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SEÇÃO ARTIGOS

Exploring the biodiversity conservation potentials and eco-benefits of wetland corridors through sustainable ecotourism and landscape design approach: Lagos-Nigeria in perspective

Explorando os potenciais de conservação da biodiversidade e os benefícios ecológicos do corredor de zonas úmidas por meio do ecoturismo sustentável e do paisagismo: Lagos-Nigéria em perspectiva

Explorando el potencial de conservación de la biodiversidad y los beneficios ecológicos del corredor de humedales a través del ecoturismo sostenible y el diseño paisajístico: Lagos-Nigeria en perspectiva

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Abstract

The primary goal of a green corridor is to efficiently connect ecosystems, providing animals with a readily accessible path between their habitats. Recently, the wetlands on the University of Lagos's campus have experienced issues including flooding, deforestation, excessive sedimentation, obstructed streams, misuse, overuse, and wetland invasion. The green corridor behind the faculties of law and management science was chosen as a model supported by sustainability principles. It is an exemplary foundation for the university's campus landscapes. The study aims to explore the potential for conserving biodiversity, the green open spaces eco-benefits, and the sustainable restoration strategies for wetlands. Direct survey techniques and qualitative data analysis were employed using the Strengths-Weaknesses-Opportunities-Threats (SWOT) matrix to analyze data obtained from primary sources. The study revealed threats to the wetlands, including habitat loss, overuse of resources, pollution, invasive species, disease, hunting, and climate change impacts. The study concludes that adaptive landscape planning, the design and construction of wetlands with physical features such as off-road bike lanes, nature walking trails, and raised hardwood platforms are ecologically sustainable and have low carbon emissions.

Keywords

Biodiversity conservation; Green corridor; Landscape design; Sustainability; SWOT.

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Resumo

O principal objetivo de um corredor verde é conectar ecossistemas de forma eficiente, proporcionando aos animais um caminho de fácil acesso entre seus habitats. Recentemente, as áreas úmidas do campus da Universidade de Lagos enfrentaram problemas como inundações, desmatamento, sedimentação excessiva, obstrução de córregos, uso indevido, uso excessivo e invasão de áreas úmidas. O corredor verde atrás das faculdades de direito e ciências administrativas foi escolhido como um modelo apoiado por princípios de sustentabilidade. Ele é uma base exemplar para as paisagens do campus da universidade. O objetivo do estudo é explorar o potencial de conservação da biodiversidade, os benefícios ecológicos dos espaços verdes abertos e as estratégias de restauração sustentável das áreas úmidas. Foram empregadas técnicas de pesquisa direta e análise de dados qualitativos usando a matriz Forças-Oportunidades-Fraquezas-Ameaças (FOFA) para analisar os dados obtidos de fontes primárias. O estudo revelou ameaças às zonas úmidas, incluindo perda de habitat, uso excessivo de recursos, poluição, espécies invasoras, doenças, caça e impactos da mudança climática. O estudo conclui que o planejamento paisagístico adaptativo, o projeto e a construção de áreas úmidas com características físicas, como ciclovias *off-road*, trilhas para caminhadas na natureza e plataformas elevadas de madeira de lei, são ecologicamente sustentáveis e têm baixa emissão de carbono.

Palavras-chave

Conservação da biodiversidade; Corredor verde; Paisagismo; Sustentabilidade; Análise FOFA.

Resumen

El objetivo principal de un corredor verde es conectar eficazmente los ecosistemas, proporcionando a los animales un camino de fácil acceso entre sus hábitats. Recientemente, los humedales del campus de la Universidad de Lagos han sufrido problemas como inundaciones, deforestación, sedimentación excesiva, obstrucción de arroyos, mal uso, sobreexplotación e invasión de humedales. El corredor verde situado detrás de las facultades de Derecho y Ciencias de la Administración fue elegido como modelo respaldado por los principios de sostenibilidad. Constituye una base ejemplar para los paisajes del campus universitario. El estudio pretende explorar el potencial de conservación de la biodiversidad, los beneficios ecológicos de los espacios verdes abiertos y las estrategias de restauración sostenible de los humedales. Para analizar los datos obtenidos de fuentes primarias se emplearon técnicas de encuesta directa y análisis cualitativo de datos mediante la matriz Fortalezas-Oportunidades-Debilidades-Amenazas (FODA). El estudio reveló amenazas para los humedales, como la pérdida de hábitats, la sobreexplotación de recursos, la contaminación, las especies invasoras, las enfermedades, la caza y los impactos del cambio climático. El estudio concluye que la planificación paisajística adaptativa, el diseño y la construcción de humedales con características físicas como carriles bici todoterreno, senderos naturales y plataformas elevadas de madera dura son ecológicamente sostenibles y tienen bajas emisiones de carbono.

Palabras clave

Conservación de la biodiversidad; Corredor verde; Diseño del paisaje; Sostenibilidad; FODA.

Introduction

It is crucial to investigate the possibilities for biodiversity preservation and the ecological advantages of wetland corridors through sustainable ecotourism and landscape architecture to mitigate the impact of climate change on the Lagos metropolis. This strategy maintains biodiversity while making use of the wetlands' natural resources, encouraging community engagement, boosting tourism, and offering financial opportunities for residents.

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Wetland restoration and biodiversity conservation are growing in popularity as ways to mitigate environmental changes, adapt to them, and improve people's health and well-being. (Adedeji, 2023; Otubu, 2021). In addition to providing compensation for direct biodiversity losses associated with human presence and urban development, wetlands are occasionally built and restored for a variety of purposes (Del Rio; Willemen; Vrieling; Nelson, 2022).

Wetland restoration involves modifying deteriorating or previous physical, chemical, or biological features to restore their natural functions (Dorado-Guerrero; Willemen, 2022; Pandey; Ghosh, 2023; Zhang; Ye; Liu; Lai; You; Dong; Dong, 2023; Masheula, 2023). This approach has faced an array of challenges because the entire ecological consciousness of the wetland, which has suffered continuous infiltration of foul sewage water and rainfall runoff packed with plastic refuse waste, is essential to the health of the primary host community and the surrounding local communities. To boost tourism, it is necessary to restore and revitalize the landscapes which will directly impact how universities and colleges are promoted internationally. Only when institutions such as a university with distinct green credentials for all of the surrounding towns appreciate and restore the degraded landscapes will they serve as a template for the host town.

The University of Lagos (UNILAG) provides a favorable atmosphere that supports teaching, learning, research, and development. The wetland in question is located behind two outstanding faculties: The Faculty of Law and the Faculty of Management Sciences. This study area was selected because of its proximity to the Lagos Lagoon and the coastal settlement, which can be accessed via the waterways and wetlands. The choice was also made due to an understanding that restoring the ecosystem dynamics, as well as the environmental needs of both plants and animals, is essential for wetland restoration and campus revitalization. The purpose of this study is to investigate wetlands as biodiversity hotspots and the use of ecotourism and landscape design as conservation tools, as well as community involvement. Including local populations in conservation initiatives, possibly through ecotourism or other sustainable activities, may promote an attitude of connection and concern for the environment.

One of the study's many benefits is increasing awareness of environmental concerns among residents, tourists, and students. The study revealed the need to sponsor conservation

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initiatives directly, provide financial assistance, and allow the initiatives to make decisions independently through research. The main objectives of the study are identifying biodiversity around campus, promoting sustainable ecotourism, enhancing sustainable tourism experiences, increasing access to green outdoor spaces, reducing campus temperatures, improving air quality, and identifying the dominant plants and animals. Wetlands are recognized as biodiversity hotspots because they support a wide range of plants and animals, including birds, reptiles, and other distinctive ecosystem elements. Ecotourism should be examined as a conservation strategy since it may improve awareness of the value of wetlands and their biodiversity, resulting in further protection efforts. Ecotourism is centered on responsible travel to natural regions. The study concludes with a suggestion to implement a biophilic landscape design for biodiversity conservation. Improving the connectivity of wetland corridors through intelligent landscape design may facilitate animal movement and support ecosystem health.

Literature Review

Ecotourism is defined as responsible travel to scenic locations and natural beauty spots including protected areas such as national parks, which are abundant in biodiversity. It involves educational and evaluative activities, protects the environment, and promotes the well-being of the local population (Del Rio *et al.,* 2022; Tang; Adesina, 2022a). The United Nations World Tourism Organization (UNWTO), defines sustainable tourism as "travel that promotes resource management in a way that fulfills social, cultural, and economic demands while preserving biological diversity, vital ecological processes, and life support systems" (UNWTO, 2017; Ye *et al*., 2023; Keramitsoglou; Koudoumakis; Akrivopoulou; Papaevaggelou; Protopapas, 2023). A crucial aspect of sustainable ecotourism is benefiting host communities socioeconomically. It can also be said that those who live in and around the destination stand to gain the most from tourism (Koko; Han; Wu; Zhang; Ding; Luo, 2023; Numbere, 2021). Ecotourism can boost the local economy by bringing in money for communities to benefit through the sale of native goods and crafts, guided tours, and lodging amenities. However, essential plants (natural components) and light structures (man-made amenities for comfort, and relaxation gazebos) need to be introduced into this park to enhance its livability and usability.

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Combining these native plant species and park furniture is essential to improving the academic landscape atmosphere in each of the wetlands while adding aesthetic value. The biophysically restored wetlands can illuminate the landscape, and the green corridors may attract the academic community. All of these elements can be implemented using an environmentally friendly landscape planning, management, and design model. Ecotourism encompasses ecological conservation, biodiversity preservation, local revitalization and renewal, and environmentally friendly travel (Tang; Adesina, 2022a; 2022b). Tang and Adesina (2022a), opined that those who develop, engage in, or market ecotourism-related activities should follow the aforementioned ecotourism guidelines with consideration to existing biodiversity and its conservation. Ecotourism has positive environmental, social, behavioral, and psychological effects. In other words, the perception of the wetlands and green space by the local residents is important, as it increases respect for and knowledge of the environment and cultures. In addition, ecotourism offers immediate monetary rewards for conservation efforts, creates wealth for the local community and private sector, and ensures enjoyable stays for both guests and hosts (Clark; Nyaupane, 2022).

A distinctive approach to creating a welcoming environment within the wetlands and their surroundings is based on ecotourism hospitality concepts. The tourism industry extends hospitality to guests while maintaining our culture and learning atmosphere by upholding these ideals (Morán-Ordóñez; Hermoso; Martínez-Salinas, 2022). Vegetation plays a beneficial role in mitigating the negative environmental effects of urban growth (Maiti; Kuniyal; Sekar; Satish; Singh; Bisht; Sundriyal, 2022; Clark; Nyaupane, 2022). This is achieved by regulating the temperature, lowering atmospheric carbon dioxide levels, improving air quality, reducing runoff from rainfall, decreasing noise pollution, increasing urban energy efficiency, improving thermal comfort within buildings, and enhancing the visual appeal of urban areas (Maiti *et al*., 2022; Adesina; Adejumo, 2018). Ecotourism sites offer low-impact, small-scale alternatives to traditional commercial mass tourism, which is common in megacities and urban areas where people travel for sightseeing (Zhang *et. al*., 2023; Masheula, 2023; Clark; Nyaupane, 2022; Sobhani; Esmaeilzadeh; Sadeghi; Wolf, 2024). It entails taking reasonable trips to protected regions, preserving the environment, and improving the quality of life for locals and the host

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communities (Sobhani *et al*., 2024; Melicher; Špulerová, 2022). Its goals may include educating tourists, funding environmental preservation, directly assisting local communities' political and economic advancement, and promoting tolerance for other people's cultures and human rights (Sobhani *et al*., 2024).

Gulpinar Sekban and Acar (2021) consider ecotourism a vital undertaking, believing that it will allow future generations to visit places that are protected, and it typically involves engagement with the living components of the natural world. The three main aims of ecotourism are environmental sustainability, human development, and socially conscious travel. Travel to protected areas and national parks typically involves visiting places where the main attractions are the flora, fauna, and cultural heritage (Tauro; Ojeda; Caviness; Moses; Moreno-Terrazas; Wright; Rozzi, 2021). It involves increasing visitor's awareness of our natural environment through responsible tourism and providing insight into how humans affect the environment (Tauro *et al*., 2021).

Figure 1 illustrates the research indicators for sustainable ecotourism and landscape design needed to sustain environmental ecology, human economic development, and social equity through socially conscious travel to protected areas. Ecological programs that promote social cohesion and cultural integrity of the community and reduce the negative impacts of traditional tourism on the environment are examples of responsible ecotourism (Figure 1). Therefore, in addition to addressing environmental and cultural factors, ecotourism must also promote wetland restoration, street design, waste management, energy efficiency, and the creation of economic opportunities for local people. In light of these factors, ecotourism is a popular option for travelers who respect environmental conservation and social justice (Qiu; Sha; Scott, 2021).

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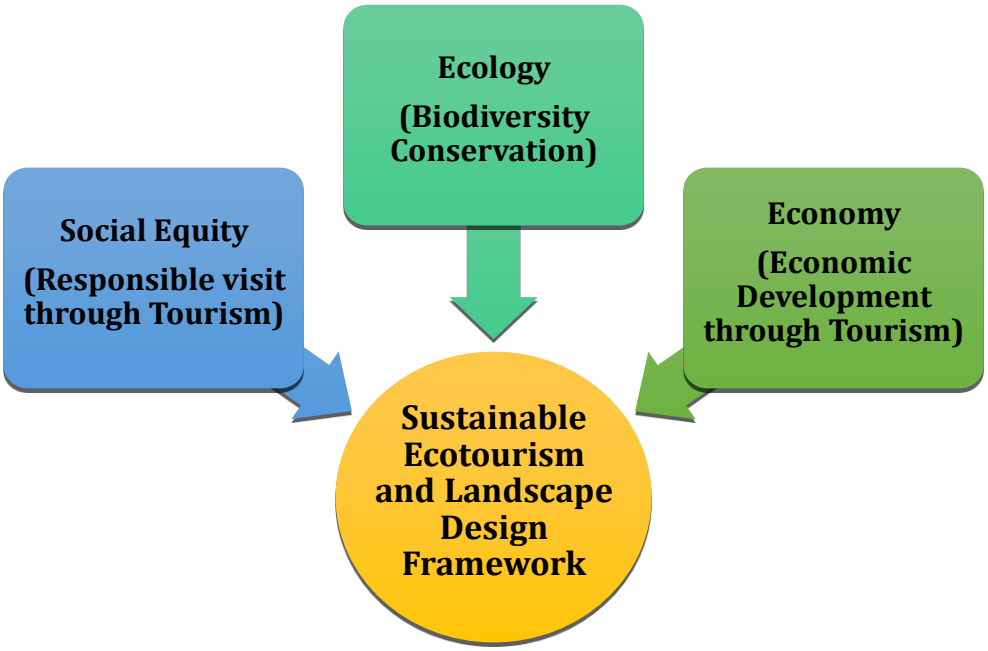
Figure 1 – The three pillars and main attributes of community-based ecotourism



Source: The authors (2024).

Qiu *et al.* (2021), define ecotourism as visiting relatively pristine environments with the express purpose of enjoying, understanding, and learning about the environment, its wildlife, and its cultural features (Qiu *et al.*, 2021; Liu; Zhang, 2024). In addition, according to Štrbac, Kašanin-Grubin, Pezo, Stojić, Lončar, Ćurčić, and Pucarević (2023), wetlands are areas where water either sits on the soil or is present at or near the soil surface throughout the year, occasionally even during the growing season. Wetland ecosystems are home to a wide variety of freshwater and terrestrial plant and animal species, and the prolonged presence of water promotes the development of unique wetland soils and ideal growth conditions for plants with special adaptations (王玥, 2023). Sustainable tourism initiatives include those that preserve the integrity of local landscapes and foster cultural appreciation while minimizing the negative environmental impacts of traditional tourism (Wan; Wan, 2023; Zhou; Yao; Chen; Tang, 2023; Bian; Li; Deng; Zhang; Liu; Wang; Wang, 2024; Liang; Zhai; Li, 2023).

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Restoration in focus

Kyriakopoulos (2023) defined restoration as the process of re-establishing and reconstructing a degraded wetland and its functions. Restoring a degraded or abandoned wetland to its original functions involves modifying its physical, chemical, or biological properties, and this process is known as wetland restoration (Kyriakopoulos, 2023). Eliminating a threat or stopping the deterioration of wetland conditions is the definition of wetland protection (Fang; Hassan; Horng, 2024). Along with the restoration of endangered ecosystems, the natural ecosystem service and species. The conservation of naturally occurring wetlands is a crucial part of the restoration strategy through ecological intervention for natural habitat protection (Kyriakopoulos; 2023; Jing; Chen, 2024).

These wetlands serve as biological buffers and green spaces that absorb and store large amounts of floodwater, which can help reduce the frequency and intensity of flooding in the campus community. Three acres or one million gallons of water can often be submerged three feet below the surface of a wetland (Fang *et al.*, 2024). The land is protected from storm surges by coastal wetlands during hurricanes and tropical storms (Enoh; Okeke; Nkechi, 2023). In the Gulf Coast region, barrier islands, shoals, marshes, and other coastal landscape features can absorb storm surges and wind waves from hurricanes and tropical storms in significant and potentially sustainable ways (Enoh *et al.*, 2023). The role of trees in restoring degraded landscapes is being increasingly recognized worldwide to halt drought, forest destruction, strip mining, water scarcity, pollution, loss of plant and animal life, and urban heat waves associated with climate change (Moshood; Adeleke; Olayemi; Ibrahim, 2023).

Leveraging the city's rivers, natural areas, urban green infrastructure, and other connections is essential when creating a restoration framework for a university's wetlands. Their continued presence impacts not only the integrity of land, air, water, and forest resources but also the quality of life (Olaleru; Agbaosi; Tijani; Emmanuel; Agidi; Otusanya, 2023). They support a variety of uses by humans and the environment. Wetlands, the foundation of the landscape, ecology, history, and recreation, create connections at local, regional, national, and international levels (Moshood *et al.*, 2023). These same authors noted that the outdoor green spaces include schoolyards, playgrounds, wetland corridors, community gathering places,

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drainage canals, farm settlements, parks and gardens, and athletic centers in the community and on university campuses. Their continued presence impacts not only the integrity of land, air, water, and forest resources but also the quality of life.

Adesina and Zhu (2022) discussed the accessibility, sustainability, and coherence of forests, their products, wetlands, and natural areas. They stated that the resources are so important that they must be restored, protected, and preserved as needed. The campus is lined with ecological and recreational trails that provide an up-close view of the natural world (Chang; Heejun; Alexander, 2024). Although there are many ways to make these places more sustainable now and in the future, visitors do not need or want to visit them (Adesina; Zhu, 2022; Chang *et al.,* 2024). Responsible ecotourism is exemplified by organizations that support the cultural vitality of the community and reduce the negative environmental impacts of conventional tourism (Adesina; Zhu, 2022; Olaleru *et al.*, 2023). Therefore, restoration ecotourism, as described in this study, often appeals to social, economic, and environmental advocates because it actively promotes reuse and recycling, energy efficiency, water conservation, and the development of income streams for local communities, in addition to considering ecological and historical factors.

Sustainable Landscape Design Approach

The goal of sustainable landscape design is to create outdoor spaces that are both ecologically conscious and visually pleasing. It places a strong emphasis on optimizing the benefits of natural systems while reducing negative environmental impacts (Kyriakopoulos; 2023; Jing; Chen, 2024). This includes establishing thriving ecosystems, conserving resources, and promoting biodiversity. This research provided a thorough examination of the essential elements of environmentally friendly landscaping, taking into account the fundamental ideas of resource conservation, which are essential for reducing waste, energy use, and water consumption. Working with natural processes, promoting biodiversity, and maintaining ecological balance are crucial (Kyriakopoulos, 2023). A major component of sustainable landscaping is long-term viability, which aims to create landscapes that can thrive despite

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requiring a lot of maintenance or source of support inputs. Sustainable landscaping can create aesthetically pleasing and useful landscapes that both locals and tourists can appreciate.

Native plants are a fundamental component of sustainable landscaping. Because native plants are acclimated to the soil and temperature of the area, less fertilizer, pesticides, and irrigation are required (Tauro *et al.*, 2021). The following considerations are important components of sustainable landscape design:

1. **Water control:** Water use can be significantly reduced by implementing effective irrigation systems, using rain harvesting strategies, and constructing highly permeable structures.
2. **Soil conditioning:** Plants grow more easily and require less chemical fertilizer when soil health is improved through methods such as mulching, composting, and reducing soil compaction.
3. **Debris reduction:** It is important to encourage composting and recycling of yard waste while minimizing the use of synthetic materials.
4. **Sheltering animals and wildlife:** Incorporating features that benefit animals, such as native plants, water features, and natural areas, can make an ecosystem more thriving and diverse.

The Study Area

The Lagos Lagoon surrounds the main campus in Akoka, offering a stunning perspective of the university. The main campus, located on 802 acres in Akoka, the eastern part of Yaba, is largely surrounded by the picturesque panorama of the Lagos Lagoon. The campus is located along the sandy barrier lagoon region of the western coast of Nigeria. The geographical area under study is bounded by the equator at latitude 6°31'14.88" and longitude 3°23'49.76" (Google Earth, 2023). The communities of Akoka, Iwaya, Onike, Abule Oja, Bariga, and Oworonsoki are all close to the main campus and the total land area that was marked for this study is approximately 2,100 m² (Figures 2 and 3).

This is intended to be the beginning of the restoration efforts for the wetlands that stretch for about 5 km along the main campus of UNILAG. The study area was selected to be in a

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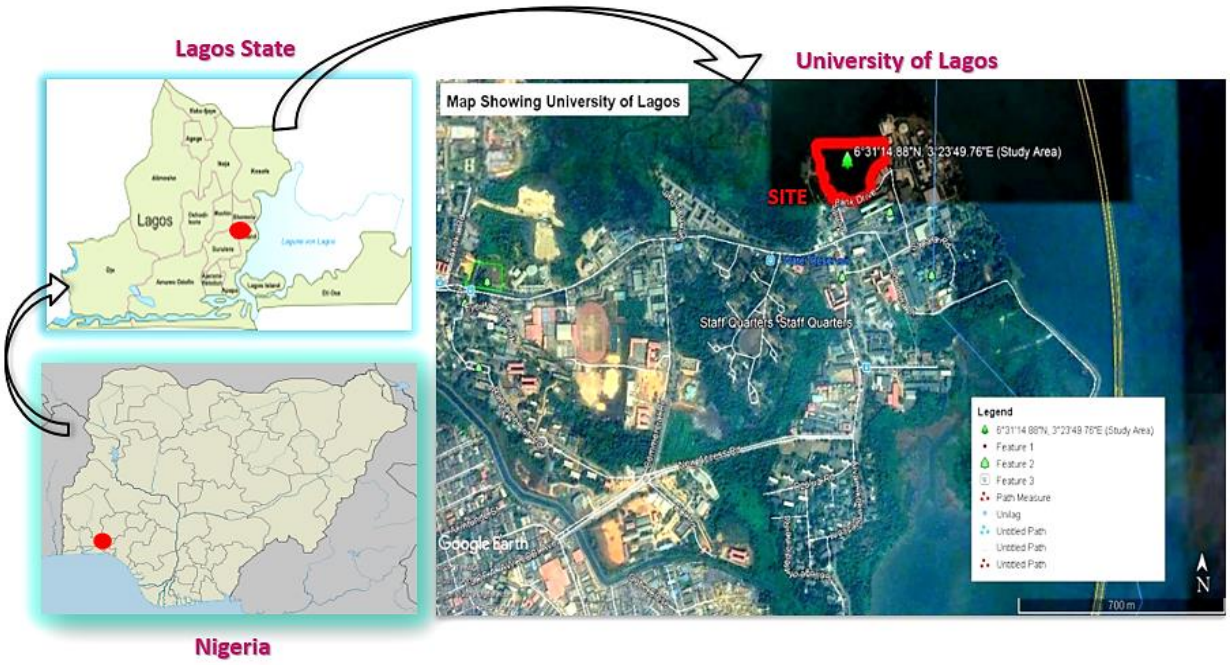
location that aligns with the most prominent, populous, and productive faculty on campus. The site was chosen for its biodiversity richness, accessibility, low risk, and location. After obtaining the base map and conducting a site inventory, it became apparent that the site has two connecting roads that provide easy access to nearby facilities without directly entering the wetland. In addition, the site contains certain species of trees and monkey habitats and has been used as a garbage dump for many years. However, the main advantages of the site over other sites along the green zone and corridor are the dominance of biodiversity of all kinds and its limited vulnerability to human encroachment.

Figure 2 – Aerial imagery of the University of Lagos showing the selected wetland



Source: The authors (2024).

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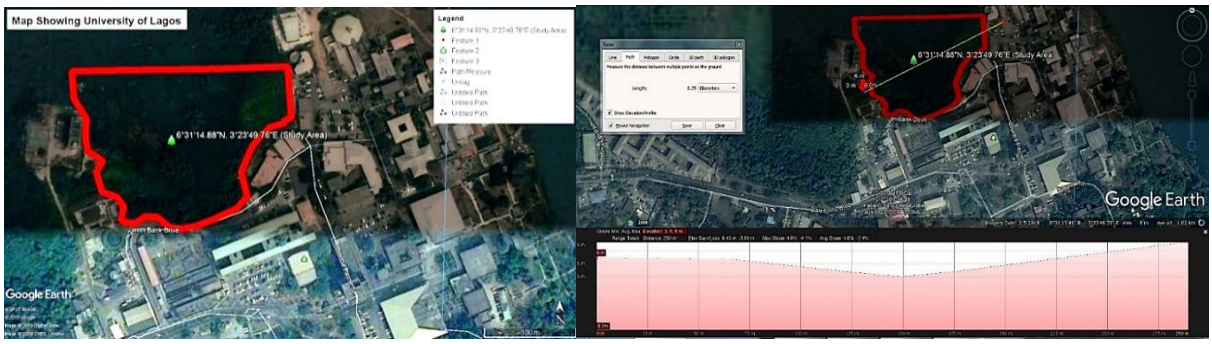
Figure 3 – a (right) & b (left): (a) Map showing the selected wetland and (b) a longitudinal section through the floodplain



(a) (b)

Source: The authors (2024).

Table 1 presents the assessment and site inventories in random order and classifies the list based on the SWOT checklist. The Green Zone and Riparian Corridor surrounding the campus share similar microclimatic conditions and have the same biodiversity, albeit in varying amounts. The SWOT analysis/matrix is a strategic planning technique used to express and evaluate the strengths, weaknesses, opportunities, and threats associated with the study area. A SWOT analysis is a strategic planning technique that evaluates the opportunities, threats, weaknesses, and strengths of an entity or task to help identify areas that need improvement and to guide decision-making. The process of SWOT analysis includes:

1. **Strengths:** Advantageous qualities of wetlands in the context of urban open space.
2. **Weaknesses:** Internal deficiencies that could affect the functioning of the landscape.
3. **Opportunities:** These are external forces that an urban open space can take advantage of.
4. **Threats:** External variables that could have a detrimental effect on the landscape.

This study carries out the SWOT analysis by first determining the objective of the possible use of the wetland and listing the following factors that determine the possible advantages, disadvantages, opportunities, and threats (see Table 1). The analysis also examines the factors of the components found and their possible effects. Finally, based on the analysis, the process creates plans to capitalize on opportunities, correct weaknesses, leverage strengths,

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and mitigate threats. It puts the tactics into practice and monitors their implementation and results. The results of this field survey led to the development of conceptual plans and designs (landscape management plan and landscape design) for strategic and immediate action by stakeholders for implementation. However, Table 2 shows the level of impact and influence the following criteria have on the assessment of the wetland for ecotourism: accessibility, ecological diversity, natural engagement, capacity, recreation, functionality, and social activities. “Opportunity” appears to have the highest rating and implies that there are inherent opportunities at the site that have yet to be explored for sustainable ecotourism. It is followed by “Strengths and Weaknesses” which show extreme impacts. However, “Threat” does not seem to have much impact on both the campus and the immediate community around the selected wetland, considering the landscape elevation profile and its proximity to existing buildings (Figure 4).

Figure 4 – Aerial imagery of the University of Lagos showing the selected wetland

Source: The authors (2024).

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Materials and Methods

The Strengths-Weaknesses-Opportunities-Threats (SWOT) matrix was used in a qualitative and exploratory manner, which included exploring the land area, current biodiversity, hydrology, and its potential through landscape mapping and analysis. The strategy consists of six steps, starting with a prospective analysis of the town. To give an idea of what a restored wetland might look like, a comparison with current wetlands is presented. This is followed by the acquisition of the base map and the completion of the site inventory. The six phases focused on defining the University's biologically diverse areas and current drainage networks. The current vegetation and drainage network of the campus were documented using secondary data from topographic maps, 2023 satellite imagery from *Google Maps*, previous soil and hydrological surveys, and fieldwork. To understand the intrinsic ecological goods and services, the second step was to map the biotopes through a direct field survey methodology, which included the following steps:

1. **The landscape features:** Site features include natural and undisturbed topography, vegetation, soils, and wetlands. There are not many major attractions near the site, except for an undeveloped wetland that offers an unobstructed view of the horizon and green vegetation consisting mostly of water weeds and raffia palm vegetation.
2. **The climate data analysis:** Research and analysis of the microclimate of the site and how it relates to the region's microclimate, taking into account the characteristics of the site.
3. **Flood and rainfall records:** There are records of water flooding into the campus in previous years due to rising water levels caused by climate change. The results show that rainfall or precipitation occurs mainly from April to November, with a variation in the amount from April to June at the lowest to July at the highest.

The wetland networks and interconnectivity are made up of extremely biodiverse freshwater areas that make up approximately 10% of the total land area of the campus. The existing site plans of the institution and its wetlands did not consider the actual evolution of the drainage network of the area over the past years of continuous noticeable encroachments and abuses. The following interrelated actions were undertaken: field surveys of the selected

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wetlands; classification of plant communities; and organized interviews with selected tourists, faculty, and students in the area. Further to record the fish and wildlife inventories of the wetlands. Information from satellite photos, topographic maps, and previous ecological research were the sources of secondary data. The third stage involves synthesizing organized interviews with students, visitors, and teachers. The remaining phases include an assessment of the current wetlands and green corridors, an analysis of open space for the design and construction of the park, and an exploration of campus opportunities and issues based on the integration of all identified phases.

Findings and Discussions

A section through the site shows that the wetland has an average depth of four meters and a gentle slope on both sides of the land. Figure 4 illustrates how close and the proximity of both the Faculty of Law and Faculty of Management Science is to the green corridor. The wetland itself is needed for ecological restoration because it is home to a variety of species that should be conserved. Along with a reasonably level upland and a steep slope, the property features an average floodplain of 4.5 meters below the natural ground level.

Table 1 – Criteria for rating the SWOT analysis

Criteria	Strength	Weakness	Opportunities	Threats
Accessibility	****	*	****	*
Ecological diversity	****	****	***	*
Natural engagement	****	*	****	*
Capacity	***	**	***	*
Recreation	**	*	****	*
Functionality	*	****	****	*
Social activities	*	**	****	*

Note: 4*(extreme impact), 3*(critical/high impact), 2*(fair/low impact), 1*(very low impact).

Source: The authors (2024).

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Table 2 – On-site assessment of the study area

Strength	Weakness	Opportunities	Threats
Good scenic view, Located in the quiet part of the campus, Proximity to the lagoon, Scenic view, Natural resources, Road access, Location within an educational institution (limited community abuse), Existing vegetation, High-value adjoining properties.	Poor maintenance of the facilities, Lack of direct access to the lagoon front, Difficult access from a major road leading directly to the waterfront, Inaccessibility for adequate analysis, A large portion of the site is used for refuse dumping.	Create employment opportunities, It can be transformed into a tourist center, Accelerate new investments, Improve socio-economic conditions, Closed dense tree canopy, Preserved animals, Natural vegetation, Road access, Presence of a financial institution.	The Lagos Lagoon (influx of boats and security breach through the lagoon), Some poisonous crabs coming out of the holes, Damaged cage, Waterlogged and marshy area, The threat of erosion, Waste pollution, Inaccessibility and undefined boundaries.

Source: The authors (2024).

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Table 3 – Existing situation on-site and research problems

Pictures	Field Survey Remarks	Challenges and Threats
	Pictures showing faculty behind the wetland.	The drainage network and rainwater runoff around the area are channeled to the wetland behind.
	Shops and unapproved buildings in front of the wetland.	The shops and illegal businesses in front of the wetland generate a lot of garbage and dirt.
	A transparent fence around the perimeter of the wetland along the existing road and academic buildings.	This is to prevent easy access or intrusion into the wetland, thereby preventing further abuse and misuse.
	Unauthorized refuse dumpsite to be relocated to designated waste disposal point.	The foul water from the waste dumped in this area ends up flowing into the wetland during heavy rain downpours. This waste also causes air pollution when burned.
	Visible signage throughout the campus. Image showing the access road.	The presence of roads directly from the wetland has caused the influx of people to directly reduce the number of monkeys.

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	Trees are planted to shade off the wetland.	Monkeys often play on trees, which also attract many species of birds.
	Picture showing the area of the wetland with a stable terrain.	This area has a limited amount of water and many dangerous reptiles. It only floods during the rainy season.
	Wetland covered with water weeds.	The part of the wetland has a depth of about 4.5m below the natural ground level.
	Bodies of water were visible, and someone could be seen fishing around the corridor.	The bodies of water must be maintained and not disturbed to preserve the animals.
	A "Wetland Restoration in Progress" sign was written on the wetland to inform people of the need to stay away from the site (see attached photo).	A restoration site must be restricted from further misuse.

Source: The authors (2024).

The main components of a SWOT analysis in Tables 1-3 are broken down as follows and are analyses of both internal and external aspects that influence an initiative or operation's goal. First, the internal elements of the wetland have control over its strengths and weaknesses, and the external elements such as the threats and opportunities are elements that are outside the

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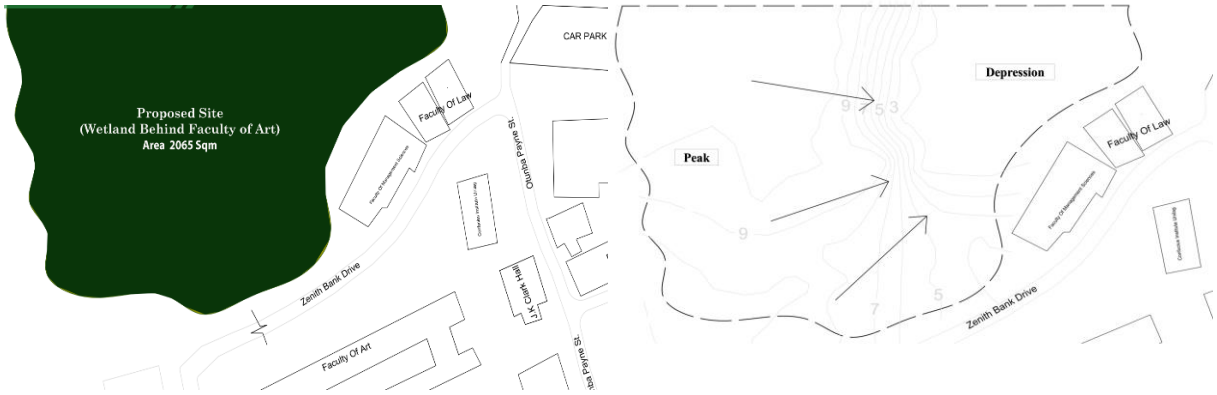
wetland's control. The relevance and suitability of the methodology that led to these findings are simply for several uses, such as the monitoring of urban space projects, urban renewal, planning for the future, and in-depth growth. Table 3 identifies possible risks and opportunities to create a successful landscape design strategy.

This analysis helps to assess the existing wetlands in the urban space, identify areas for progress, and develop new strategies. After careful analysis of the three hotspot areas through the existing situation on-site research. This study determined the advantages and disadvantages of the various aspects that were considered, as well as setting goals for their growth. This methodological approach helps to take a fresh and diverse look at the wetland habitat. Figures 5 (a) and (b) show the existing buildings and road infrastructure and the current direction of runoff into the wetland. A large amount of human waste has been deposited into the area through these facilities. Figures 5b and 6 show the main contours and direction of water flow runoff from the existing environmental situations around the existing buildings.

Figure 5 a & b – a) The study area location plan. b) The boundary of the study site (2,100 m^2) alongside the peak and depression



(a) (b)

Source: The authors (2024).

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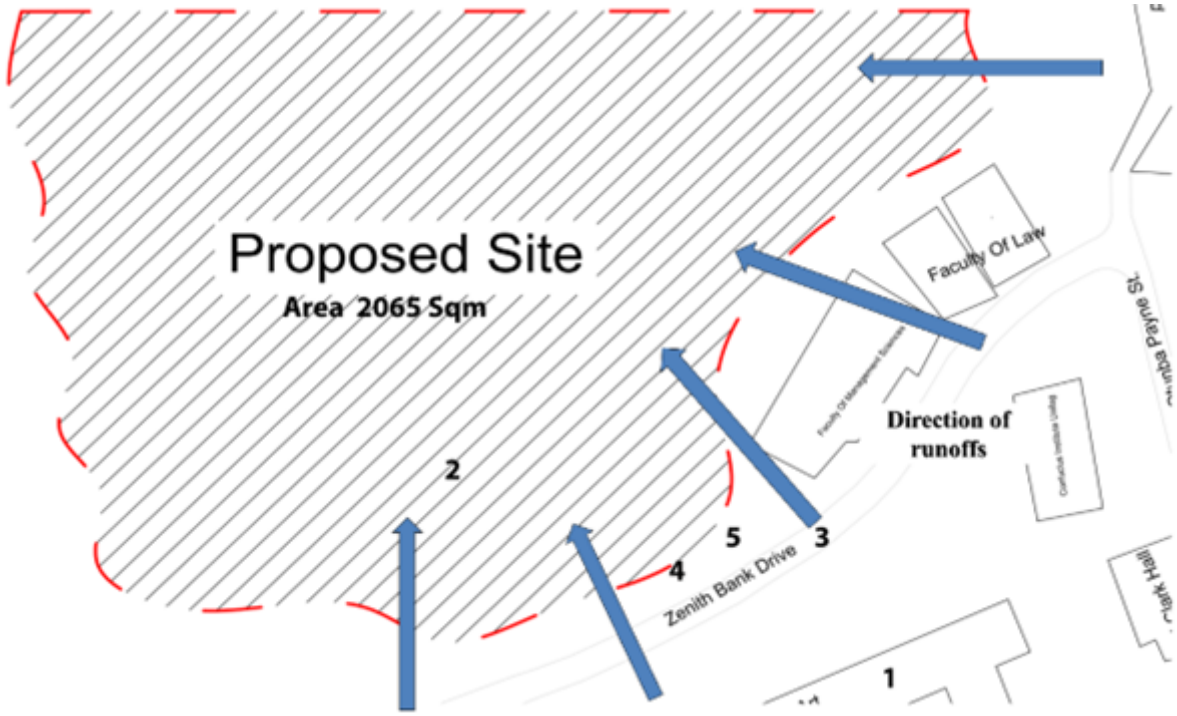
Figure 6 – Maps showing the contour of the study area and the direction of drainage/runoff



Source: The authors (2024).

Biodiversity and Ecological Sampling

Different wetlands can have distinct plant communities, with each species adapted to the local hydrology (the amount, distribution, and flow of water at a particular site). Wetland plants are typically called hydrophytes because of their unique ability to thrive in waterlogged soils. Many animal species, including birds and insects, depend entirely on wetlands for important stages of their life cycles, while many others use wetlands for feeding, resting, or other purposes. While some wetlands are scattered across the landscape in upland depressions that hold water or in areas where groundwater rises to the surface, this research showed that many wetlands are transitional zones between upland and aquatic ecosystems (Figure 7).

The water content of a wetland can vary greatly, and while some wetlands are inundated only periodically but maintain saturated soils for much of the unflooded time, others, such as the wetlands used in this study, are inundated constantly. Waterlogged soil conditions persist long enough to support wetland-adapted plants and to develop hydric soil characteristics, even

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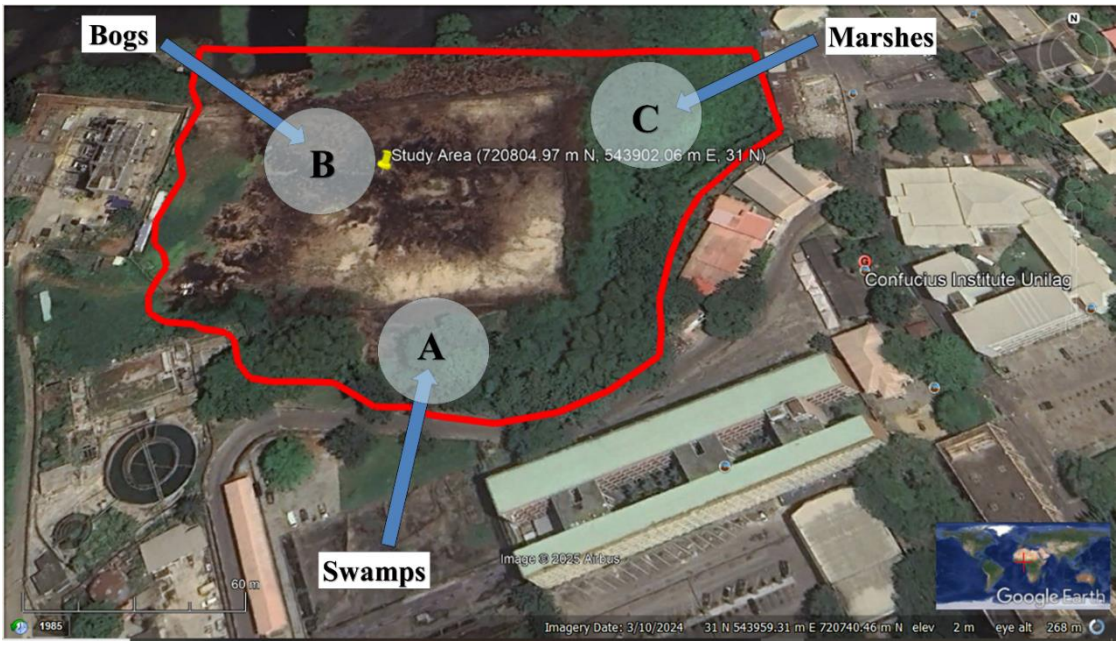
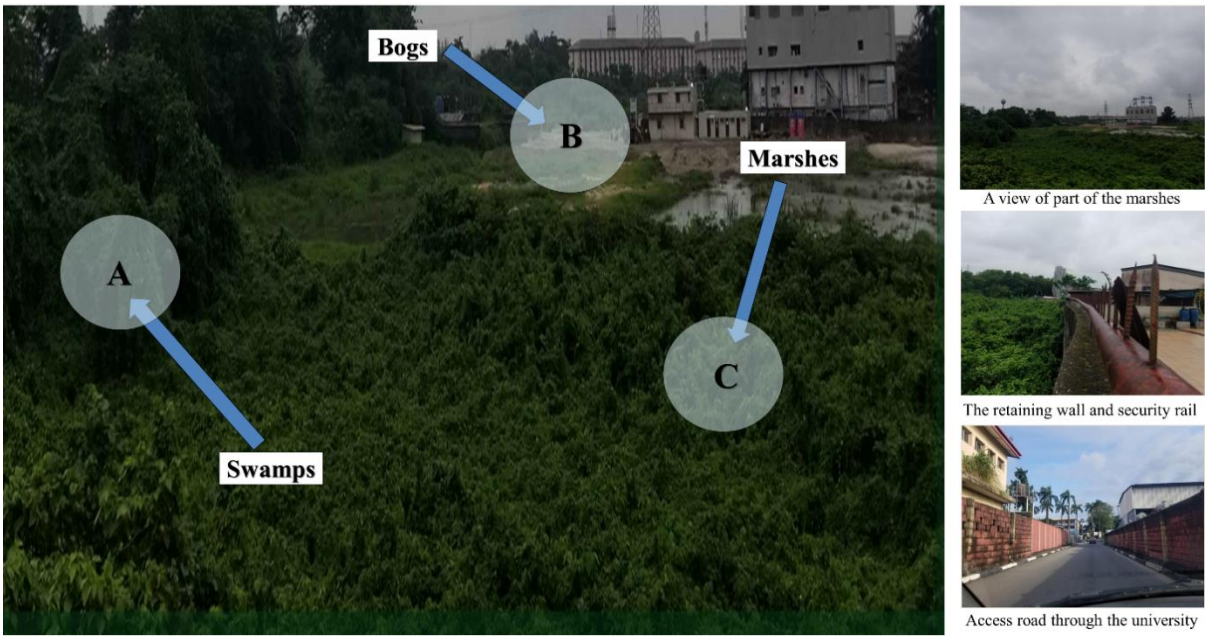
though other wetlands may flood infrequently. When chemical changes occur in the soil as a result of low oxygen levels caused by prolonged saturation, hydric soils are created.

Figure 7 – Aerial imagery of the University of Lagos showing the selected wetland



Source: The authors (2024).

Figure 8 – Aerial imagery of the University of Lagos showing the selected wetland



Source: The authors (2024).

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As determined by field studies, and shown in Figures 7 and 8, there are several types of wetlands, each identified by soil composition, water chemistry, water flow, and plant diversity. Trees, shrubs, or herbaceous plants can be considered the dominant vegetation types in these wetlands. Rainwater or groundwater, whose chemistry ranges from extremely acidic to alkaline, may provide them with food. Aquatic and emergent macrophytes are the two main categories of wetland vegetation; aquatic plants live underwater or float, while emergent plants have roots in the mud and rise above the water. The research location is a freshwater swamp forest with three types of vegetation: bogs, swamps, and marshes — which, in terms of hydrology, are the three main forms of wetlands.

Figures 7 and 8 illustrate how each presents unique characteristics depending on its water sources and its capacity to retain or release water. Swamps (Zone A) are characterized by trees or shrubs and are often found where the ground is frequently flooded; trees and other woods predominate. Bogs (Zone B) are usually characterized by mosses and lichens and are found in places with acidic, wet soils. Sphagnum mosses predominate in acidic, nutrient-poor environments, and this type of wetland contains peat and often has a variety of plants. In the case of bogs (Zone C), grasses, sedges, cattails, and bulrushes are examples of the herbaceous flora that define these wetlands, which support non-woody emergent plants (Figures 7 and 8).

Following the three categories of wetlands observed in the study area, several mammals and reptiles were seen in the three sampled hotspot areas A, B, and C (hotspots with an average diameter of 50 m). The study detected the presence of the following animal species: *cercopithecus mona*, *naja melaleuca*, pangolin, *tragelephus spekei* (sitatunga), *cercopithecus nictitans* (white-nose monkey), and giant forest squirrel, as well as *thryonomy swinderianus* and *veranus nilotius*, nicknamed the monitor lizard. Reptiles such as pythons are dominant in this area. The following fish species are found in the wetland and green corridor: *heterabran chusbidorsaili*, *heterotis niloticus*, *gymnarchus niloticus*, *cittrari nuscitharus*, *lates niloticus*, *tilapia nilotica*, *tilapia galilaea*, and *tilapia sillii*. Bicycle and jogging routes are some of the aspects of conservation, as well as a skywalk, an aqua pond, a restaurant, a gazebo, monkey and bird watching points, and a watch tower. Sufficient native trees should be planted for restoration. Bitter Kola (*garcinia kola*), Baobab (*adansonia grandidieri*), Monkey Puzzle

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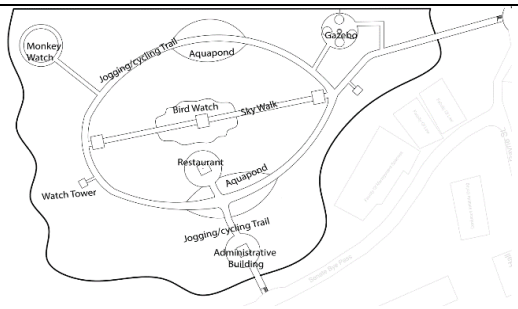
(*araucaria araucana*), Magnolia (*magnolia officinalis*), Kola Nut (*cola nitida*), Loulu (*pritchardia kaalae*), Hinton's Oak (*quercus hintonii*), St. Helena Gumwood (*commidendrum robustum*), Clanwilliam Cedar (*widdringtonia wallichii*), Honduran Rosewood (*dalbergia stevensonii*), and African blackwood (mpingo, *dalbergia melanoxylon*) are among the trees that should be introduced for conservation.

Table 4 shows the existing condition of the site and the proposed conceptual distribution of activities: in addition to the trees, there are light-colored buildings made of environmentally friendly materials (ecolodges), such as ponds, security posts, ticket booths, retail shops, rest areas with wooden chairs, a recreation arena with a nice view of the surroundings, gazebos, mini-zoo, parrot gardens, wooden walkways, and restaurants. The common fauna that once inhabited the area around fifty years ago is extinct due to the degradation of the environment. It has a swamp forest located in the poorly drained parts of the floodplain leading to the lagoon. The underlying soil contains a very high level of organic matter and the trees in the swamp forest often reach a height of about six meters.

Table 4 – Showing the existing condition of the site and the conceptual distribution of activities

Selected Wetland	Schematic Diagram
	
Aerial imagery showing the site condition of the selected wetland and the site boundary.	Conceptual diagram to show the proposed ecotourism activities.

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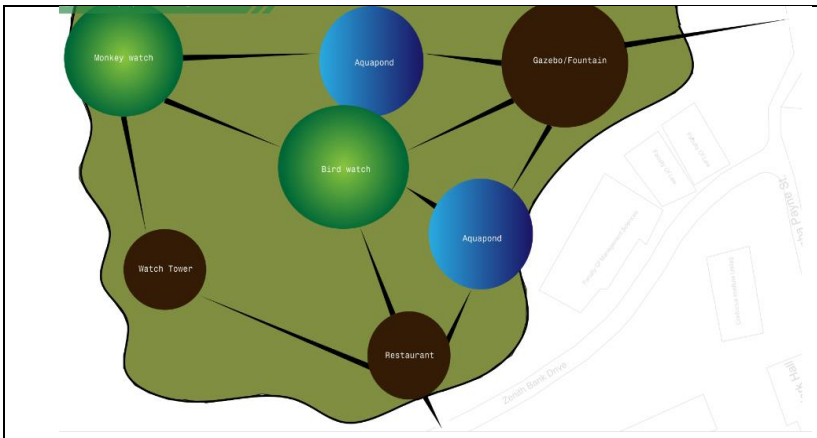
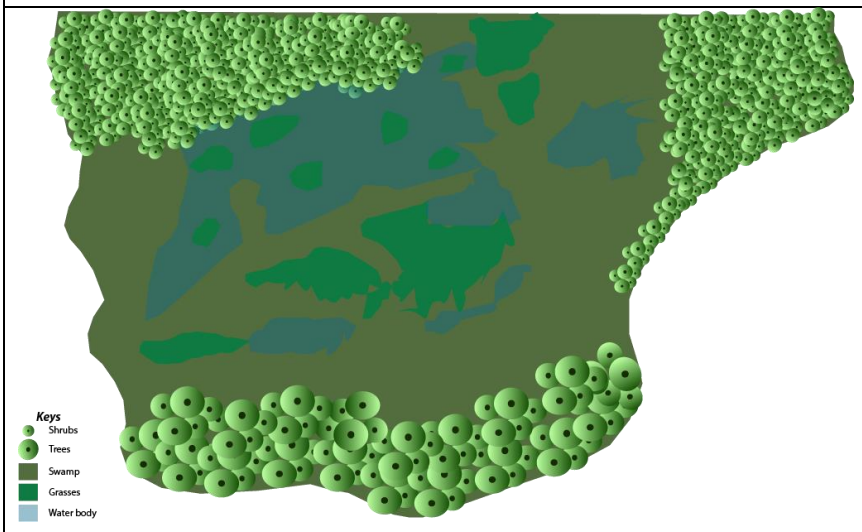
	The bubble diagram shows the spatial distribution of human impact areas and the proposed activities on the wetlands. All activities will have no direct negative impact on the wildlife.
	This panel shows the vegetation analysis of the existing situation on the site to be restored and preserved. For effective conservation of the wetland, more native trees would be added to the existing vegetation in the swamp area (hotspots A, B, and C).

Source: The authors (2024).

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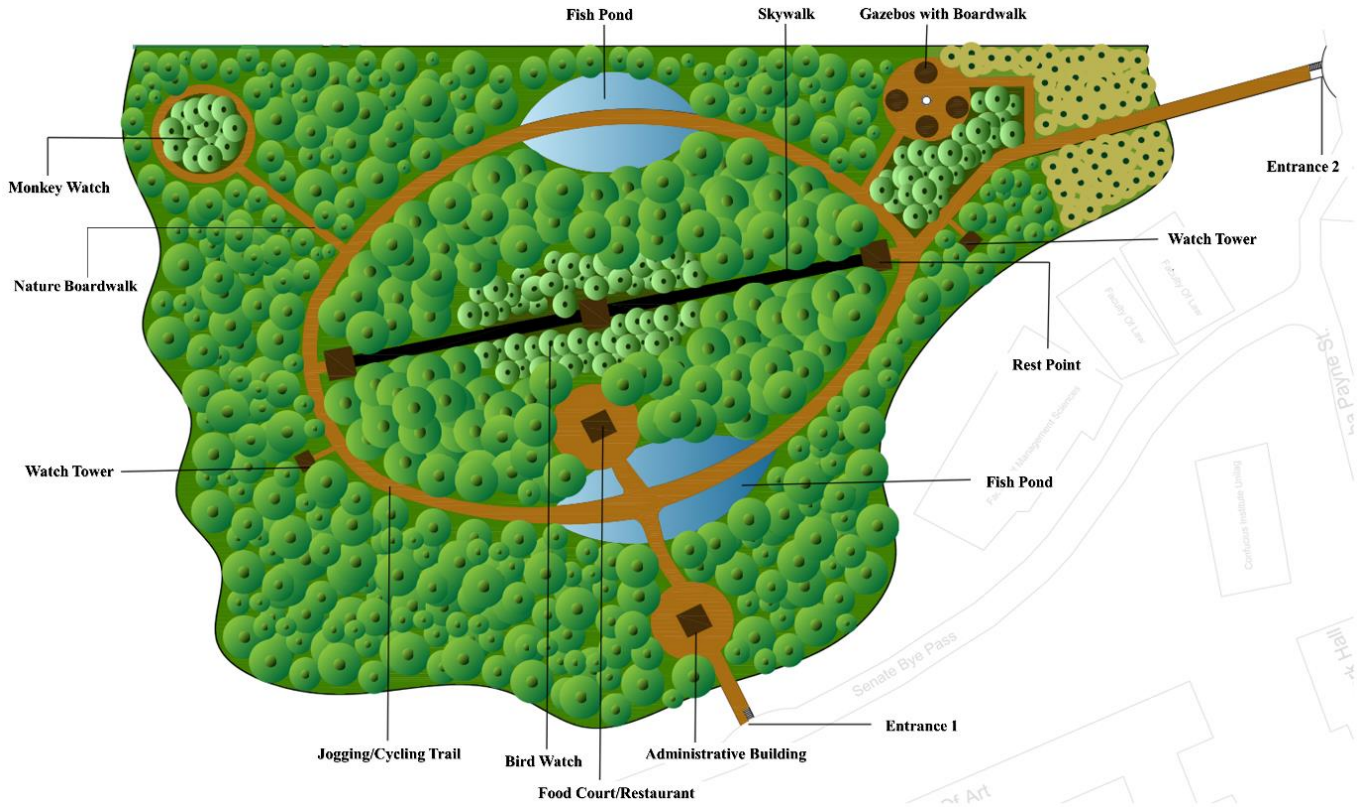
Figure 9 – Site plan showing the proposed ecotourism activities



Source: The authors (2024).

Concept, Development, and Proposed Action Plan for Ecotourism Design

The main goal of the restoration project was both the satisfaction of ecological imperatives and human needs at the location. To level the ground and facilitate the installation of boardwalks, access roads, walkways, and camping tents at an average elevation of 6 meters above sea level, some parts of the site would need to be cut and filled to solve the site's problems. Some of the identified ecotourism activities would not directly affect the wetland (Figure 9 and Table 5). In addition, it also facilitates restoration, with the main biodiversity being maintained for ecotourism purposes. The multifaceted consideration of multidimensional wetland restoration and its regard for potential misuse by the surrounding communities, over which the college has little to no control, should allow the site to act as a sponge, increase the value of open green space, and be social, resilient, and adaptive landscapes.

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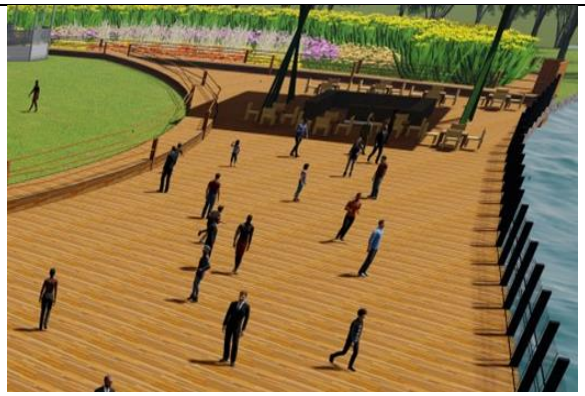
Table 5 – Demonstrating material selection considerations, deck construction, and landscape design concerns

Design Considerations	Remarks
	Elevated natural boardwalks made of treated bamboo, seasoned timbers, and guardrails as barriers to prevent falling into the swamp.
	Rest area and ecolodge for relaxation and shelter from the rain. Snack and souvenir shop and conservationist office.
	Skywalk for nature observation. The tourists can walk on the boardwalks and relax in the designated rest areas.

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	Typical accesses 1 and 2. The proposed accesses to the wetland will be connected to the existing road for both pedestrians and cyclists.
	Elevated boardwalks are made of marine boards and seasonal timbers with vertical bamboo railings to prevent falling in the swamp.
	Aqua pond is specially designed for specific species of fish for easy control, maintenance, observation, and scientific research.

Source: The authors (2024).

Mapping Existing Wetlands and Green Corridors

On-site mapping of all current wetlands in the study area is the first step in restoring green space while providing answers to questions such as What is the biodiversity index and assessment of the site? What is the degree of greenness, are they accessible, do they make sense, are they connected to the soil, etc.? Only a tiny part of the wetlands is always accessible, and due to a lack of suitable land, reclamation by sand filling has been done in some upland parts

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of the wetlands for university development projects. These are the findings of the analysis and field inspection.

In virtually every city, densification and global warming will be major topics of discussion in future urban development. Key issues include wetland restoration, heat island effects, air pollution, and social issues such as stress and loss of connection to nature. Sustainable cities are based on robust ecosystems. Restoring the environment helps to mitigate the urban heat island effect, moderate and lower urban temperatures, and reduce air pollution.

Creating a Campus Greening Action Plan

Setting goals for revitalizing and greening the academic community is the main purpose. However, some questions that come to mind are What are the biggest problems facing the campus environment and landscapes today? Is it water retention, open space comfort, air effectiveness, or the psychological health of faculty and youth? After that, we can design the future of the university. To address periodic ecological issues and encourage residents to explore the natural areas outside the city, a link between local and regional green spaces should be established. It is also imperative to provide visually appealing and creative wetland access features that will draw people to the green spaces.

Restore to Reconnect

Regular interaction with urban natural areas can promote improved psychological balance, self-esteem, and tolerance. It is important to have larger green spaces, such as neighborhood parks, pocket parks, and gardens within 500 meters, and street green spaces, such as trees, pedestrian vegetable gardens, and open spaces, within 100 meters to create a highly interconnected green infrastructure that enhances everyday green. Although they both involve covering building surfaces with vegetation, it is crucial to treat them as two distinct interventions, as there are significant differences in how these technologies are applied and structured, as well as the impact they have on urban ecosystems. Wetlands must be part of a larger ecological infrastructure, either in the city or in the university community, to increase their value.

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Integrating green corridors around some of the faculties adjacent to the wetlands is challenging due to their difficult topography, connectivity, and location for access road construction. There will be places where students can see and interact with natural plants and wild or semi-wild animals associated with the university environment. Native plant communities are ideal for our urban streetscapes, city parks, regional greenways, and vegetated stormwater infrastructure. In addition to providing habitat and biodiversity, native plants help capture and infiltrate stormwater, improving water quality. Depending on the topography and location of the corridor, boardwalks, and skywalks should be constructed of sustainable and ecological materials.

Table 5 shows the wooden board deck made of seasoned and treated hardwood as well as the side guardrails made of environmentally friendly materials on an elevated formwork at an average height of 5-7 meters above sea level. The pictures show the use of a treated hardwood boardwalk at an average height of 5-7 meters above sea level, depending on the average height of the stable ground surface. All elements of the boardwalk are vertically constructed guardrails made of treated bamboo and are well maintained with anti-rust and anti-termite chemicals and paints to prevent deterioration and corrosion.

Benefits of Sustainable Landscape Design

Findings from the site indicated the need for energy efficiency, and this study considered how landscaping, such as the use of shade trees to reduce the need for cooling and design for natural ventilation, affects energy use. Designing a sustainable landscape that is appropriate for the marsh requires an understanding of the site's current conditions, which were identified through the site study. These conditions include soil type, solar exposure, and drainage patterns. The design can be made both visually pleasing and sustainable by using collaborative techniques and working with local professionals, including landscape architects, planners, and horticulturists. Survey respondents emphasize the importance of protecting the natural world by reducing greenhouse gases, conserving resources, and promoting diversity to create a healthy planet. In terms of ongoing waterway maintenance costs, this guarantees a reduction. Improved health and well-being, stress reduction, improved air quality, and recreational

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activities are all benefits of green space. In addition to providing significant neighborhood benefits through the ecological contribution to overall health and attractiveness, a well-designed and managed landscape will enhance the quality of the host community.

Conclusion

The design and formation of a distinctive and sustainable landscape design approach to create a welcoming environment within and around the facility and its surroundings are the principles of ecotourism and tourism hospitality. Therefore, there will be enhancement and protection of the natural ecosystem and wetland biodiversity will be preserved for future adventure. To enhance the green corridors and riparian buffers within the University of Lagos river profile, the University authority may be able to collaborate with the surrounding communities for mutual benefit. This wetland restoration study is a deliberate attempt to do so by adhering to the basic principles of restoration, which include restoring the landscape to self-sufficiency and replanting with native plant species to stabilize the riverbanks and reduce sedimentation. It is also important to control the flora and fauna and ensure that the habitat created supports healthy aquatic species and fauna within the fragile and geomorphic ecosystem. Conduct an ecological assessment and thorough study of the landscape and the biological mechanisms that drive it, focusing on soil, hydrology, and vegetation, and using native plants as the framework for restoration.

Therefore, there is a need to start planning wetlands and their natural habitats for ecotourism worldwide immediately, and a sustainable way to achieve this is to study the places that have been neglected and damaged to make aesthetic changes. The advantages and disadvantages of wetlands should be considered and linked to the ecological services the environment provides. The landscape needs of a university campus should not only guide the creation of academic goals and a vision but should also be achieved by re-establishing connections with the existing green open spaces by creating biological, artistic, and physical networks between the buffer zone and the green corridors that separate the campus from the host communities. It is equally important that concerned public and private organizations take immediate action to address the laws, regulations, and policies that will allow the degraded

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landscapes to become green again. Institutions, both local and foreign, should be able to research current projects that address campus-related issues of biodiversity conservation, ecology, forest management, bioremediation, and wetland restoration practices.

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