TVET INNOVATION TO ECOLOGICAL HEALTH AND NAVIGATIONAL POTENTIAL OF WATERWAYS, THROUGH HIGH-RESOLUTION BATHYMETRIC MAPPING

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Abstract

This study examines the ecological health and navigational potential of the University of Lagos (UNILAG) Lagoon Front, which is part of the Lagos Lagoon system, using high-resolution bathymetric mapping surveys. Nigeria faces environmental challenges due to human activities, resulting in pollution and threats to ecological integrity and human well-being. The investigation reveals significant variations in water depth and lagoon bed shape, impacting aquatic life and navigation. Deeper areas are crucial habitats for larger fish species, while shallower parts support benthic creatures. Navigational safety varies, with deeper regions providing smooth passage for boats, while shallow areas pose challenges, particularly for larger vessels. Striking a balance between navigational safety, ecological needs, and biodiversity preservation is essential for sustainable use and conservation. The findings offer insights for coastal management, environmental protection, and sustainable development, guiding effective strategies to address Lagos Lagoon's challenges.

Keywords: Aquatic life, Bathymetry, Biodiversity, Navigation, Sustainable

Introduction

Lagos Lagoon, a lake located in the fastest growing metropolis of Lagos in Nigeria is facing major environmental challenges due to various manifestations of human activities. With increasing population and expanding industrial sector, Lagos has developed industrial, agricultural and large domestic waste. Consequently, Lagos Lake has become a place of garbage accumulation and pollution. The Lagos Lagoon has been identified as the most polluted ecosystem in Africa according to the World Health Organization (WHO) Africa and the United Nations Environment Report

The major sources of pollution in the Lagoon are from the oil and textile industry and municipal sewage discharged by the Ogun and Osun rivers. These waste streams containing various chemicals and pollutants pose a serious threat to the lake's ecosystem. Moreover, over fishing activities, sand mining and mining further contribute to the degradation of the lake ecosystem. The misuse of those resources is often finished unsustainably and has delivered loss inside the coastal wetlands of approximately 50% of its entirety worldwide. The haphazard use of the coastal sources has created lack of species of ecological significance and degradation of water satisfactory (Davidson, 2014; Lotze et al., 2006). Additionally, natural occurrences consisting of the spread of invasive species and weeds and the global sea stage upward thrust have additionally impacted on changing the ecosystem of coastal lagoons (Glimore, Wilson & Barrett, 2008).

As a part of urbanisation, commercial effluents, agricultural field run-off, refuse and sewage, home waste dumped into water bodies are damaged right down to release vitamins which assist the survival of microscopic organisms (Gedam, 2016). The impact of this pollution on the ecology of fish and mammals in the lake is of great concern.

Studies have shown that the accumulation of the lagoon waste threatens the health and welfare of aquatic animals. These impacts can have ripple effects on fish and mammal ecosystems, potentially affecting the number of people who rely on the lake for their livelihoods. Comprehensive research and efforts to address the challenges faced by the Lagos River taking into consideration hazardous pollution and possible impacts on ecosystems and human welfare: And if doing it is necessary for the ecosystem of the lake alive. An understanding of the situation, including its bath measurements, sedimentation rate, and other hydrographic characteristics, is vital for developing effective strategies for sustainable management and conservation. Technology and advances in the digital world have a significant impact on innovation. Many technological innovations have been applied to bathymetry with various instruments and applications. Some are including single-beam echo sounders, multi-beam echo sounders, LiDAR, and satellite-derived bathymetry, but for the purpose of exploring technical and vocational education and training (TVET), this

study employed a combination of conventional surveying instruments with advanced technological hydrographic instruments.

This study aims to investigate the bathymetry and substrate composition of the Lagos Lagoon, with a specific focus on the UNILAG Lagoon Front. By utilizing high-resolution mapping approaches and echo-sounding surveys, this study seek to provide valuable insights into the spatial distribution of water depths and substrate composition. The findings from this research will contribute to the understanding of the lagoon's ecological condition and inform decision-making processes for coastal management, environmental protection, and sustainable development in the region.

Research Study area

Figure 1: Shows the site area, Lagos Lagoon front

Lagos Lagoon is part of the larger Lagos Lagoon Complex that stretches from Benin Republic to Nigeria. It is composed of nine interconnected lakes: Yewa, Ologe, Badagry, Iyagbe, Lagos, Kuramo, Epe, Lekki and Mahin. The study area is located at the University of Lagos (UNILAG) Lagoon Front, an ecologically important area of the Lagos Lagoon System. The study area is approximately 485,516 square meters (equivalent to 119.97 acres). The Unilag reservoir front is important as an aquatic habitat and has the potential to attract aquatic tourism. The aim of this study is to assess its bathroom measurements and explore opportunities for sustainable development and conservation.

METHODOLOGY

The methodology used in this study involved a high-resolution mapping method used to monitor the watershed of the University of Lagos (UNILAG) lake in the main area of the Lagos Lake system This method enables is a comprehensive hydrological map that provides detailed information on spatial distribution depth and lake bed structure

Instrumentation

Various instruments were employed during the survey to ensure accurate data collection and processing:

Table 1: Showing purpose of instrument used

Instrument	**Purpose**
Binoculars	Visual observations and identifying submerged features in the lagoon.
Echo-sounder (echoMap CHIRP 75sc)	Measuring water depth at regular intervals during the survey, providing crucial bathymetric data.
DGPS (CHCNav I50 RTK GNSS)	Precise georeferencing and positioning of survey points, enabling accurate spatial data collection.
Levelling instrument	Precise height measurements and elevation reference, contributing to accurate depth calculations.
Car battery	Providing a reliable power supply for the instruments during the survey to ensure uninterrupted data collection.
Life Jacket and Lifebuoy	They ensure the safety of the survey team.
Survey boat	Serving as the platform for data collection, equipped with necessary instruments and tools to facilitate data acquisition.

Instrument Test

Rigorous instrument testing was conducted to ensure instrument accuracy and reliability prior to the start of the study. Using two control points with known coordinates in the project area, the GPS connected to the echo sounder was tested by comparing the known actual coordinates with the known actual coordinates, looking for any differences in the performance of the equipment carefully checked for accuracy.

Data Acquisition

The data collection portion of the survey was conducted in a survey boat. The boat was equipped with necessary equipment including an echo sounder and DGPS to collect data during the passage of the UNILAG lake front. By keeping boat speeds constant during data collection, the study ensured uniformity of data variance, providing a complete picture of the lake bath measurements

Data Processing

After data collection, the data stored in the echo-sounder were downloaded and uploaded to a personal computer. Garmin Homeport software was used for data transmission, organization, and storage on an external memory device. Data were then imported into Microsoft Excel for transformation, adjustment, and conversion from latitude and longitude to U.T.M. references to the sources.

Tidal readings and reduced wave gauge values were used to shift the water depth upward. The processed data were exported back to ArcMap to plot slope maps, digital elevation models (DEMs), and spot elevations, providing a complete picture of bathymetry in front of the UNILAG lagoon

Computation and Reduction of Sounding Data:

The reduction of numerical and acoustic data takes into account the decrease in lake volume relative to the measured data. Depth measurements obtained at each point were reduced and measured from a reference depth, enabling the determination of reduced levels and contributing to an accurate depiction of the bathymetry in the study area.

Creating Bathymetric Maps

To present the findings visually, the processed data was exported to ArcMap, a Geographic Information System (GIS) software. ArcMap was used to create bathymetric maps, slope maps, Digital Elevation Models (DEMs), and spot heights. These maps offered a detailed representation of the underwater terrain and provided valuable insights into the spatial distribution of water depths and substrate composition in the UNILAG Lagoon Front.

RESULTS

The dataset presented consists of east, north, depth, reduced depth gauge contour map and digital elevation model obtained from University of Lagos (UNILAG) Lagoon Front. The survey covered a specific area within the larger Lagos Lagoon system, and the data offers valuable insights into the underwater topography and water depths at various locations.

Table 2: Sample of Depth and Reduced Depth Measurements

S/N	Easting	Northing	Depth	Reduced Depth
444	544319.6	720773.9	0.28	-0.329
445	544321.9	720776.4	0.38	-0.447
446	544322.2	720776.8	0.47	-0.553
447	544330.5	720777	0.59	-0.694
448	544333.7	720777.6	0.71	-0.835
449	544345.7	720782.8	0.85	-1
450	544351.8	720785.8	0.93	-1.094
451	544364.1	720791.2	1.02	-1.2
452	544371.1	720793.7	0.97	-1.141
453	544377.7	720796.4	1.02	-1.2
454	544379.6	720797.2	1	-1.177
455	544380.2	720797.5	1.02	-1.2
456	544381.6	720797.7	1.04	-1.224
457	544382	720797.7	1.11	-1.306
458	544403.2	720816.6	1.11	-1.306
459	544402.1	720818.3	1.11	-1.306
460	544401.7	720819.1	1.09	-1.283
461	544401.5	720819.6	1.14	-1.341
462	544401.5	720820.8	1.14	-1.341
463	544402	720822.1	1.11	-1.306
464	544404	720827.8	1.04	-1.224
465	544415.2	720832.1	1.11	-1.306
466	544425.1	720833.7	1.16	-1.365
467	544438.5	720836.1	1.19	-1.4
468	544453.8	720838.1	1.19	-1.4
469	544476.9	720841.2	1.21	-1.424
470	544493.5	720845.3	1.23	-1.447
471	544512.7	720849.8	1.33	-1.565
472	544534.6	720854.4	1.45	-1.706

The "depth" column represents the recorded water depth at each survey site, while the "reduced depth" column shows the depth measurements after reduction from the sampling station A reduced depth calculation is required to provide a water a it has been accurately represented in comparison with known data and to provide a formal basis for detailed analysis and interpretation.

Bathymetric surveys of the UNILAG lake front provided valuable insights compiled into informative maps and models. These visual images provide a comprehensive understanding of subaqueous geology and water depth distribution in the study area.

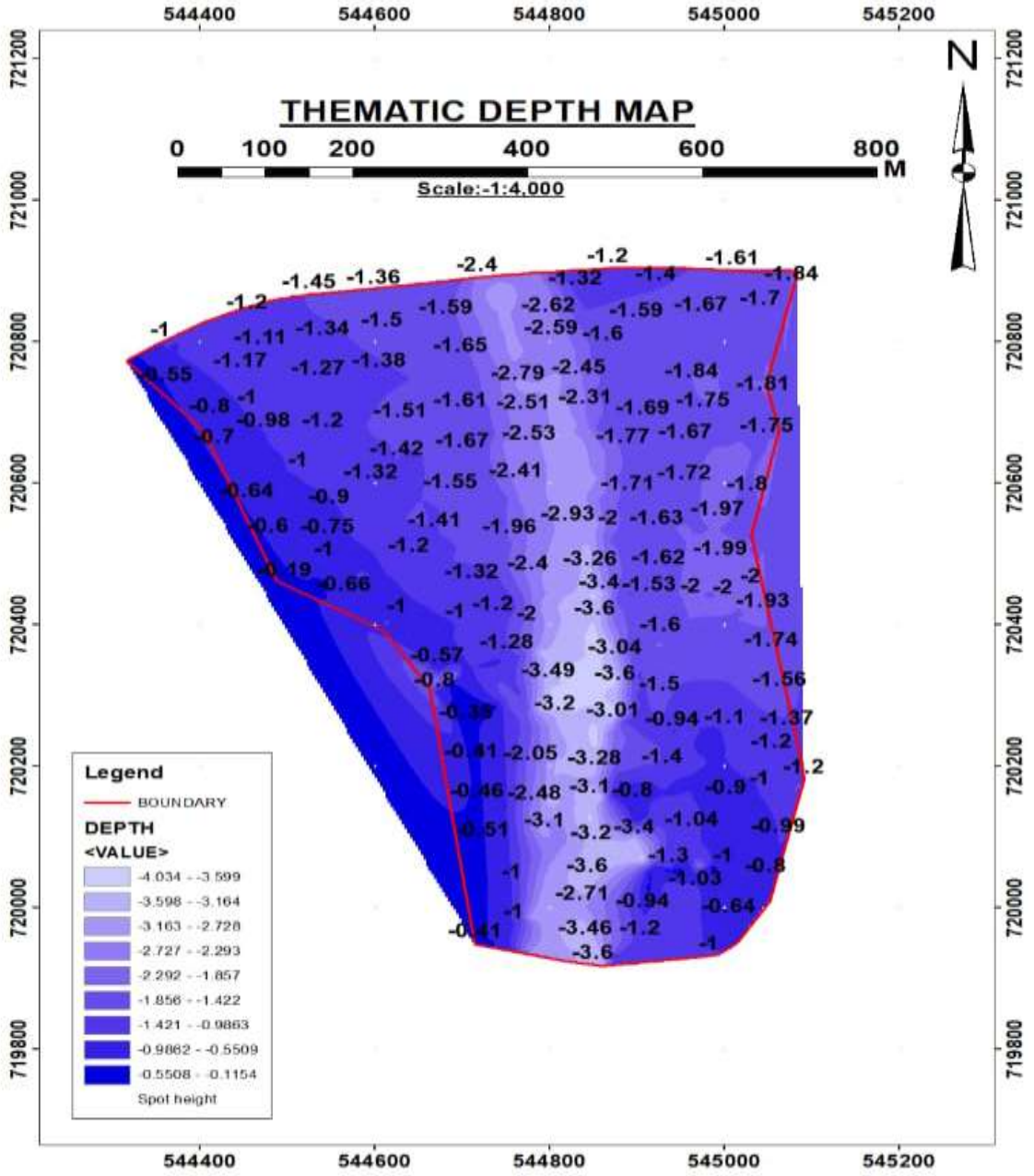

Figure 2: Showing the Thematic Depth Map of the Study area.

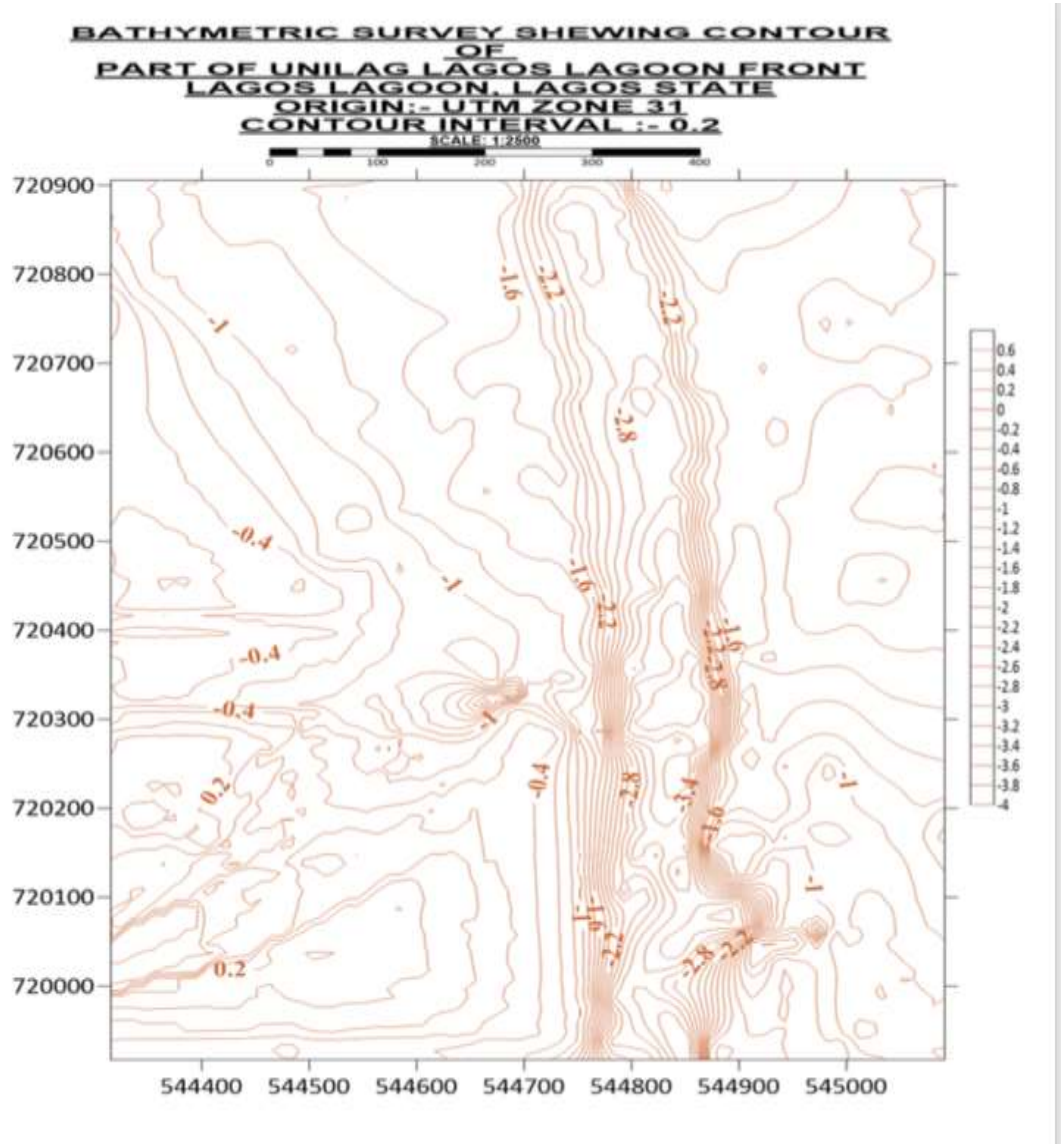

Figure 3: Showing the bathymetric survey of the study area

DISCUSSION

Elevations are used to accurately determine the primary seafloor elevation in deep land. Measuring the depth of each drop from the seafloor provides a more accurate picture of the water depth at specific locations. For clarity, the depth of each area is clearly marked on the map, facilitating a better understanding of the underwater terrain.

In contrast, a contour map uses contour lines to indicate areas of equal water depth. The density of these contours acts as an indicator of how fast depth changes. This map provides a detailed two-dimensional view of lake floor elevation variability and therefore provides invaluable results. Its elevation changes, thus providing valuable insight into its underwater landscape. To determine the depth at specific locations on the contour map, you can view the corresponding contour line and the corresponding depth value. This interactive and informative visualization enhances the understanding of lake bottom subsurface complexity and depth variation.

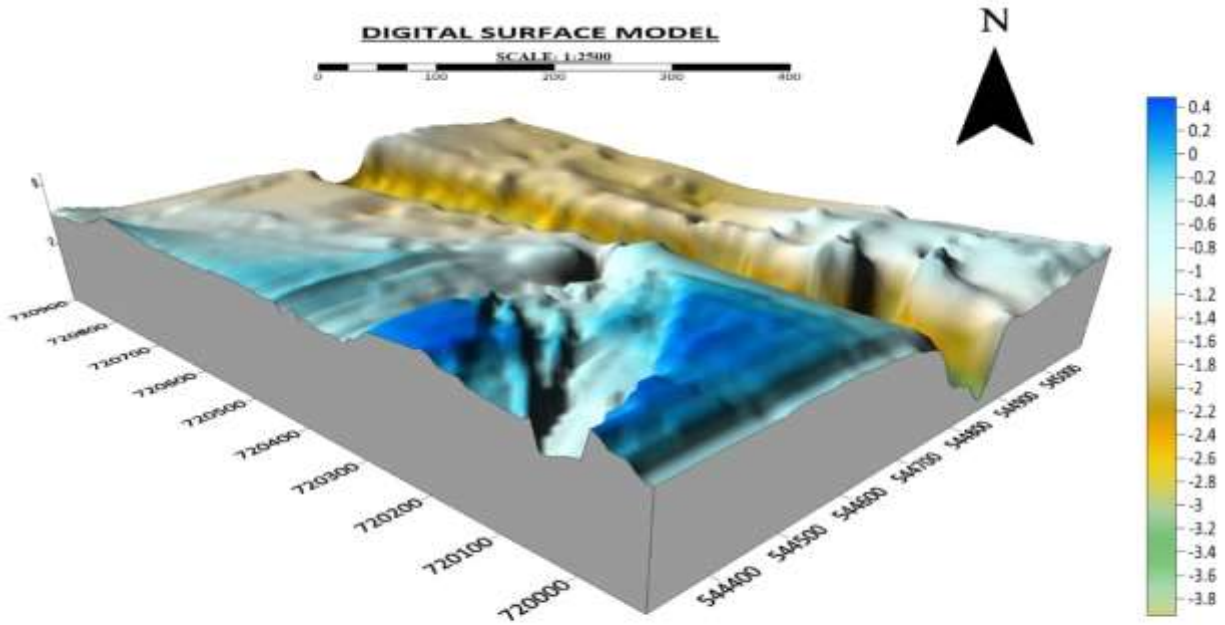

Figure 3: Showing the Digital Surface Model of the study area.

The digital surface model (DSM) identifies three dimensions by creating water depths in 3D format. These models provide a comprehensive view of the subaqueous topography, and facilitate a more detailed understanding of the relationship between various depth zones and the overall structure of the lake.

Depth distribution and variation

The dataset collected shows a range of water depths, highlighting the dynamic nature of the lagoon's underwater terrain. From a shallow depth of about 0.28 m to the deepest point of 3.65 m, these data provide insight into the spatial distribution of depth along the UNILAG lake front.

Ecological insights

As you descend deeper into the water, there occurs an area where sunlight can no longer penetrate (Nkwoji & Edokpayi, 2013). Light plays an important role in aquatic ecosystems as it determines marine and freshwater ecosystems. The varying depths of the lake create distinctive environments, providing habitats for specialized aquatic species such as deep-water evolutions and fish in the park areas whereas shallow areas may be more suitable for species that thrive in shallow areas. Understanding this ecological concept allows us to understand the complex ecology of the lagoon, and the ability of various species to coexist and adapt to their diverse habitats.

Navigational potential of the lagoon

Safeguarding navigational safety, ecological equilibrium, and biodiversity preservation is an essential prerequisite for effectively harnessing and conserving the resources of the lagoon (Ward et al., 2022). Amidst the diverse depths it offers for potential navigation routes, astute management becomes a necessity to ensure uninterrupted passage while upholding the intricate ecological balance. This delicate equilibrium is paramount for the lagoon's overall vitality.

Navigating varying depths and addressing challenges

The lagoon's diverse depths present a unique set of navigational challenges. Shallow areas, where depths range from approximately 0.28 to 0.9 meters (Easting: 544319.6 to 544351.8, Northing: 720773.9 to 720785.8), require special consideration due to their potential navigational complexities. These regions may pose challenges for larger vessels, necessitating the formulation of well-planned and closely monitored routes to ensure safe and unobstructed passage.

Conversely, the deeper areas beneath the bridge, with depths reaching up to 3.65 meters, present their own set of navigational considerations. These areas, while promising for potential navigation, require prudent management to avoid disturbing the delicate ecological balance. Meticulous planning ensures that the navigational needs are met while preserving the lagoon's unique ecosystem.

In essence, effective navigational management encompasses a dual responsibility: addressing challenges posed by shallower depths and harnessing the navigational potential of deeper areas. By striking this balance, the lagoon can continue to accommodate human activities while safeguarding its ecological integrity, thereby ensuring its sustained functionality for both present and future generations.

CONCLUSION

The recent study on the University of Lagos (UNILAG) Lagoon Front has provided important insights into the ecological health and navigational possibilities of the Lagos Lagoon system. The high-resolution bathymetric mapping surveys have revealed the intricate underwater topography, displaying various water depths and substrate compositions, which hold significant implications for the aquatic ecosystem and navigational activities within the lagoon.

The variations in water depth provide distinct habitats for aquatic organisms, contributing to the overall health and balance of the ecosystem, and it is crucial to acknowledge and preserve these habitats. The study also highlights the navigational safety concerns in the shallower areas, particularly for larger vessels. Effective management strategies are necessary to establish safe and well-planned routes to mitigate risks associated with shallower depths. Careful planning is also required for the deeper areas with potential navigational routes to avoid disturbing the fragile ecosystem while maximizing their utility for water transportation.

RECOMMENDATIONS

After analyzing the results of this study, we suggest several recommendations for further research and management decisions:

I. Environmental Conservation and Restoration: The UNILAG Lagoon Front is ecologically vital, so it's important to implement measures to conserve and restore its habitats. This includes regulating fishing, controlling pollution, and preserving the surrounding natural vegetation.

II. . Regular Monitoring and Data Collection: To make informed management decisions, it's essential to continuously monitor water quality, bathymetry, and ecological health. Regular data collection will allow authorities to track changes and respond to emerging issues.

III. Sustainable Tourism Development: We recognize the potential for water tourism in the lagoon, so we suggest promoting sustainable tourism practices. This involves designing tourism activities that minimize negative environmental impacts while supporting local economic development.

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