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Major Causes of erosion and mitigation measures in Bangalore A study in the perspective of Bangalore

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Abstract-

Bangalore is one of India's fastest developing cities, known as the "Silicon Valley of India" for announcing and accelerating the country's IT-based sectors. Bangalore has developed into a worldwide metropolis that draws tourists as well as other industries in other sectors and enterprises from all over the world that accelerating the city's extraordinary economic and physical growth. Bangalore has seen unprecedented urbanisation and sprawl in recent decades as a result of concentrated development operations with a concentration on manufacturing for the region's economic prosperity.

Increased impermeable catchments result in higher catchment yield in less time, resulting in flood peaks that are up to three times higher than typical. Flooding happens more quickly due to the greater flow times. This involves engineering solutions and flood preparedness, as well as a grasp of the landscape's ecological and hydrological processes, as well as a variety of other factors in diverse Banglore areas. Our research includes a fact study and prediction analysis of significant records and data related to our research objective, which let us come to a conclusion on the principal causes of erosion in Banglore and mitigation methods.

Keywords-Bangalore Floods: What Causes Them and How to Prevent Them, The impact of growth on groundwater quality in Bangalore's Peenya industrial district - a case study, Banglore's lantic water bodies and ecological assessment, Banglore's integerated wetland ecosystem: a long-term solution to the city's water woes, Bangalore City's Rain Water Harvesting Initiative as a Case Study in Water Conservation in Urban Areas, Banglore's Mitigation Strategies.

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1. Hypothesis-

With a population of 10.4 million people, Bangalore is one of the fastest growing cities in Asia. Bangalore was established as major urban area in South India after the states of Karnataka, Tamil Nadu, Telangana, and Andhra Pradesh, as well as Kerala and Puduchery, were connected to Mumbai. The climate in Bangalore is tropical savanna with distinct wet and dry seasons. Bangalore's climate is often more temperate throughout the year due to its high elevation. In addition, the city is essential throughout the development of industrial corridors in India's southern states. Air pollution, flooding, hazardous waste disposal, and chaotic, nonscientific rubbish rescues are all major problems in the city. The study delves into Greater Bangalore's growth pattern and its implications for local climate as well as natural resources, necessitating appropriate strategies for long-term management. Major causes of erosion have stemmed from a lack of planning and enforcement. The key causes of erosion in Banglore are discussed in this report, as well as mitigation strategies.

2. Introduction-

Bangalore is the administrative, cultural, commercial, industrial, and knowledge hub of Karnataka. Greater Bangalore is a 741-square-kilometer territory that encompasses the city, its surrounding municipal governments, and outgrowths. Throughout the year, the climate in the city is pleasant and healthy. It is known as India's "Garden City" because of its tree-lined streets, numerous parks, and lush greenery. It's also known as the "Silicon Valley".

Flood mitigation in the urban context necessitates a combination of watershed land-use planning and regional development planning. This involves flood preparedness and engineering solutions, as well as an awareness of the landscape's ecological and hydrological functions. For our Research Objective to gain a thorough image of the key causes of erosion and mitigation techniques in Banglore in the several regions where we conducted our research, all of these issues must be presented in advance.

2.1.Bangalore's Vartur Lake has been impacted by heavy metal contamination-

The second largest lake in Bangalore is Varthur Lake. It is part of a system of interconnected tanks and canals, i.e. three chain of lakes fig 1. In the upstream joins Bellandur lake, which has a catchment area of about 148 square kilometers (14979 hectares), and the overflow of this lake flows into Varthur lake, from where it flows down the plateau and into the Pinakini river basin.

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As a result, all surface runoff, wastewater, and sewage from Bangalore South taluk end up in Varthur Lake. The lake's capacity for assimilation had been exceeded by pollution levels.

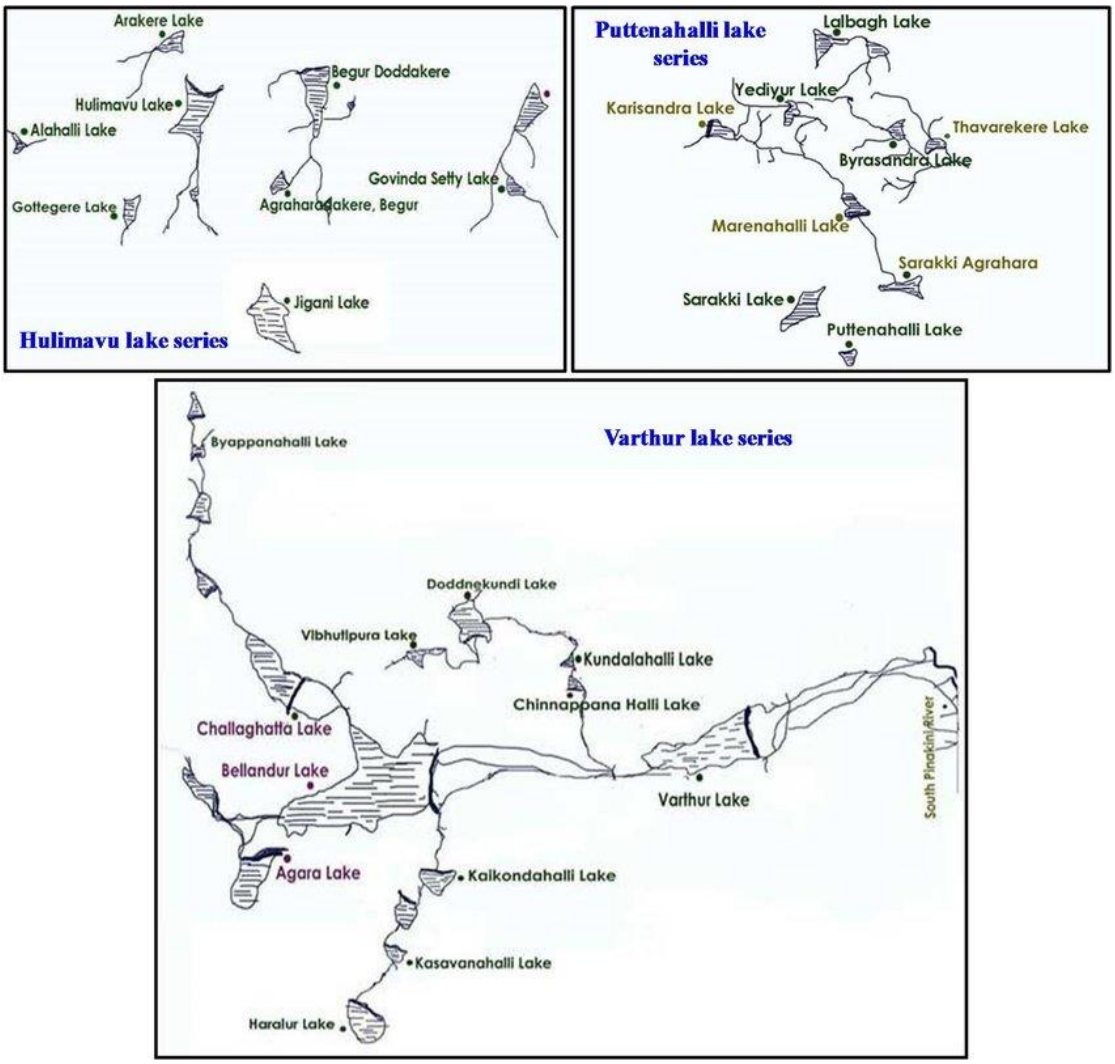

Fig1.Lakes in Kormangala-Challaghatta Valley(Interconnected chains)

Unscientific waste and pollution disposal in urban water bodies has wreaked havoc on human health and aquatic life. Cadmium, Cobalt, Chromium, Nickel, and Lead were all found to be in excess of drinking water limits in Vartur Lake in Bangalore. The lake's Sediment Geo-accumulation Index revealed moderate Manganese, Copper and lead contamination. This necessitates taking prompt action to carry out the essential environmental mitigation measures for the lake see fig2.

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Fig2. At Vartur Lake in Bangluru, there are hazardous water bodies.

According to the water quality analysis, Varthur is severely polluted/enriched with nutrients, with a high organic load, increased organic matter decomposition, oxygen depletion, and macrophytes cover.

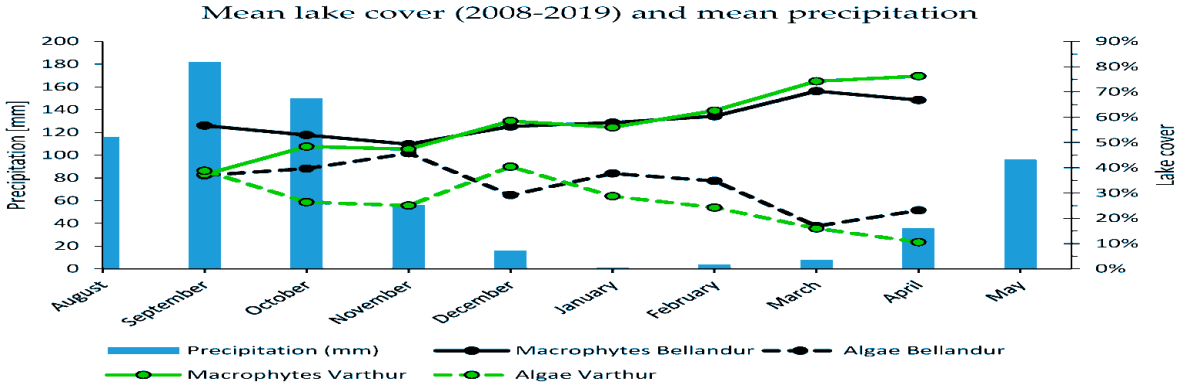

Fig3. A Remote Sensing Analysis of Bellandur and Varthur Wetlands.

2.2.Traditional coffee growers in Bangalore's perceptions on climate variability and mitigation strategies-

Growers noticed a rise in temperature, a delay in monsoon commencement, and an unpredictable pattern in rainfall distribution. Long-term weather data from the district backed with these qualitative judgments. The majority of agronomic management interventions and crop diversity are used by growers to respond to climate unpredictability. Moreover, a small number of coffee farmers use off-farm revenue diversification. According to the results of an ordered probit model,

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whereas acreage under coffee and crop diversification have a negative impact. Understanding these perceptions aids in the development of synergistic adaptation strategies and the implementation of long-term mitigation measures to lessen the coffee sector's vulnerability, particularly the livelihood security of small coffee growers in Banglore as shown in fig 4.

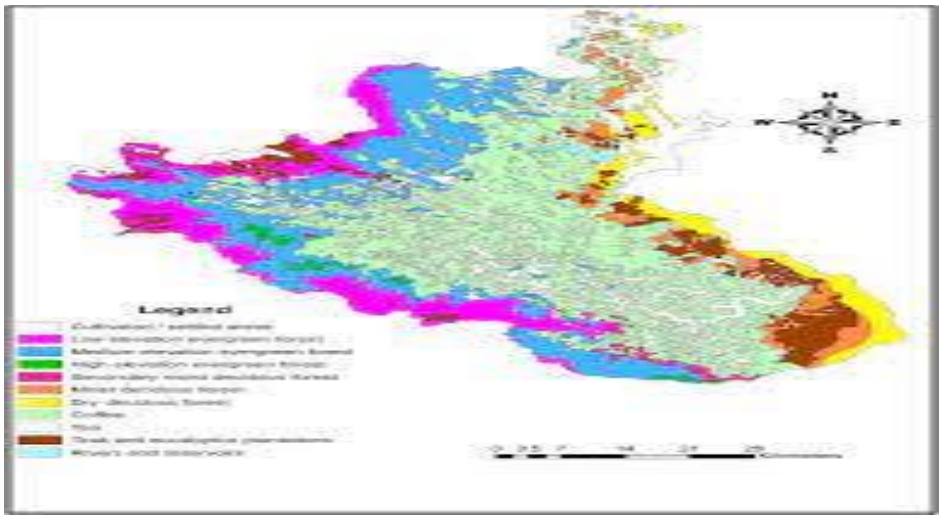

Fig4. Traditional coffee growers in Bangalore's perceptions and strategies

2.3.A case study of a banglore-based mobile application for municipal garbage monitoring-

Bangalore is a city with a one-of-a-kind solid waste management problem. Despite significant progress in garbage collection and segregation, only 20% of waste is still picked or is picked in an irregular manner. Bangalore has created the Public Affair Centre Garbage Tracker app, which employs citizen science and visual mapping to highlight the numerous problems ailing the city's waste collection system. The pilot operation, which took place in four wards, brought to light the problems that arise at each collection location. These issues were tracked for 9 months, revealing inconsistent garbage collection, non–segregation of waste, inconvenience caused during collection, and non–compliance with waste transportation using a bottom–up approach.

2.4.Chikkabettahalli Lake in Banglore is a case study-

2.5.

Chikkabettahalli Lake is in the Adityanagar neighbourhood of Greater Bengaluru, Karnataka. Greater Bangalore has a pleasant climate throughout the year, with summer temperatures ranging from 18°C to 38°C and winter temperatures ranging from 12°C to 25°C.

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Fig6. Threats faced by Chikkabettahalli Lake

Water samples were taken from the lake's inlet and outlet in November 2014. During the sampling process, water temperature, pH, electrical conductivity, and dissolved oxygen were all determined on the spot. Other elements to consider are nitrate, orthophosphate, total alkalinity, calcium and magnesium hardness, total hardness, chlorides, chemical oxygen demand, sodium, and potassium (see figs 7 and 8).

Fig7.

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Fig8.Water Sampling Sites

3. Related Works-

3.1.Bangalore Floods: What Causes Them and How to Prevent Them-

The rise in impervious surface associated with high-density urban growth in the catchment, as well as the loss of wetlands and vegetation, has resulted in frequent floods in Bangalore (since 2000, even during regular rainfall). This is in addition to the narrowing and concreting of storm water drains, the lack of appropriate drainage maintenance works with the changes in enhanced run-offs, the encroachment and filling in of the floodplain on the waterways, obstruction by sewer pipes, manholes, and relevant structures, deposits of building materials and solid wastes with subsequent blockage of culverts, and the encroachment and filling in of the floodplain on the waterways (bridge and culverts). Illegal developments have narrowed the streams and filled up the floodplain as a result of a lack of planning and enforcement. The revenue map of Jakkasandra village, which is located upstream of Bellanduru Lake is shown in fig 9.

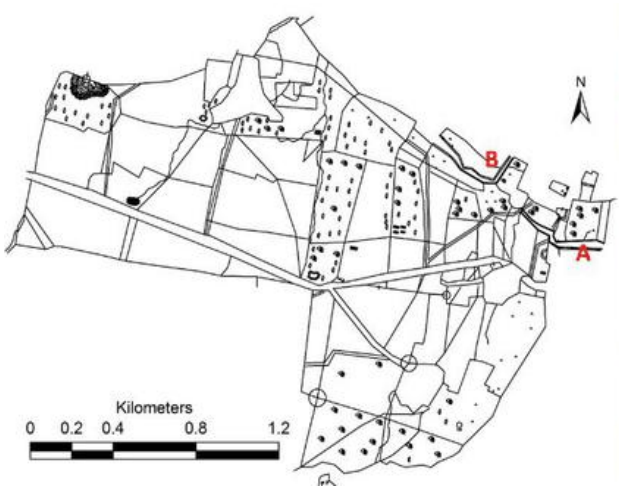

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Fig9. Jakkasandra Village map

Causes-

- Loss of lake interconnection owing to drain encroachment or solid waste dumping, Construction and Demolition wastes.
- Lakes are being de-notified, while flood plains and wetlands are being encroached upon.
- Narrowing and concretizing storm water drains reduces the natural drains' hydrological functioning.
- Decreased open space, wetlands, and vegetation cover due to loss of pervious areas

Prevention-

- Remove any barriers between lakes to reestablish interconnectivity
- Protect Valley Zones and Wetland Buffer Zones: Valley zones should be protected because of their biological role, and these areas should be designated as "NO DEVELOPMENT ZONES."
- Do not limit or concretize natural drains.
- Banglore should be decongested.

3.2. The impact of growth on groundwater quality in Bangalore's Peenya industrial district - a case study-

Rapid industrialization, which has recently become a pressing need for a rising country like India, has become a major source of groundwater contamination. Massive pollution inputs have pushed pollution levels past the environment's absorption capacity. The industries that release pollutants into groundwater resources as a result of their operations do not strictly regulate their pollutants to ensure that they do not exceed safe levels. The majority of companies release their effluents into neighboring open pits or into unlined channels that flow towards low-lying soil depressions, contaminating groundwater. If not properly handled and regulated, industrial effluents can pollute and harm groundwater resources.

Bangalore is considered the fastest growing metropolis in Southeast Asia. This expansion has taken a toll on the city's geological resources, the most important of which is groundwater. Because surface water supplies are no longer sufficient to meet the city's needs, groundwater

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becomes the only other source of high-quality water. However, groundwater contamination is an issue in some parts of the city, particularly in the industrial belts like Peenya Industrial Area.

In Peenya Industrial Area, More than 2100 enterprises, mostly in the chemical, leather, pharmaceutical, plating, and associated industries, occupy a 40-square-kilometer area in Bangalore's northern outskirts.

Fig10. The industrial sector of Bangluru's Peenya has been choked.

3.3. Banglore's lantic water bodies and ecological assessment-

A full grasp of what defines a healthy ecosystem is required for water resource restoration, conservation, and management. Monitoring and assessment give the foundational data on the state of our water bodies.

The Chamarajasagar reservoir is located on the outskirts of Bangalore, surrounded by agricultural and forest area, and serves as a source of drinking water for the city. Madiwala Lake, on the other hand, is located in the centre of Bangalore, and it receives pollution from both home and industrial effluent. The major physico–chemical and biological characteristics were used to assess the surface water quality of both. Temperature, transparency, pH, electrical conductivity, dissolved oxygen, alkalinity, total hardness, calcium hardness, magnesium hardness, nitrates, phosphates, sodium, potassium, and COD data of the specified waterbody were included in the physico-chemical studies. Except for the pH values, which suggest more alkalinity, the extensive analyses of the parameters in Chamarajasagar reservoir show that it is relatively unpolluted. Natural causes and agricultural runoff from the basin can both be blamed for this. The influx of

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sewage, on the other hand, has a substantial impact on the limnology of Madiwala Lake, contributing significantly to the dissolved solids, total hardness, alkalinity, and low DO levels.

3.4. Banglore's integrated wetland ecosystem: a long-term solution to the city's water woes-

Wetlands are a diverse group of aquatic environments that include marsh, fen, peat land/open water, flowing water, and static water. These ecosystems, which are located at the crossroads of land and water, are ecologically significant in terms of a region's stability and biodiversity, as well as energy and material flow. These ecosystems are aptly referred to the "kidneys of the landscapes" because they play an important role in nutrient uptake and bioremediation of heavy metals, volatile organic chemicals, and other xenobiotic substances. They also assist in groundwater recharge and shoreline stabilization. These transnational zones or ecotonal regions support food chains and are home to a diverse range of species. Wetlands act like huge sponges, delaying runoff, lowering flood levels, and reducing coastal and stream bank erosion.

Wetlands are ecological barometers that reflect the health of a region by providing ecosystem services such as controlling regional microclimates and replenishing ground-water aquifers, all of which have an impact on the lives of those who live nearby.

The city of Banglore is built on two mountains with three watersheds. The city's northern and eastern parts have mild slopes, whereas the city's southern and western parts have relatively harsh undulating terrain. The region's undulating landscape has aided in the formation of interconnected water bodies to suit domestic and irrigation needs during the pre-colonial period. Banglore's growing population has resulted in a massive influx of sewage into a wetland, contaminating the wetlands and groundwater system in the area.

3.5. Bangalore City's Rain Water Harvesting Initiative as a Case Study in Water Conservation in Urban Areas-

Urbanization and its repercussions are difficult to manage because they place more demands on infrastructure, particularly for vital services such as water, sanitation, transportation, and housing. Given the current water problem, water collecting can be beneficial in various ways. Rain water harvesting enhances water access and availability. In addition to improving the availability and quality of ground water, RWH aids in the reduction of floods. It lowers reliance on a steady supply of water, eliminates soil erosion and enhances soil quality, and revitalizes defunct wells/bore wells by recharging ground water.

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Rainwater harvesting can be divided into two categories: (1) surface storage and (2) ground water recharge.

3.6. Banglore's Mitigation Strategies-

Some of the most important mitigating strategies in Banglore to protect and reduce the socio-environmental impact are listed below. Because these elements are so intertwined, any envirnmental mitigation action that affects one has an impact on the others.

- In situ moisture conservation, rainfall collecting and recycling, efficient irrigation water usage, conservation agriculture, agricultural energy efficiency, and the use of low-quality water are all vital technologies.
- Watershed management is now widely recognized as a viable technique for rain fed agriculture growth. Many elements of the watershed approach contribute to mitigation efforts.
- Carbon sequestration is aided by the planting of multipurpose trees on degraded soil. At the landscape level, crop and soil management strategies can be modified to reduce pollution.
- Rainwater collecting and conservation are the most effective mitigation techniques.

4. Methodology-

This research is based on the major causes of erosion in Bangalore and mitigating measures. Several literature evaluations and fact assessments have been made available to the general public all over the world. We gathered relevant material that supports or contradicts the items specified in the research's Introduction Section, and then conducted our analysis based on the background study. The following are some of the areas of research that we're looking into:

- What are the major causes of erosion in the region of Banglore?
- What are the strategies to mitigate it?

5. Study Area and Data Collection-

For the aim of observation and analysis in this research on Major causes of erosion and mitigation methods in Bangalore, we gathered important information from Government and Authorized Agency portals that were made available for public use. To understand more about the themes, we met with experts, journalists, and institutes working on key studies/activities on climate change, landscapes, drainage, soil, waterfalls, prospects, and difficulties. We also suggested a number of online academic, research-based libraries to help deepen and evaluate the knowledge.

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As a result, facts, statistics, and information are acquired from reputable official portals, research/survey/journal references in this field, opinion polls, and review reports formally provided by relevant agencies/institutions/functioning bodies/research organizations.

Data/information is being collected till 2021 with the objective of observing trade and political shifts or developments in the world's main countries. The reliability of this data/information is validated using the credentials and methods mentioned in those information sources, and it is extensively checked to verify that it does not contain any contradictory or misleading facts that could jeopardize social, political, or economic stability.

6. Finding and Conclusion-

With all due regard to its standing as a 'Silicon Valley' and 'Garden City,' Bangalore confronts significant hurdles in addressing and delivering basic infrastructure and services to all of its stakeholders. Despite numerous initiatives and activities anticipated by previous and present urban local bodies, as well as parastatal bodies, the rationalization of geographical units for these activities could signal the start of a coordinated effort in meeting the city's demands.

The loss of lakes as a result of urbanization has resulted in a decline in watershed yield, water storage capacity, wetland area, migrating bird numbers, flora and fauna diversity, and ground water. The water treatment facility must be built to provide residents with safe drinking water.

The only method to meet the ever-increasing demand for potable groundwater is to harness it by safeguarding it from contamination and supplementing it with rainfall gathering. To provide communities with safe drinking water, the water treatment facility must be developed.

The only way to meet the growing demand for drinkable groundwater is to protect it from contamination and replenish it with rainfall collection. The following are some of the challenges that this study discovered in terms of successful service:

- Inadequate trash segregation and lack of knowledge source of information;
- Service providers with insufficient capability (financial and human);
- A breakdown in communication among city officials and other parties involved
- Waste management is not well-known;
- Stakeholders are not held accountable;
- A scarcity of information and data

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7. Recommendation and Suggestions-

1. To avoid the disastrous effects of climate change, it is necessary to minimize greenhouse gas emissions in order to conserve freshwater supplies and ecosystems.
2. Conducting capacity studies for all macro cities: Adopting holistic regional planning approaches in fast urbanizing macro cities such as Bangalore that encompass all components (ecology, economics, and social challenges).
3. Flood prevention necessitates open space preservation (vegetation, water bodies). For mitigation, wetlands must be restored, drainage network blockages must be removed, encroachments must be removed, indiscriminate disposal of solid waste in storm water drains must be avoided, lake beds must be caught, and lake connectivity must be restored.
4. Individual management plans for huge bodies of water: Most major bodies of water have distinct characteristics.
5. As a result, distinct management strategies for individual water bodies are required.
6. Lake restoration: Goals for aquatic ecosystem restoration should be reasonable and based on the notion of expected circumstances for distinct ecoregions.
7. Rainwater harvesting: When rainwater harvesting techniques are used extensively and comprehensively, they can cut water body taxation and reduce electricity usage.
8. Take a multidisciplinary approach: Collaboration study including ecological, social, and multidisciplinary strategies is required for aquatic ecosystem conservation and management.

8. Acknowledgement-

To give our research the framework it needed, we had to look for both qualitative and quantitative data from reputable sources. We were lucky in that we were able to secure the necessary information/resources for the official and research websites under a creative commons license that allowed for free access and reuse. We appreciate the free access materials provided on the Major causes of erosion and measures of mitigation in Banglore official website for statistical data and facts.

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