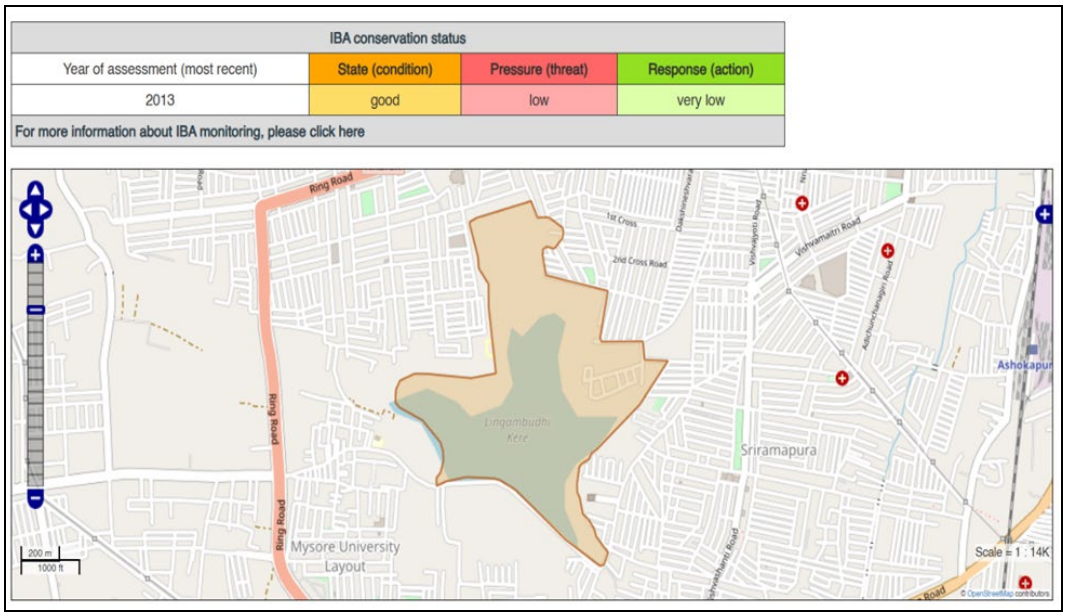
Source: *Msysuru vision.com*

Fig 23: Bird species of the lake

Table 1: Table showing no of different species of bird migration

Category of Birds	Reasons for categorizing	No. of species	Remarks
Resident species	Breeding, foraging and roosting for a minimum of four years	91	Result reveals 09 species are absent; 13 species population reduction;
Local species	Only foraging	37	15 resident species
Rare Local species	Species recorded less than three times	14	2 species population increased.
Regular Migratory species	Winter migrants that are regular every year	42	Balance 52 species are maintaining status quo.
Rare Migratory species	Winter migrants	26	Result reveals 5 species are absent; 8 species population reduction.
New regular migratory species	observed less than three times	2	Balance 24 species are maintaining status quo.
Vagrant	Observed arriving only in the last 3 season	1	These are not considered for variation study.
Total	regularly, might continue to arrive	213	Result reveals 6 species are absent;

Source: *Msysuru vision.com*



Source-*© 2024 Birdlife International UK charity registration number 1042125*

Fig 24: Biodiversity conservation assessment of the lake

What is the IBAT Data for Biodiversity?

The Integrated Biodiversity Assessment Tool (IBAT) supports biodiversity disclosure requirements by providing critical, high-quality data from three of the world's most authoritative data sources-the IUCN Red List, the World Database on Protected Areas (WDPA), and the World database of Key Biodiversity Areas (WDKBA).

This small lake has a variety of habitats which sustain a vibrant birdlife-wetlands, including the lake and adjacent paddy fields, mudflats and drains, open dry land, scrub forest, Sesbania and Acacia plantations, grassland, bamboo groves, mango and coconut groves, and orchards. It hosts over 5,000 waders during the spring migration and over 1,000 in the autumn migration. During spring migration, the largest components in the wader group are the Wood Sandpiper Tringa glareola and the Curlew Sandpiper Calidris ferruginea (up to 400).

Autumn migration, up to 300 Curlew Sandpiper and 200 Wood Sandpiper Tringa glareola have been seen. (2000) 25,000 ducks in January 1998, and 4,000 waders in March the same year. A large number of egrets Egretta spp. (up to 3,000), mynas Acridotheres spp. and the Rosy Starling Sturnus roseus (up to 10,000)

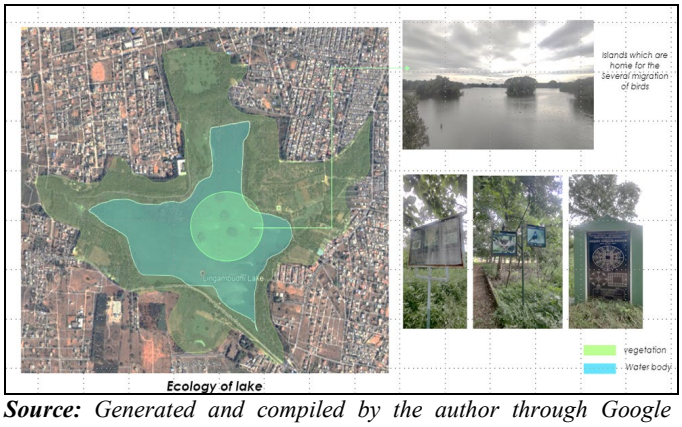
The lake hosts a large number of globally threatened Spot billed Pelican Pelecanus philippensis every summer, when other lakes dry up. March-April 2002, nearly 600 birds of this species, whose world population is estimated by Wetlands International (2002) between 2,500 to 5,000 and the threshold for 1% of biogeographic population set at 40, making it an extremely important site for the species in southern India and qualifying it as an IBA under criterion

The lake is the only known regular breeding site in southern India of the extremely rare Indian subspecies of the Lesser Spotted Eagle Aquila pomarina hastata The Spot-billed Pelican has also attempted to breed here. Birds rare in India such as Rusty-rumped Grasshopper-Warbler Locustella certhiola (Thejasvi and Shivaprakash in press) have been recorded from the lake.

This IBA, which is only partially protected, has around 110 species of butterflies. No large wild mammal of any conservation concern is found here.

(https://datazone.birdlife.org/site/factsheet/lingambudhi-lake-and-environs-iba-india)

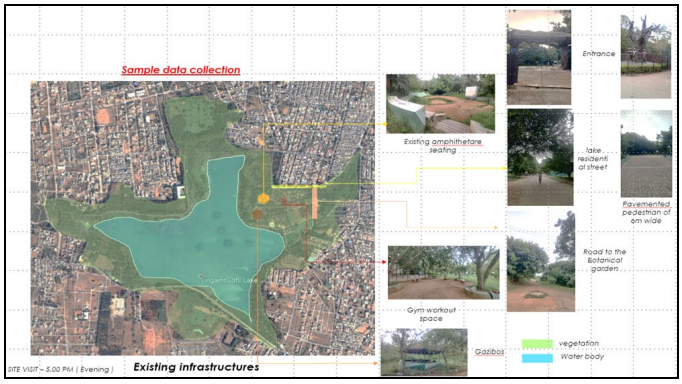
7. Existing Contextual Analysis of Lake (Study Precinct)



Source: *Generated and compiled by the author through Google earth pro and site visit*

Fig 25: Documentation of the lake

The lake consist of the 4 small islands in the middle of the lake biodiversity which is the home for bird seasonal migration. Some paths consist of the botanical nomenclature of flora and fauna. Medicinal plantations also seen inside park. Signage boards needs to be added to for better pathways connections



Source: *Generated and compiled by the author through Google earth pro and site visit*

Fig 26: Sample data collection of the lake

The existing infrastructures are OAT, gym working, Kids play area, Gazebo, predestined and pavement main entrance of the lake. The infrastructures needs to be maintained for better working.

Source: *Generated and Compiled by the author through Google earth pro and site visit*

Fig 27: Services of the lake

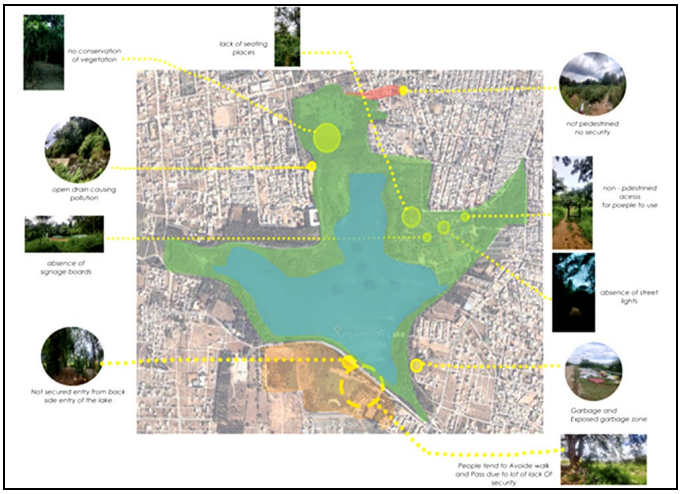
In between the premises of the lake there are solar panelled street lights for as sustainable energy conservation in the park. Drainage line is running inside the lake drinking water and public toilet is planned inside the lake near the main entrance of the lake.

Source: *Generated and compiled by the author through Google earth pro and site visit*

Fig 28: Pedestrian pathways of the lake

In between the premises of the lake there are solar panelled street lights for as sustainable energy conservation in the park. Drainage line is running inside the lake drinking water and public toilet is planned inside the lake near the main entrance of the lake. Maintaining the landscaping is crucial to have better pavement pedestrians

8. Analysis



Source: *Generated and Compiled by the author through Google earth pro and site visit*

Fig 29: Key Issue Mapping

Negative impact of urbanization is causing urban lake to shrink their size and lake existence is at risk in many urban areas. Master plans/Development plans have failed to address the issues of lakes and water bodies. Urban lake treated merely just as one of the land use

- Non pedestrianized pathways for walking/jogging
- Lack of maintenance of Gym equipment
- Absence of signage boards along the access points
- Insufficient of seating benches for the public
- Landscape design formulations
- Infrastructure needed to be added inside the premises of the lake Public toilet, extra kids play area, streetlights, meditation chamber, public toilet

a) Key Concerns about Planning System of the Lake

Pollution Leading to the Disturbance inside the Lake Biodiversity

Water Pollution:-Eutrophication: Excess nutrients from sewage can trigger algal blooms, depleting oxygen levels in water bodies and causing fish kills.

Pathogen Contamination: Bacteria and viruses present in untreated sewage can cause waterborne diseases like diarrhoea and cholera if ingested

Source: *Google*

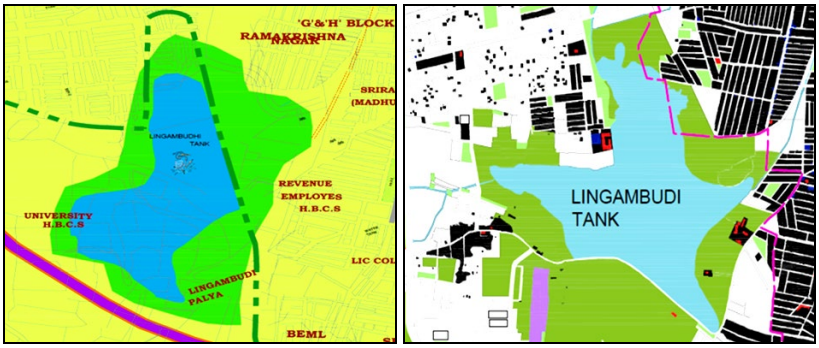
Fig 30: Storm drain clogging

Industrial Waste: Industrial effluents containing harmful chemicals entering the lake ecosystemIndustrial waste discharge can cause significant environmental problems including water pollution, contamination of soil and groundwater, harm to aquatic life, and potential health risks to humans due to the presence of toxic chemicals like heavy metals, which can enter the food chain if untreated wastewater is released into water bodies used for drinking or agriculture

Source: *Google*

Fig 31: Garbage throw on the street

Encroachment of the Lands



Source: *Faculty, SPA UOM*

Fig 32: CAD drawing of Lake Precinct, 1995 **Fig 33:** CAD drawing of Lake Precinct, 2009

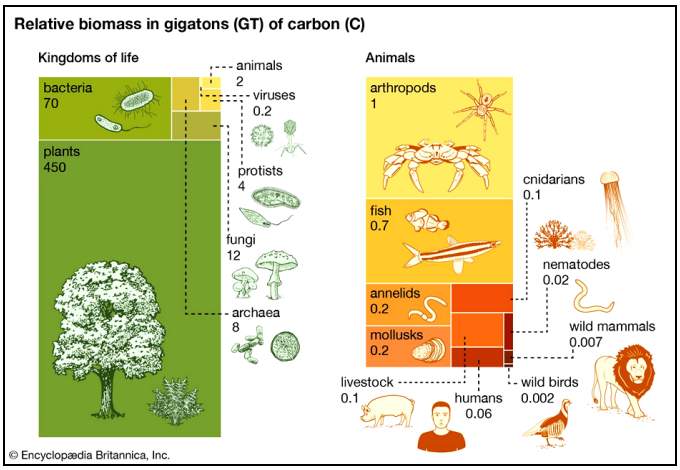
In the above figure, there is reduce in the green cover from 1995 lake precinct to 2009 lake precinct encroachments cause impacts to the functions and values of those natural areas, such as a decline in water quality, loss of habitat (both aquatic and terrestrial), disruption of equilibrium (or naturally stable) conditions, loss of flood attenuation, or reduction of ecological processes.

"Poor Lake Shore Management" due to a lack of proper practices and regulations along a lake's shoreline, leading to detrimental effects like erosion, pollution, habitat destruction, and overall decline in the lake's ecosystem health, often caused by activities like excessive development, improper vegetation removal, lack of buffer zones, and inadequate storm water runoff management.

Source: *Google*

Fig 34: Stagnation of drainage

b) Key Concerns about Ecological Diversity of the Lake Biodiversity Loss



Source: *Google (The Editors of Encyclopedia Britannica)*

Fig 35: Bio diversity loss index

Biodiversity loss, a decrease in biodiversity within a species, an ecosystem, a given geographic area, or Earth as a whole. Biodiversity, or biological diversity, is a term that refers to the number of genes, species, individual organisms within a given species, and biological communities within a defined geographic area, ranging from the smallest ecosystem to the global biosphere. (A biological community is an interacting group of various species in a common location.)

Likewise, biodiversity loss describes the decline in the number, genetic variability, and variety of species, and the biological communities in a given area.

This loss in the variety of life can lead to a breakdown in the functioning of the ecosystem where decline has happened.

Biodiversity loss by destroying or fragmenting natural habitats, which can lead to a decline in the richness and abundance of native species:

- **Habitat Destruction:** Urbanization can destroy natural environments where plants, wildlife, and other organisms live.
- **Habitat Fragmentation:** Urban expansion can fragment habitats into smaller, isolated patches.

Unsuitable Landscaping Practices: Improper vegetation management on the shoreline leading to erosion and nutrient loading. (Like over fishing, human wastes, industrial wastes)

Decline of Bird Species

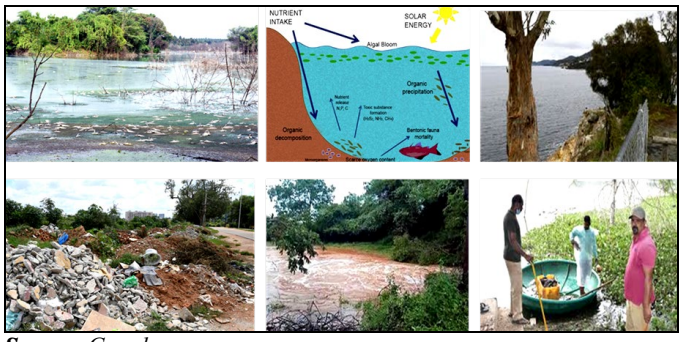
The current environmental condition assessment of the Lake and its environs based on field observations, discloses that the Lake continue to be constrained by following problems opinions Manjunath Sadashiva in 2007. In the Interview-Star of Mysore news paper

- Decreased freshwater inflow
- Sewage inflow and Eutrophication
- Absence of proper fencing
- Dumping of building debris and garbage
- Unscientific forestation
- Fishing activity

- **Human Activities**

Erosion is influenced by many factors ranging from natural causes such as weather to human activities like urban development and excess recreation. The loss of vegetation and trees, natural topography and tectonic activity, and stormwater runoff are common contributing factors to lake erosion

Urban development, excess recreation, and improper drainage systems can all accelerate erosion



Source: *Google*

Fig 36: Human activities violating the health and hygiene

- **Nutrient Pollution**

Excess nutrients like nitrogen and phosphorus from fertilizers can trigger algal blooms, depleting oxygen levels and harming other aquatic life.

Excess nutrients like nitrogen and phosphorus from fertilizers can trigger algal blooms, depleting oxygen levels and harming other aquatic life.

Source: *Google*

Fig 37: Depletion of the water nutrients

- **Sedimentation**

Erosion from land development can lead to sediment buildup in lakes, impacting water clarity and affecting benthic organisms.

Reduced Light Penetration: High sediment levels cloud the water, hindering photosynthesis by aquatic plants.

Smothering of Benthic Organisms: Sediment settling on the lakebed can suffocate bottom-dwelling organisms.

Fish Egg Mortality: Sediment deposition can

Source: *Google*

Fig 38: Erosion of land

Bury and suffocate fish eggs. Reduced water clarity: The presence of suspended sediments can make the water appear cloudy and murky

- **Invasive Species**

Non-native species introduced to a lake can outcompete native species for food and resources, disrupting the food web.

Floating Pennywort this aquatic weed can grow up to 20 cm a day and form dense mats across water bodies. Infamous Great Lakes invaders include the Sea Lamprey, Zebra and Quagga Mussels, Round Goby, and Phragmites. Invasive species are significant and immediate threats to the ecosystems and economies of the Great Lakes basin

Source: *Google Study reveals the Great Lakes' top 10 most harmful invasive species By Shealyn Paulis*

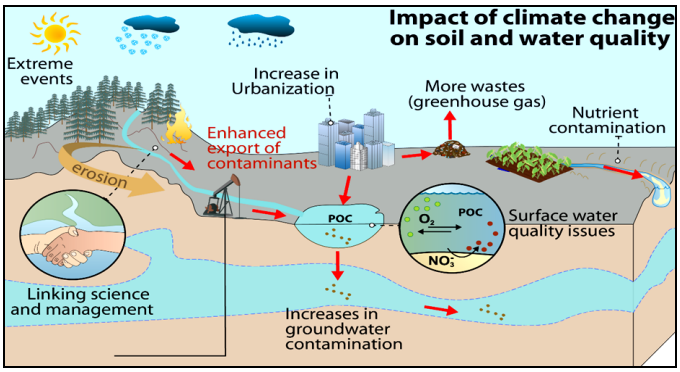
Fig 39: Invasive species evading the lake

- **Climate Change**

Rising temperatures can lead to altered lake stratification, impacting oxygen levels and species distribution.

Chemical Contamination and Acidification: Rainwater containing high levels of sulfur dioxide can acidify lakes, impacting aquatic life. Industrial waste and certain pesticides can directly poison aquatic organisms.

Climate change is expected to affect or already affecting how water moves above and below the ground and everything that moves with water.



Source: *Google Engineered Critical Zone Laboratory Engineering and Science for Sustainable Water Resource Management*

Fig 40: Impact of the urbanization polluting the water bodies

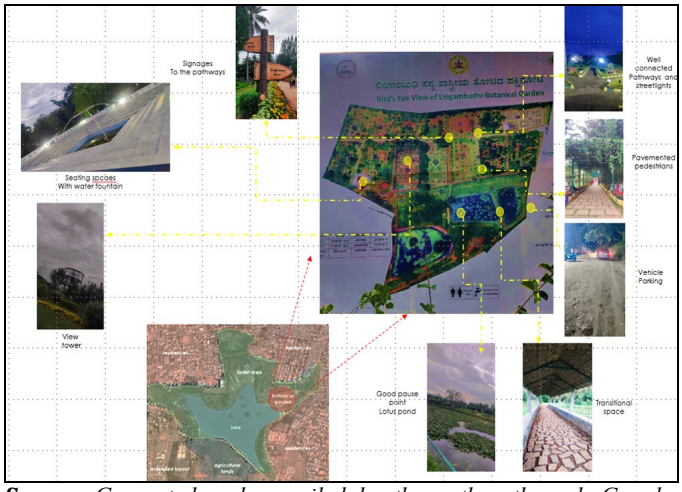
Some areas are predicted to receive less rainfall, drier climate, frequent freeze-thaw cycle, while other areas are going to receive higher precipitation than historic normal (see the picture above). Consequently, these changes would affect the water balance in many regions. Because a balance of water cycle is necessary to maintain the supply of nutrients, elements, and trace elements to all life forms and help in natural dissipation and degradation of contaminants, a disruption of the water cycle during climate change is expected to affect these processes. This makes it difficult to achieving global sustainability at local and global scale.

9. Live Case Study – Lingambudhi Botanical Garden (A Contextual Study Reference for Redesigning the Lingambudhi Park)

Contextual study is done to get inferences from the landscape that's been design by the horticulture department of Mysore, beside the Lingambudhi Park. 11 years after it was first proposed, Mysuru city's first Botanical Garden was open for visitors and tourists on Sept. 26, coinciding with the inauguration of Dasara-2022.

The idea of the Lingambudhi Botanical Garden was floated in 2011 along the lines of the Lalbagh Botanical Garden and the famed Botanical Garden at Ooty and the wait is finally over.

The Botanical Garden has been developed on a 15-acre plot with an estimated budget of Rs. 4 crore. The garden was first inaugurated on Sept. 26, 2024 symbolically during the inauguration of the Dasara Flower Show at Kuppanna Park. On Sept. 27, Horticulture Minister N. Munirathna will visit the Botanical Garden," Horticulture Department Deputy Director Rudresh told Star of Mysore.



Source: *Generated and compiled by the author through Google earth pro and site visit*

Fig 41: Live case study showing the landscape design in master plan

Garden, attracts birds from far and wide. It has over 300 varieties of plants and medicinal plants too. The Botanical Garden has been developed in such a way that it will emerge as a natural study centre for Botanists, Zoology students and others who have keen interest in natural resources,

Over 300 different plant species made an entry and the Garden now is dedicated to the collection, acclimatisation, conservation, multiplication and display of a wide range of indigenous and exotic plant species.

The Botanical Garden has been laid out with themes including medicinal and aromatic garden, rose garden, topiary garden, butterfly garden, bamboo block, ficus block, rockery, arboretum, fragrance block, palmatum, minor fruits block and well-maintained water pools to attract aqua birds.

Indigenous Tree Species

Over 26 indigenous tree species have been grown here like the large-flowered bay tree, Krishna siris, black varnish tree, Karen wood, marking nut tree, hiptage, weeping bottle brush, red bottle brush, orange climber, stone apple and many more. Also, one can see here that a lot of space has been provided for the conservation of end angered tree species like albizia, Indian bael, red sanders and other endangered species

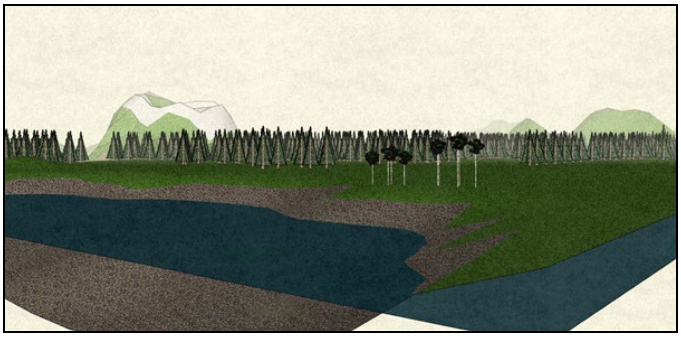
Source: *Photos compiled by the author through site visit*

Fig 42: Water fountain

The trees surrounding the small ponds by the side of the Lake act as dovecot for migratory birds for breeding. Over 5-6 very rare varieties of lotus are grown here. The Pergola inside the Garden provides partial shelter and shade for the pathway. Beautiful red jade vines spread across the pergola and the vine blooms twice a year. Rose garden, topiary-The rose garden has 80 varieties of roses that display different colours and shapes. The beauty is enhanced by miniature roses, standard roses and hybrid roses.

10. Strategies/Proposal

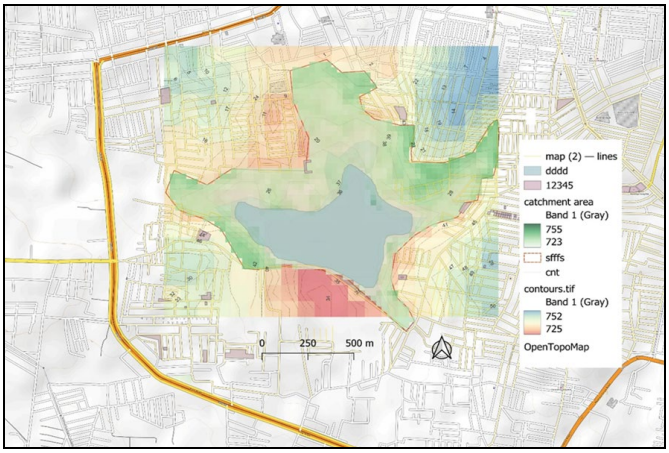
a) Ecological Conservation Strategies



Source: *Generated, designed and complied by the author through and sketch up model*

Fig 43: 3d sketch up model showing the visualization of the lake

Lake conservation is the process of managing and restoring lakes to ensure their long-term sustainability.



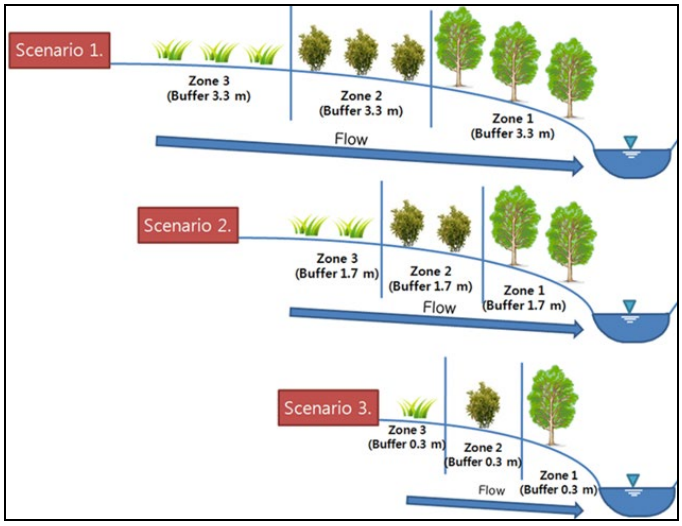
Source: *Generated and compiled by the author through QGIS*

Fig 44: Overlaying of the blue green network with surrounding Lake Precinct

Strict Regulations: Implementing zoning laws to protect lake shorelines and buffer zones to keep

Integrated Watershed Management: Addressing land use practices within the lake's catchment area.

Three riparian buffer scenarios to evaluate water quality improvement.



Source-*enhancement of SWAT-REMM System to Analyse Reduction Characteristics of Nonpoint Source Pollution with Various Riparian Buffer System Scenario*

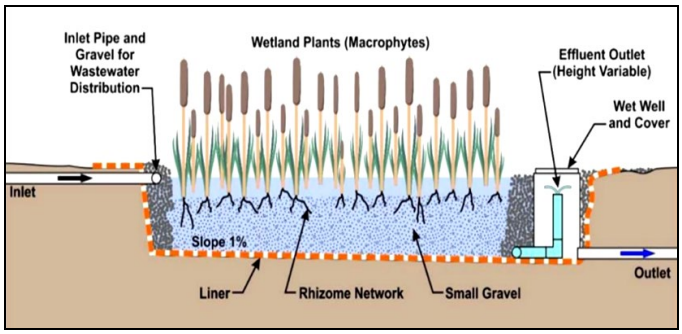
Fig 45: Buffer zones giving in the different levels of the vegetation

Storm Water Management Systems: Implementing strategies to capture and treat storm water runoff before it reaches the lake.

Enhanced grass swales feature check dams that temporarily pond run-off to increase pollutant retention and infiltration and decrease flow velocity

Source: *Google*

Fig 46: Storm water collecting pits



Source Google: *Nature Environment and Pollution Technology An International Quarterly Scientific Journal*

Fig 47: Rhizobium plantation helps in observing the water

Constructed Wetlands

There are designed storm water wetlands to reduce flood peaks, improve the water quality of surface run-off, and restore part of the city's natural habitat and birdlife, in addition to artificial wetlands (e.g., horizontal flow) for wastewater treatment

Source: *Google Ecosystem Restoration: A Replicable Model*

Fig 48: Man made wetlands

Rainwater Harvesting: Installing rainwater harvesting systems to help conserve water percolation trenches and small ponds were created.

Buffer Zones: Creating buffer zones around lakes

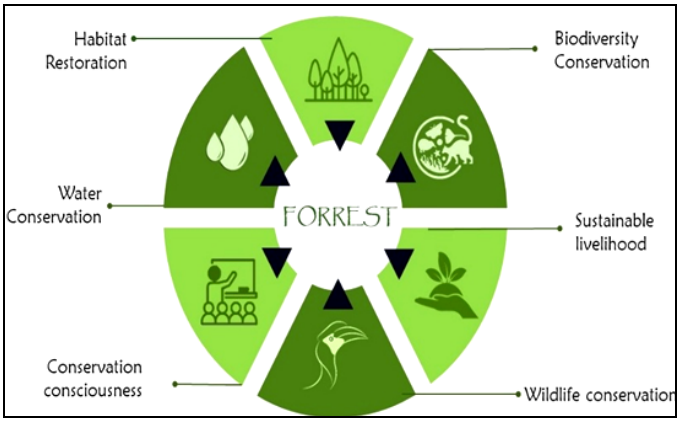
Technology: Using advanced technologies like floating treatment islands, wetland development, and bio-remediation to improve water quality

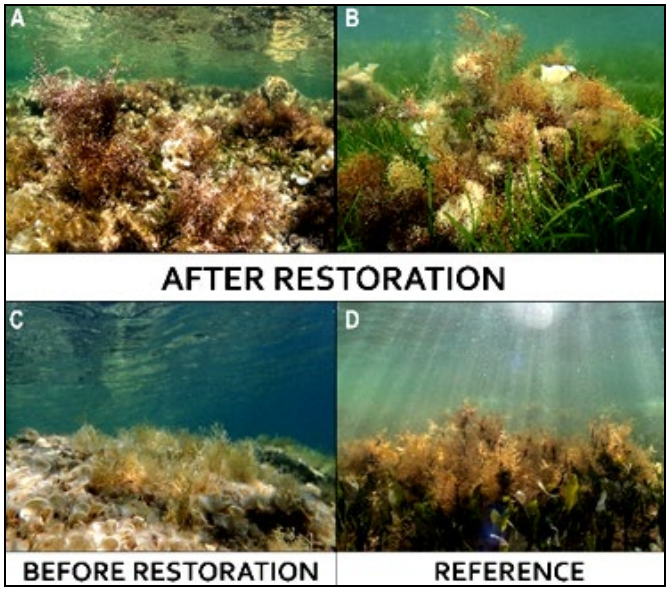
Restoration: Restoring lakes to address the problems caused by pollutants

Reintroduction of Native Species: Reintroducing native flora and fauna to lake

Public Awareness Campaigns: Educating communities about the importance of lake conservation and responsible behaviors.

Lake Restoration Projects: Implementing measures to improve water quality, such as sediment removal and aquatic plant management.





Source: *Google Ecosystem Restoration: A Replicable Model*

Fig 49: Before and after restoration of the aquatic ecosystem

Some ecosystems have traditionally been more actively restored than others (e.g., terrestrial forests and grasslands) and several years of practice have determined what characterizes successful restoration. In general, vegetation structure, species diversity, and ecosystem functions have been suggested as the three key attributes to assess restoration outcomes (Ruiz-Jaen & Aide, 2005; Wortley *et al*., 2013).

However, while the trajectory of vegetation structure (e.g., vegetation cover, density, and biomass) and species diversity (e.g., richness and abundance) following restoration is well understood, knowledge regarding the recovery effect on ecosystem functions is still limited (Brudvig, 2011; Kollmann *et al*., 2016)

Bio-fencing

Fencing: Fencing around lakes to prevent land encroachment, garbage dumping, and loss of wetland area

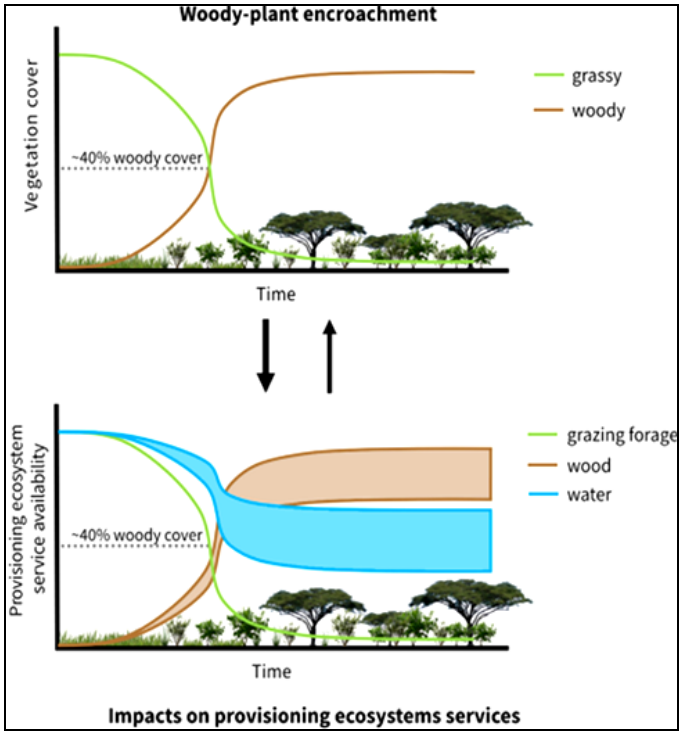
A series of earthen bunds with vegetation that can protect wetland ecosystems and wildlife habitats. Vegetation buffers can improve water quality, flood resiliency, and the biodiversity of the area can benefit farmers by improving irrigation efficiency and water storage capacity

Source Google: *Ecosystem Restoration: A Replicable Model*

Fig 50: Natural creepers acting as the fencing

Woody Encroachment

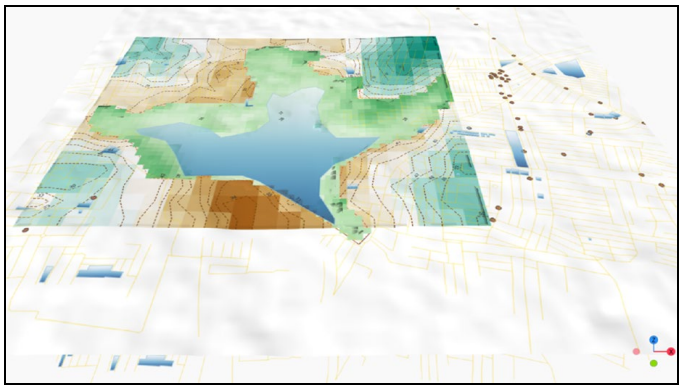
Conceptual model of woody-plant encroachment impacts on provisioning ecosystem services. As shown along the x-axis of time, woody-plant encroachment tends to transition from high grass and low shrub or tree (representing woody plants) cover to low grass cover and high shrub or tree cover. Grass biomass changes are the most certain, while changes in suitable wood and water availability are less certain and are therefore shown with variable responses in shaded lines. While woody-plant encroachment impacts provisioning ES, the potential for marginal feedbacks exist (shown with arrows). For example, increased grazing pressure on diminishing grass biomass will further drive shifts from a grass- to wood-dominated ecosystem



Source: *Nature-reliant, low-income households face the highest rates of woody-plant encroachment in South Africa*

Fig 51: Woody-plant encroachment

Desilting of lake



Source: *Generated and compiled by the author through QGIS*

Fig 52: Overlaying of the blue green network with surrounding Lake Precinct topo model

Desilting is a process that removes sediment, silt, and debris from the bottom of lakes, rivers, canals, ponds, and reservoirs. It's a type of dredging that helps restore the water body's original capacity and depth, and improve water flow. Desilting is important for the health and functionality of water bodies, and for a number of reasons,

Water Availability: Desilting helps ensure that water is available for drinking, agriculture, and industrial purposes.

Biodiversity: Desilting helps maintain water bodies at their optimal capacity, which supports biodiversity.

Flood Alleviation: Desilting can help mitigate issues related to sedimentation and flooding.

Source: *Google*

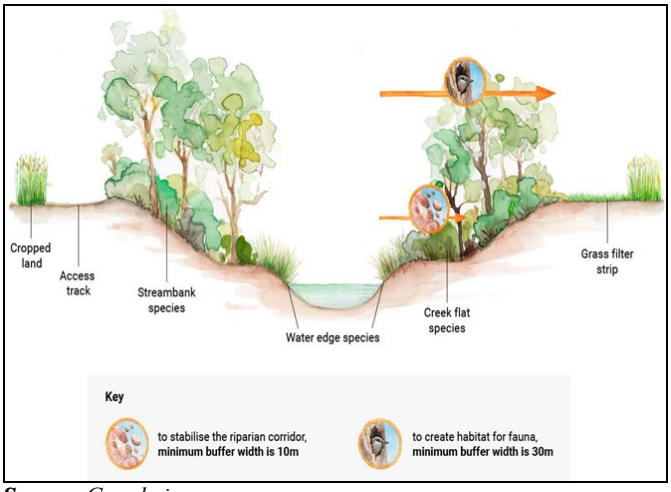
Fig 53: Desilting of Lake

Groundwater Recharge: Desilting can help recharge groundwater and increase the water table

Groundwater is the water present in spaces in soil or sands under the earth, or between cracks of rocks lying deep inside. The complete region of sands, soil, and semi-permeable rocks holding the groundwater is known as an aquifer.

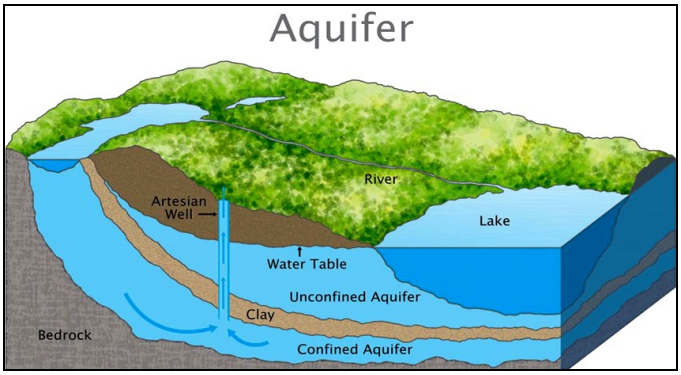
You'd have also heard the term water table. It's the topmost surface of the aquifer region as shown in the above diagram. The region just below the water table is called the water table aquifer or unconfined aquifer or phreatic aquifer. The unconfined aquifers are those where water from the surface can directly seep into the aquifer.

The confined aquifer is the aquifer region where a layer of impermeable soil, rock or clay is present preventing the direct influx of water from ground surface.



Source: *Google image*

Fig 54: Ground water recharge pits



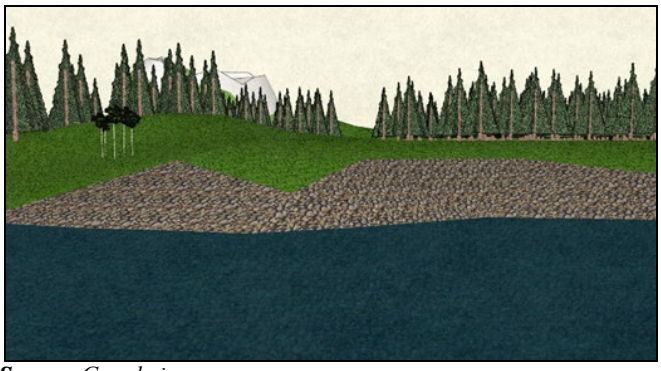
Source: *Google image*

Fig 55: Aquifer process inside the depth water layers

Groundwater recharge happens mainly through

i). Naturally through rain

Water from rainwater and snow melt can directly fill the aquifer-unconfined from the areas of high altitudes having openings to the unconfined aquifer.



Source: *Google image*

Fig 56: Digital model elevation the lake

ii). Rivers and Lakes

Water from rivers and lake can also contribute to groundwater recharge but marg3. Wetlands wetland is an area flooded with water where a number of aquatic plants and other species thrive. The groundwater recharge mainly occurs at the soil present around the edges of the wetland. Although the soil under most wetlands is impermeable, small area wetlands, where perimeter to volume ratio is high may contribute to recharge groundwater.

iii). Depression Focused Recharge

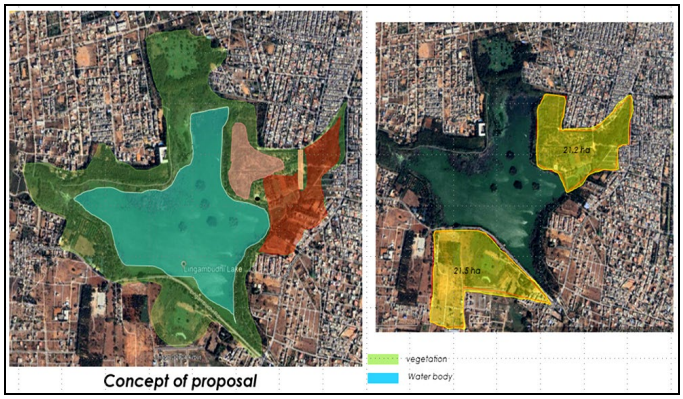
There's the term called "Field Capacity" in groundwater recharge, which is defined as the amount of water the land or soil can hold after the excess water fell due to rain is drained out. If the water present on the ground doesn't exceed the field capacity of the area, then a little amount of water infiltrates into the groundwater. However, if water gets collected in low lying areas, it exceeds the field capacity of the land and percolates through the ground surface recharging the aquifer

b) Planning and Design Considerations

Sample Survey (Secondary Data Collection)

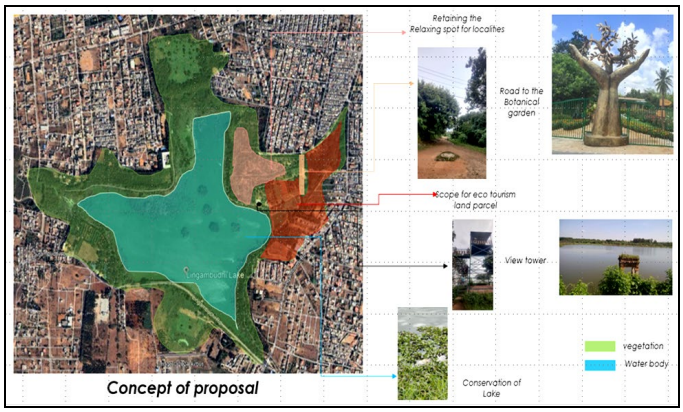
To understand the users end perspectives and needs and issues of the lake. This sample survey was conducted by one to one direct conversation and also the study the planning and designing needs for the users based on the survey done through frequent visits on different schedules

The conceptual proposals has been proposed to improve the quality of the infrastructures. The below red and brown area has been considered for the redesigning of spaces. Such as widening of pedestrians for jogging and running, conservation of aquatic habitat and increasing the security of the lake. Addressing the maintenance issues to give solutions for biodiversity loss of the lake.



Source: *Generated and complied by the author through Google earth pro and site visit*

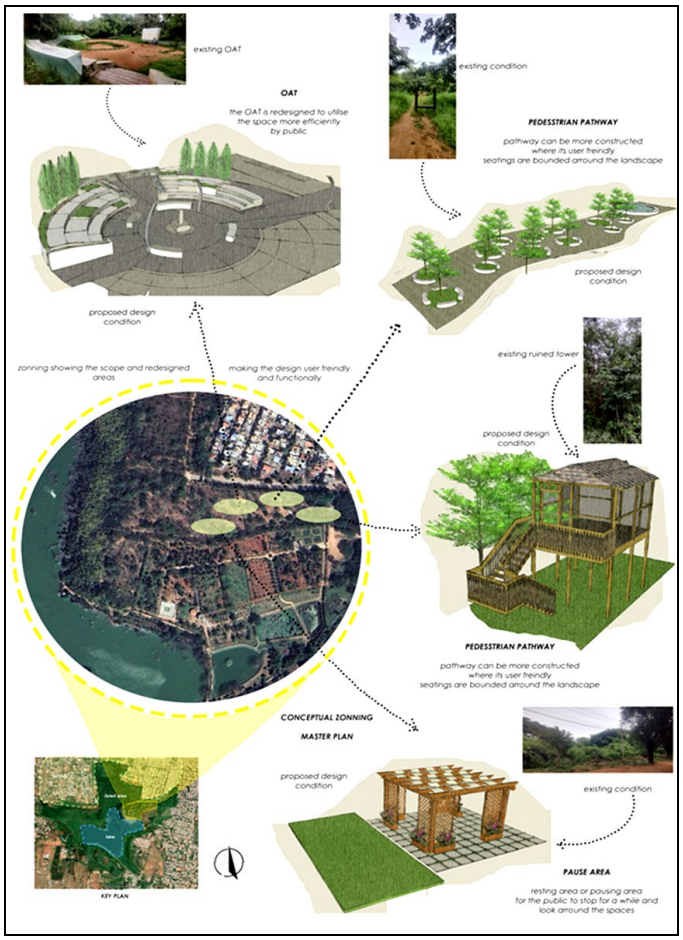
Fig 57: Land parcels highlighted to show the site taken to proposal of design



Source: *Compiled and generated by the author through Google earth pro and site visit*

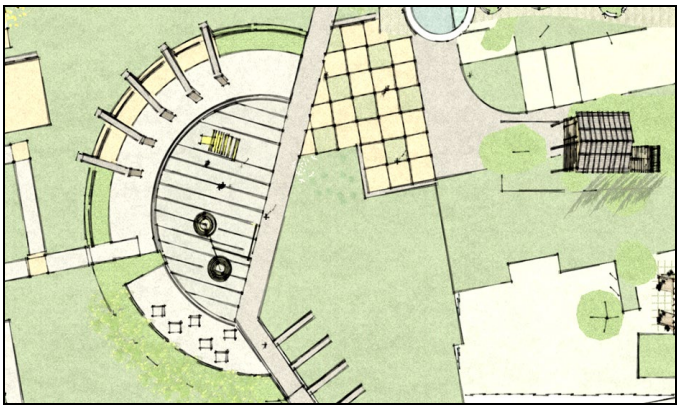
Fig 58: The elements having scope of redesign

Concept of Redesign Major Green Pockets



Source: *Generated, designed and complied by the author through Google earth pro and site visit and sketch up model*

Fig 59: Redesign of the lake development



Source: *Generated, designed and complied by the author through and sketch up model*

Fig 60: Conceptual Master Plan

The conceptual plan is too show the analysis how the better the public spaces can be designed and improve the quality of life and habitat within the lake premises

- Landscape was designed to the standards with concepts
- Transitional spaces connected to the multipurpose uses
- Pavement pedestrian pathways, Seating pause places
- Kids area/Playground area
- View point within the botanical park
- Signage boards for all pedestrian paths
- Connecting bridge two green spaces
- Water fountain with seating around for public gathering

Lingambudhi Lake to be conserved as Biodiversity Hotspot

Source: *Generated, designed and complied by the author through and sketch up model*

Fig 61: View showing the pathways and the pause areas inside the lake

The pause tower acting as the landmark within lake surrounded by natural landscape with recreated proposal of pergola gathering space to enhance the user experience

Source: *Generated, designed and complied by the author through and sketch up model*

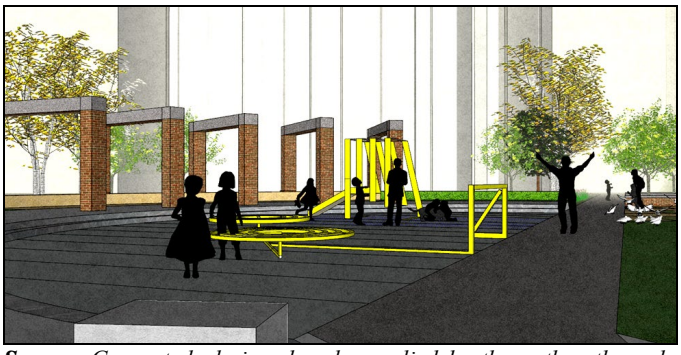
Fig 62: Seating spaces along the pedestrian pathways

Circular seat benches with elongated pavement pathways for the public

Source: *Generated, designed and complied by the author through and sketch up model*

Fig 63: People gathering area with the flourished landscape

Trees surrounded by the kids play area and retaining existing trees improve the breathing environment



Source: *Generated, designed and complied by the author through and sketch up model*

Fig 64: Kids play area

Pavement ground gives the sense of security for the kids to wander around and creating openness and sense of place in the urban ecosystem is most important for urban designers

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