

Urbanization and Wetland Degradation: Land Use Land Cover Change Analysis of the Aberdeen Creek, Sierra Leone River Estuary

Aloysious Kingsley Suleiman (✉ akingsleysuleiman@gmail.com)

Tongji University College of Environmental Science and Engineering <https://orcid.org/0009-0001-2067-899X>

Changming Yang

Tongji University College of Environmental Science and Engineering

Alpha Sesay

Njala University

Research Article

Keywords: Urbanization, Wetland Degradation, Mangroves, Ramsar site, LULC

Posted Date: November 7th, 2023

DOI: <https://doi.org/10.21203/rs.3.rs-3443677/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

The rapid urbanization of the global population is having devastating impacts on wetlands globally. In Sierra Leone, urbanization has resulted in the degradation of mangroves and the overall destruction of the wetland around Aberdeen Creek. This study therefore maps out, characterizes, and assesses the Land Use Land Cover Change, and potentials of Aberdeen Creek situated on the Sierra Leone River Estuary. The study will serve as an eye-opener for sustainable land use planning and preserving the Wetland under the supervision of the Ramsar Convention. In that light, the research was carried out using remote sensing and GIS techniques to analyze the extent of degradation on the wetland in three time series, which were mainly driven by Landsat imageries acquired in 2000, 2023 and predicted a 2033 scenario if urgent actions are not taken. The results show that there is an exponential settlement and infrastructural growth in the study area resulting to the quest for land, housing and other facilities/infrastructures that have given rise to changes in land cover, reduction and loss of the Wetlands. Furthermore, comparing the various time series, the result shows that, by the year 2000 there were abundant mangroves, but over two decades later in 2023, there is a drastic reduction in the mangroves, and the 2033 estimation predicted a worrisome outcome for the wetland. The study equally revealed alarming rates of environmental degradation due to ineffective legal frameworks and enforcement systems. It is therefore recommended that urgent actions be taken to evacuate people from those areas, halt further encroachment and regenerate lost species and ecosystems.

Introduction

The rapid population growth, unplanned urbanization and industrialization in the periphery has generated pressure and changes in land use patterns, causing extensive urban expansion (Islam et al., 2014). The rise in Land use and land cover have been affected globally, regionally, and locally by urbanization. In most cities, urbanization has a significant impact on the landscapes and environments, and natural areas become impermeable as a result of urban land use. Changes affect the environment by altering the surface temperature, soil moisture content, and vegetation coverage (Rahman et al., 2023). Moreover, push factors, such as high housing costs and service value and land prices in urban core areas have facilitated the fragmentation of wetland areas, including marshland and mangrove areas, over the last two decades (Athukorala et al., 2021). Wetlands and related urban green infrastructure have perhaps expressed the most dramatic impact of the urbanization phenomenon that has marked Africa's Urban dispensation (Bigon, 2013; Cobbinah et al., 2022). Research by Danso, (2021) indicated that residential land use was the most predominant of all land uses in the Accra metropolis and that most of the wetlands are encroached upon by the urban poor in their quest for an affordable place, resulting in a substantial number of unauthorized structures on wetlands for both commercial and residential purposes. Earlier research stated that the modification of Earth's territorial surface by human activities is commonly known as land use/land cover change (LULC) and the global intensity is far greater now than thousands of years ago (Hassan et al., 2016). Timely and proper assessment of wetland area change is essential for conserving wetlands (Basu et al., 2021). Land use and Landcover change studies have

become key components for managing natural resources and monitoring environmental changes (Chigbu et al., 2011).

Since the formation of the Ramsar Convention in the 70s, more than 2,300 wetlands have been added to the list, and its very own report stated that since 1970–2015, wetlands of International importance have declined by 35% (Gardner and Finlayson, 2018). However, the remaining natural wetlands cover only a fraction of their original area and have been progressively declining for centuries in most of the World through drainage and conversion (Davidson, 2014). Most of the wetland loss was due to the expansion of urban built-up areas rather than industrial or transportation lands (Mao et al., 2018). During this period, researchers have explained the urban landscape pattern and quality, urban sprawl, and consequences of urban land use change and modelled the future urban expansion (Rahman et al., 2023). Mangroves are tropical ecosystems of high relevance for biodiversity conservation and the provision of ecosystem services to the human population living along their shores. However, mangroves are at risk of disappearing especially in areas of high urban development, as urban sprawl leads to rapid environmental changes (Garcés-Ordóñez et al., 2023). Therefore, it is essential to model and analyze the dynamic nature of urban areas and their environments to develop new planning strategies and make cities sustainable for living (Webb et al., 2018). This is because as Garcés-Ordóñez et al., (2023) revealed, most of the degrading factors in the mangrove ecosystem of Mallorca Lagoon are urban Sprawl, wastewater discharges, litter accumulation, mangrove logging and landfilling. These causes are often fueled in two folds; first is the tendency of the traditional authorities to release land for development without official planning approval on the one hand, but also the failure of the formal urban planning institutions to implement policies on wetland use and management (Cobbinah et al., 2022). Wise use of wetlands therefore requires a thorough understanding of the drivers of change so the root causes of wetland loss and degradation can be addressed (Gardner and Finlayson, 2018). The ability to safeguard requires a detailed knowledge of their spatial and temporal distribution with the advent of Geographic Information System (GIS) and Remote Sensing (RS) technologies, wetland distribution can be mapped based on Land Cover/Use data without the use of laborious and costly field visits (Maxa and Bolstad, 2009). Remote Sensing technologies marked a remarkable change in the field of urban studies because researchers are able to model the urban spatial forms and change at various scales with precise accuracy and quantify their impacts on the urban environment and climatic systems (Mobasheri, 2020). A statistical analysis revealed a positive, significant relationship between the change in population density and the loss of wetlands due to settlement expansion, indicating that urbanization plays a major role in landscape transformation (Athukorala et al., 2021). However, some new degradation control measures based on traditional and scientific knowledge must be used to reverse the wetlands degradation (Wang et al., 2012).

In Sierra Leone, population growth, rapid and unplanned urbanization, illicit land grabbing and intense deforestation are the major factors that have contributed to biodiversity decline over the past years (Fayiah and Fayiah, 2022). Generally, Land-cover change is one of the most tangible indicators of land degradation in Sierra Leone (SLARI, 2022). Freetown, which is the country's political and business capital, has undoubtedly experienced the most severe land-cover changes over the past three decades. This is

largely driven by the available, business and livelihood opportunities which have increased the city's population since the post-war era (Mansaray et al., 2016). Official estimates for the year 2000 suggest that Sierra Leone had 105,300 hectares of mangroves, or roughly 0.007% of the global total (FAO, 2007; Mondal et al., 2018). However, according to the World Bank report (2011), mangrove forests in Sierra Leone have decreased by 45% between 2000 and 2010 due to the intense human activities, and the intensification of land-use activities especially in urban and peri-urban settings in Sierra Leone is a threat to biodiversity sustainability and by extension adequate availability of ecosystem services (Fayiah and Fayiah, 2022). The drivers of LULC change are attributable to population growth as the main underlying driver and agricultural expansion and infrastructural development as the main proximate or direct drivers (Lahai et al., 2022). However, Machiwa et al. (2021) such changes could be halted through the restriction of certain activities, such as cultivation and building along wetland peripheries, for the benefit of both the current and the future population.

Subsequent studies attempted to shed light on the state of wetlands in Sierra Leone. However, there is limited information about the spatial distribution, characteristics, and potential use of these ecosystems, which will serve as a guide for sustainable land use planning around Aberdeen Creek. For example, Mondal et al., (2017) decadal changes in mangrove extents in Sierra Leone using remote sensing data, in which long-term changes in mangrove extent between 1990–2016 were observed. Their study revealed the Scarcies River estuary witnessed the greatest mangrove loss since 1990, while the Sierra Leone River Estuary experienced mangrove gains over the last 26 years. However, their research focused first on all mangrove vegetation hotspots in Sierra Leone including the SLRE, secondly, they didn't pay attention to the urban part of the Sierra Leone River Estuary (SLRE) which hosts the Aberdeen Creek right in the capital city of Freetown which is densely populated due to urbanization. Reingold, (2019) on the other hand reviewed Disaster-Risk Management (DRM) structures which can tackle intensive and extensive risks -including eviction threats-through strategic resilience-seeking practices in cooperation with the multiple scales of government.

This study tried to answer one question; i.e. "How significant is the Impact of Urbanization on the Aberdeen Creek Wetland?" This paper therefore aimed to map, characterize, and assess the Land Use Land Cover Change, and Potentials of the Aberdeen Creek situated at the Sierra Leone River Estuary Ramsar Site. Being the only Ramsar Site in the Country, data generated in this study would be useful for sustainable land use planning. It would provide insights into the patterns of environmental change and the processes underlying them. With land-cover data, stakeholders can be well informed about the nature of land-cover change and its associated impacts on the environment. Such data could provide a basis for the formulation of environmental policies (Misra and Balaji, 2015). Hence, the integration of wetlands into urban planning practice could lead to the successful management of wetlands in many countries (Cobbinah et al., 2022). Although protecting and conserving mangroves will alleviate environmental and climate change impacts, such realities will only be initiated and sustained with the support of local populations (USAID, 2017).

This work consists of seven (7) distinct sections. The study area, data acquisition procedures, Dataset, and Methods are described in Materials and Methods section. The results of the study are described in the Results section comprising of Distribution, LULC Classification maps and Charts. The results are then discussed in the discussions section. A conclusion was then drawn and discussed in the Conclusion section, and finally some recommendations were given in the recommendation section.

Data and Methods

Study Area

The Sierra Leone River is the combined estuary of many smaller creeks and a few major rivers. The Sierra Leone River Estuary spans from Cape Point on the western side of the Freetown peninsula and covers 295,000 hectares between 13°03' West and 8°37' North along the coast. Over 110 km of mud or mud-sand foreshore, mostly backed by mangroves, and 1800 ha of intertidal mud and muddy sand make up the Sierra Leone River estuary (EPA, 2020). However, only Aberdeen Creek, Bunce Creek, and mudflats south of Tasso Island had extensive mudflats. It is an important breeding habitat for multiple waterbird species (ESA,29/01/2016). The Sierra Leone River Estuary Ramsar Site contains the Aberdeen Creek and other areas. This creek is situated nearby to Murray town, Aberdeen, Cockle Bay and the locality of Cockeril, and have been subjected to enormous encroachment by the public. The creek is the last remaining mangrove and wetland ecosystem on the city coast, where Cockle Bay, an informal settlement on the creek whose population has increased from 5,000 to 20,000 residents (Reingold, 2019) is located. The Sierra Leone River Estuary is home to most of the western region's mangrove resources (Ramsar Convention, 2002). Mangrove degradation and clearance around Freetown, Sierra Leone, have greatly reduced the ability of these wetlands to protect the city from seasonal flooding, which regularly affects different parts of the coast and destroys livelihoods and property (Reingold, 2019).

Data acquisition procedure

The research used modern technology, remote sensing, and GIS techniques. These techniques: Satellite remote sensing, are ideal for mapping and monitoring inland valleys because they provide high spatial and temporal resolution datasets at the landscape level. It also allows for less time-consuming measurements of sensitive sites, without the potential challenges that traditional field methods present (Shuman et al., 2005). Digitally analyzed satellite images were integrated with other spatial data such as land use, uplands, and road networks/settlements to constitute the basis of key site selection. The datasets used were mainly derived from Landsat imageries acquired in 2000, 2023 and predicted 2033. These images were sourced from one of the USGS websites; (<https://glovis.usgs.gov/>) and Landsat look viewer. Landsat is one of the most popular satellite sensors for mangrove mapping due to its spatial and temporal coverage and accessibility. Numerous global studies have utilized Landsat images and optical imagery from SPOT, MODIS, ASTER, QuickBird, WorldView, and IKONOS to quantify mangrove extents and spatiotemporal changes (Mondal et al., 2018). The characteristics of the images are shown in Table 1 below. The Geo-information software: ArcGIS 10.5 was used in the image processing and

visualization of the processed images, while the EXCEL spreadsheet was used to calculate the hectare and percentages of the four indicators. False Color Composite (RGB) of the three bands for each of the selected dates was made to increase the pictorial quality for easy visual interpretation and identification of features on the images. The images were then classified using the Maximum Likelihood algorithm into four classes: Bare land, Built-up area, Mangrove swamp and water bodies. All the data were geometrically rectified to a common map reference system (UTM MAP PROJECTIONS ZONE 28 WEST, WGS 84 GEODETIC DATUM as shown in the Table below. Data from other sources including population density and zonal boundaries were obtained from the website of Statistics Sierra Leone at <https://www.statistics.sl/>. The terms Land Use Change Land Cover Change shall hence be referred to as LULC and the Sierra Leone River Estuary SLRE. Landsat data series used for Land use and Land cover analysis of the Aberdeen Creek on Sierra Leone River Estuary, Freetown over the last two decades and a predicted 2033 (see Table 1). Long-term studies are essential to understanding the effects of urbanization on wetlands and the effectiveness of management actions (Kentula et al., 2004).

Dataset

Landsat data series used for Land use and Land cover analysis of the Aberdeen Creek, Freetown over the last two decades and a predicted 2033.

Table 1
Characteristics of satellite imageries

Satellite dates	Type of Landsat image	Spectral resolution (m)
2000	Landsat 8 OL1	30
2023	Landsat 7 ETM+	30
2033	Landsat 9 OL1	30

Results

The results were analyzed using tables, maps, and charts. The size and area of the land cover changes were calculated and represented in hectares (Ha) and percentages (%) (see Table 2). The rationale for these was based on change detection over time and the total size of the study area. The study revealed an exponential growth in the study area which has led to the quest for land, housing and other facilities/infrastructures that have given rise to changes in land cover, thus, reduction and loss of other land uses.

Table 2
Land Use and Land Cover Distribution for 2000, 2023 and 2033

Land Use Classes	Year 2000		Year 2023		Year 2033	
	Area (ha)	%	Area (ha)	%	Area (ha)	%
Bareland	24.66	5%	12.87	3%	32.58	7%
Built-up-areas	120.96	26%	356.94	76%	382.77	81%
Mangrove swamp	174.96	37%	77.94	17%	42.3	9%
Waterbodies	151.29	32%	24.12	5%	13.5	3%
Grand Total	471.87	100%	471.87	100%	471.15	100%

As shown in Table 2, the land-use/ land-cover distribution pattern in the year 2000 shows mangrove swamp occupies 37% of the landcover category in the study area, followed by water bodies and built-up area with a percentage of 32% and 26% respectively. This means that the vegetation then was readily abundant and there was available mangrove swamp with less competition for land uses because the population was less. The Bare land surfaces occupy the least of the land use and had about 5%. The land-use/land-cover distribution for 2023 also shows that the mangrove occupies about half of the landcover distribution (17%) whilst the built-up area almost doubled between 2000 and 2023 (76%). This is followed by the water bodies (5%) and bare land (3%) a decrease from 2000 to 2023 land-use distribution respectively.

In 2033, the predicted land-use/landcover distribution shows an increase in the built-up by 81%, while the mangrove swamp would decrease to 9% and water bodies to 3% of the land-use distribution making it the lowest land-use/ land-cover category in the study area. The bare land shows a slight increase occupying only 7% of the total area and this is attributed to land use conversion for other urban activities. Since the end of the war in 2002, Freetown has experienced exponential population growth, and the advent of motorbikes (Okada), Tricycles (Keke) and other informal business has led to more people being attracted to the city life. This has however come at a cost, since land and rental costs for standard apartments are very expensive, many of the urban poor will prefer to reside in formal settlements, which are mostly reclaimed wetland areas. This conforms to the studies of Chigbu et al., (2011) who noted a significant disparity and trend in vegetation land cover due to rapid urbanization and socio-economic activities. Oluseyi, (2006) equally revealed land use types are subject to major changes in vegetation cover and sprawl development.

Land Use and Land Cover Change Classification Maps

The supervised classification system using the maximum likelihood classifier as explained in the methodology was used for the analyses of the imageries. Figures 2, 3 and 4 show the classified maps adopted in this study.

The classified Land Use Land Cover maps in Figs. 2,3 &4 shows a clear distinction between the various LULC activities on the Aberdeen Creek Wetland. In Fig. 2 for instance, we noticed that there was abundant mangrove vegetation representing 37% of the total land area because there was less competition for settlements around wetlands, bareland areas were minimal, built up areas were also low representing 27%, and water bodies intact. Figure 3 shows a drastic change in the LULC patterns, built up area have overtaken the abundance of mangrove vegetation because of the massive rural-urban migration and the tourist hotspot along the beach. Built up areas which were representing 27% have increased to 76% and mangrove is now occupying 17% decreased by 20%. Finally, Fig. 4 is all about the future occurrence if actions are not taken. By 2033, built up areas shall rise to about 81% due to the increasing quest for land resources for housing and recreation. Mangroves would be reduced to 9%, water bodies to 3%, and 7% bareland. LULC classification is a game changer for prompt actions.

Land Use and Land Cover Classification Charts

Figure 5,6 & 7 seven is accordance with Table 2 to further conform with the Landsat and GIS dataset presented in Figs. 2,3 & 4. By 2033 only few hectares of mangroves, barelands, and mangrove would remain.

Discussions

The Aberdeen Creek, located along the Sierra Leone River Estuary “See Fig. 1”, was officially recognized as a Ramsar site in 1999. The site holds significant ecological value as a biodiversity hotspot, serving several ecological functions. Hundreds of seasonal birds have found their way to the creek, which also functions as a breeding ground for fish and was once home to several mangrove trees that act as carbon sinks and safeguard coastal communities from flooding and climate change. Unfortunately, the creek has undergone a massive decline in its overall health due to various human activities See “Figure 3”. The creek has historically provided a habitat for numerous mangroves, which serve as carbon sequestration agents and offer protection to coastal settlements from flooding events and shifts in climatic patterns. The captivating landscape of the creek prior to the year 2000 prompted the Ramsar convention to designate the region as a component of the Sierra Leone River Estuary “Figures 2 & 5”. The drivers of LULC change are attributable to population growth as the main underlying driver (Lahai et al., 2022). However, significant changes have occurred since then, particularly following the end of the 11-year violent civil conflict in 2002, which resulted in the mass migration of thousands of people from rural areas to seek improved livelihoods in the city of Freetown. The violence not only resulted in the displacement of people but also gave rise to socio-economic and environmental challenges. The growing urbanization and its myriad negative effects on natural systems have continued to degrade the wetland 23 years after the war ended “See Fig. 3”. This is because state authorities and institutions have found it difficult to control both the growing population as well as areas in the city expansion has taken place. This has resulted in a situation where the demand rate for resources becomes higher than the rate of resource provision required for eco-friendly economic growth (Parsa et al., 2011), hence the looming unsustainability of the environment “as shown in Fig. 8”. To identify a sustainable solution, it is

imperative for authorities to analyze the sequential process of land acquisition, determine the appropriate policy to prevent encroachments, and devise strategies for improving the existing informal settlements inhabited by low-income families. Several groups of immigrants have inhabited the vicinity of the creek since the war ended, successfully establishing several settlements including Thompson Bay, Crab Town, Cockle Bay, and the Lumley Beach area, as indicated in. The drivers of LULC change are attributable to population growth as the main underlying driver (Machiwa et al., 2021). Urbanization is also associated with an increase in population and the attendant problems of waste generation and disposal as well as undue pressure on the use of other coastal resources e.g. mangroves (EPA, 2020). Notably, the Lumley Beach area has emerged as a prominent tourist attraction, thus leading the heightened built-up areas over the years “as indicated in Figs. 3 & 6”. The strategies employed to inhabit these sites are intriguing. Initially, people, especially low-income residents encroach into plots of the marsh, constructing makeshift and temporary dwellings using corrugated iron sheets and sticks (known locally as Pan Body). Over time, they assert ownership of the property, transitioning into constructing permanent concrete buildings. According to the field reports, complex systems of land rental, acquisition and transfer has equally emerged in these areas, despite their recognition by central government and city authorities as informal. Earlier illegal occupants of these settlements often establish a system wherein prospective occupants must seek approvals from them (by paying some money), who then facilitate the transfer of the land, thereby creating a system believed to be quasi-legal.

Significant reclamation activities take place along the creek, including individuals from both low- and high-income brackets leading to an increase in the built-up areas “as shown in Figs. 6 & 7”. While low-income earners often construct makeshift and low-quality structures, high-income earners are engaged in the development of duplexes “See Fig. 8c&d”. In certain areas of the wetland, there have been an encroachment of up to 150 meters or more into the Creek. If such encroachments and mangrove degradation continue, ecological and environmental risks are likely to intensify, resulting in devastating geohazards (Jin et al., 2020). Tourism, recreation and seaside residents also contribute to the degradation of coastal ecosystems through increased effluent discharge into coastal waters and beach litter as well as coastal population increase (EPA, 2020). However, a pertinent inquiry arises, if low-income earners are viewed as residing in informal settlements, while high-income earners construct duplexes in the same area, one would want to know who authorizes the construction of mansions in areas supposed to be protected? What makes it more interesting is that settlements claimed to be informal by central government and city authorities often have access to public social services like schools, healthcare centers, electricity, pipe borne water, etc. This does not only intensify the quasi-legal claim of residents of these perceived informal settlements, but also serves as incentive for further encroachment and wetland ecosystem degradation. Wetland degradation in Sierra Leone is an interconnected problem that needs to be treated with all seriousness; otherwise, the 2033 predicted scenario “in Fig. 7”, would likely manifest with devastating environment, social and ecological consequences. To halt and avert such occurrences, urgent actions are needed to ensure ecological restoration, even though this may take time to actualize (Garcés-Ordóñez et al., 2023) because considerable damage has already been done.

Conclusion

Urbanization and ineffective legal frameworks are major drivers of the ever-growing land use changes in the Western Urban Area, Freetown Sierra Leone. This has contributed immensely to the poor economic system, ineffective urban planning structures and environmental degradation. This research aimed to characterize and assess the land use cover and potentials of Aberdeen Creek, Western Urban Area, Freetown Sierra Leone, which will guide and provide insight into sustainable land use planning and wetland ecosystems protection. From the study findings, the following conclusions have been drawn:

- The establishment of recreational services along Aberdeen Creek has attracted many people to the area, thus contributing to the physical expansion of Aberdeen Village.
- The most remarkable LULC change occurred between 2000 and 2023, which saw a decrease in mangrove swamp areas due to urbanization.
- Built-up areas are increasing at an alarming rate in the study area, decreasing water bodies and subsequent impacts on wetlands and the immediate environment “as in Fig. 4”.

Land use/land cover mapping and detection of changes shown here may not provide the ultimate explanation for all problems related to land use/land cover changes. However, it serves as a base to understand the patterns and possible causes and consequences of land use/land cover changes in the area.

Recommendations

From the results obtained and conclusions reached, the following recommendations are proffered:

1. Due to urbanization, which has seen the creation of recreational centers along Aberdeen Creek, has attracted a lot of people to the area thus, contributing to the physical expansion of Aberdeen and many informal settlements. This has posed a great threat to the existence of the mangrove swamps in the area as observed by the change from the year 2000 to 2023. It is, therefore, recommended that the Government through the Ministries of Environment and Agriculture through Forestry Division, Environmental Protection Agency, National Protected Area Authority (NPAA), Freetown City Council and other concerned private agencies ensure that the mangrove forest ecosystems of Aberdeen Creek, Freetown Sierra Leone are restored and conserved.
2. With the rapid conversion of the already dwindling mangroves into residential and industrial areas and some being used as sand mining sites for housing construction, the total amount of mangroves available for agricultural, fishing, and environmental protection purposes is under threat. As a result, wetlands are due to a decrease in the water table which indicates the high potential risk of drought (water shortage). To ameliorate this ongoing challenge, effective policies that protect and ensure mangroves and wetlands sustainability are urgently needed. The Ministry of Lands should effectively plan the allocation and use of lands at and around Aberdeen Creek. They should be vigilant and ensure mangroves and other wetlands are not converted to housing construction.

3. This study used a digital mapping technique known as Remote-sensing (RS) technology and geographic information systems (GIS) which are new technologies to map inland mangroves in Sierra Leone. As such, Land use/land cover mapping and detection of changes shown here may not provide the ultimate explanation for all problems related to land use/land cover changes. However, it serves as a base to understand the patterns and possible causes and consequences of land use/land cover changes in the area. It is recommended that these techniques of soil mapping be frequently used to map the mangroves and other wetlands like inland valleys in other parts of the country for a detailed understanding of the spatial distribution, nature and properties and the potential uses of those lowlands. This will help to protect ecologically valuable sites in the country and will help residents of the area to be safe from natural disasters such as flooding and health-related illnesses that may occur because of the massive degradation of the wetland.

Declarations

Ethics approval and consent to participate.

Before embarking on this research, the Authors first wrote letters to appropriate entities dealing with the study area and subject matter for their consent and participation, after which the study was carried out. Legal protocols were observed before undertaking this work.

Consent for Publication

The Authors have consent for the publication of this manuscript.

Availability of Data and materials

The Datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Competing Interests

The Authors have no financial interest in this research and there is no conflict of interest

Authors Contribution

All authors contributed to the study's conceptual and design. Material preparation, data collection and analysis were performed by [Aloysious Kingsley Suleiman], [Changming Yang], and [Alpha Sesay]. The first draft of the manuscript was written by all authors, who equally read and approved the final manuscript for submission.

Funding

The Authors declare that no Funds, grants, or other support were received during the preparation of this manuscript.

Acknowledgements

The corresponding author acknowledges the Government of Sierra Leone for his recommending to the Chinese Embassy, and the MOFCOM for granting him a Scholarship to study abroad. The contribution of the co-authors, especially Mentor Professor Changming YANG, and Family Members are also acknowledged for their support and understanding.

Authors Information

Aloysious Kingsley Suleiman graduated from Njala University with a Bachelor's Degree in Rural Development Studies, Institute of Geography and Development Studies, School of Environmental Sciences. He currently works at the Sierra Leone National Disaster Management Agency.

Changming Yang is an Associate Professor and Senior Lecturer at the Institute of Environment for Sustainable Development, College of Environmental Science and Engineering, Tongji University, Shanghai, China. He provided technical advice throughout the research process.

Alpha Sesay is a Lecturer and a PhD Student at the Institute of Geography and Development Studies, School of Environmental Sciences, Njala University, Sierra Leone.

References

1. Athukorala D, Estoque RC, Murayama Y, Matsushita B (2021) Impacts of Urbanization on the Muthurajawela Marsh and Negombo Lagoon, Sri Lanka: Implications for Landscape Planning towards a Sustainable Urban Wetland Ecosystem. *Remote Sens* 13(2):316
2. Basu T, Das A, Pham QB, Al-Ansari N, Linh NTT, Lagerwall G (2021) Development of an integrated peri-urban wetland degradation assessment approach for the Chatra Wetland in eastern India. *Sci Rep* 11(1):4470
3. Bigon L (2013) Garden cities in colonial Africa: a note on historiography. *Plann Perspect* 28(3):477–485
4. Chigbu N, Igbokwe J, Orisakwe K (2011) Analysis of landuse and landcover changes of Aba uraban using medium resolution imageries. *Spat Inf Process* 11:1–14
5. Cobbinah PB, Korah PI, Bardoe JB, Darkwah RM, Nunbogu AM (2022) Contested urban spaces in unplanned urbanization: Wetlands under siege. *Cities* 121:103489
6. Danso GK, Takyi SA, Amponsah O, Yeboah AS, Owusu RO (2021) Exploring the effects of rapid urbanization on wetlands: insights from the Greater Accra Metropolitan Area, Ghana. *SN Social Sciences* 1(8):212
7. Davidson NC (2014) How much wetland has the world lost? Long-term and recent trends in global wetland area. *Mar Freshw Res* 65(10):934–941
8. EPA (2020) Integrated Costal Zone Management of Sierra Leone. Environment Protection Agency–Sierra Leone

9. Fayiah M, Fayiah MS (2022) In: Chibueze Izah S (ed) Biodiversity in Africa: Potentials, Threats and Conservation. Springer Nature Singapore, Singapore, pp 601–622
10. Garcés-Ordóñez O, Ríos-Mármol M, Vivas-Aguas L-J, Espinosa-Díaz LF, Romero-D'Achiardi D, Canals M (2023) Degradation factors and their environmental impacts on the mangrove ecosystem of the Mallorquin Lagoon, Colombian Caribbean. *Wetlands* 43(7):85
11. Gardner RC, Finlayson C 2018 Global wetland outlook: state of the world's wetlands and their services to people, pp. 2020–2025
12. Hassan Z, Shabbir R, Ahmad SS, Malik AH, Aziz N, Butt A, Erum S (2016) Dynamics of land use and land cover change (LULCC) using geospatial techniques: a case study of Islamabad Pakistan. *SpringerPlus* 5(1):812
13. Islam MS, Rana MMP, Ahmed R (2014) Environmental perception during rapid population growth and urbanization: a case study of Dhaka city. *Environ Dev Sustain* 16(2):443–453
14. Jin W, Cui Y, Wu S, Cheng D (2020) Ecological risk resonance of urbanization and its effect on geohazard disaster: the case of Freetown, Sierra Leone. *Urban Ecosyst* 23(5):1141–1152
15. Kentula ME, Gwin SE, Pierson SM (2004) Tracking changes in wetlands with urbanization: Sixteen years of experience in Portland, Oregon, USA. *Wetlands* 24(4):734–743
16. Lahai MK, Kabba VT, Mansaray LR (2022) Impacts of land-use and land-cover change on rural livelihoods: Evidence from eastern Sierra Leone. *Appl Geogr* 147:102784
17. Machiwa H, Mango J, Sengupta D, Zhou Y (2021) Using Time-Series Remote Sensing Images in Monitoring the Spatial–Temporal Dynamics of LULC in the Msimbazi Basin, Tanzania. *Land* 10(11), 1139
18. Mansaray LR, Huang J, Kamara AA (2016) Mapping deforestation and urban expansion in Freetown, Sierra Leone, from pre- to post-war economic recovery. *Environ Monit Assess* 188(8):470
19. Mao D, Wang Z, Wu J, Wu B, Zeng Y, Song K, Yi K, Luo L (2018) China's wetlands loss to urban expansion. *Land Degrad Dev* 29(8):2644–2657
20. Maxa M, Bolstad P (2009) Mapping northern wetlands with high resolution satellite images and LiDAR. *Wetlands* 29(1):248–260
21. Misra A, Balaji R (2015) Decadal changes in the land use/land cover and shoreline along the coastal districts of southern Gujarat, India. *Environ Monit Assess* 187:1–13
22. Mobasher A (2020) pp. 1–8
23. Mondal P, Trzaska S, De Sherbinin A (2017) Landsat-derived estimates of mangrove extents in the Sierra Leone coastal landscape complex during 1990–2016. *Sensors* 18(1):12
24. Oluseyi OF (2006) Urban land use change analysis of a traditional city from remote sensing data: The case of Ibadan metropolitan area. *Nigeria Humanity & Social Sciences Journal* 1(1):42–64
25. Parsa A, Nakendo F, McCluskey WJ, Page MW (2011) Impact of formalisation of property rights in informal settlements: Evidence from Dar es Salaam city. *Land Use Policy* 28(4):695–705

26. Rahman A, Roy SS, Talukdar S, Shahfahad (2023) Advancements in Urban Environmental Studies: Application of Geospatial Technology and Artificial Intelligence in Urban Studies. Springer, pp 471–478
27. Reingold J (2019) Transforming Freetown. Coastal Resilience and Community-Ecosystem Based Practices
28. Shuman CS, Hodgson G, Ambrose RF (2005) Population impacts of collecting sea anemones and anemonefish for the marine aquarium trade in the Philippines. Coral Reefs 24:564–573
29. SLARI March 14 (2022) Land Degradation Assessment in Moyamba and Pujehun Districts, Sierra Leone, https://procurement-notices.undp.org/view_file.cfm?doc_id=291060
30. Wang M, Qi S, Zhang X (2012) Wetland loss and degradation in the Yellow River Delta, Shandong Province of China. Environ Earth Sci 67(1):185–188
31. Webb R, Bai X, Smith MS, Costanza R, Griggs D, Moglia M, Neuman M, Newman P, Newton P, Norman B, Ryan C, Schandl H, Steffen W, Tapper N, Thomson G (2018) Sustainable urban systems: Co-design and framing for transformation. Ambio 47(1):57–77

Figures

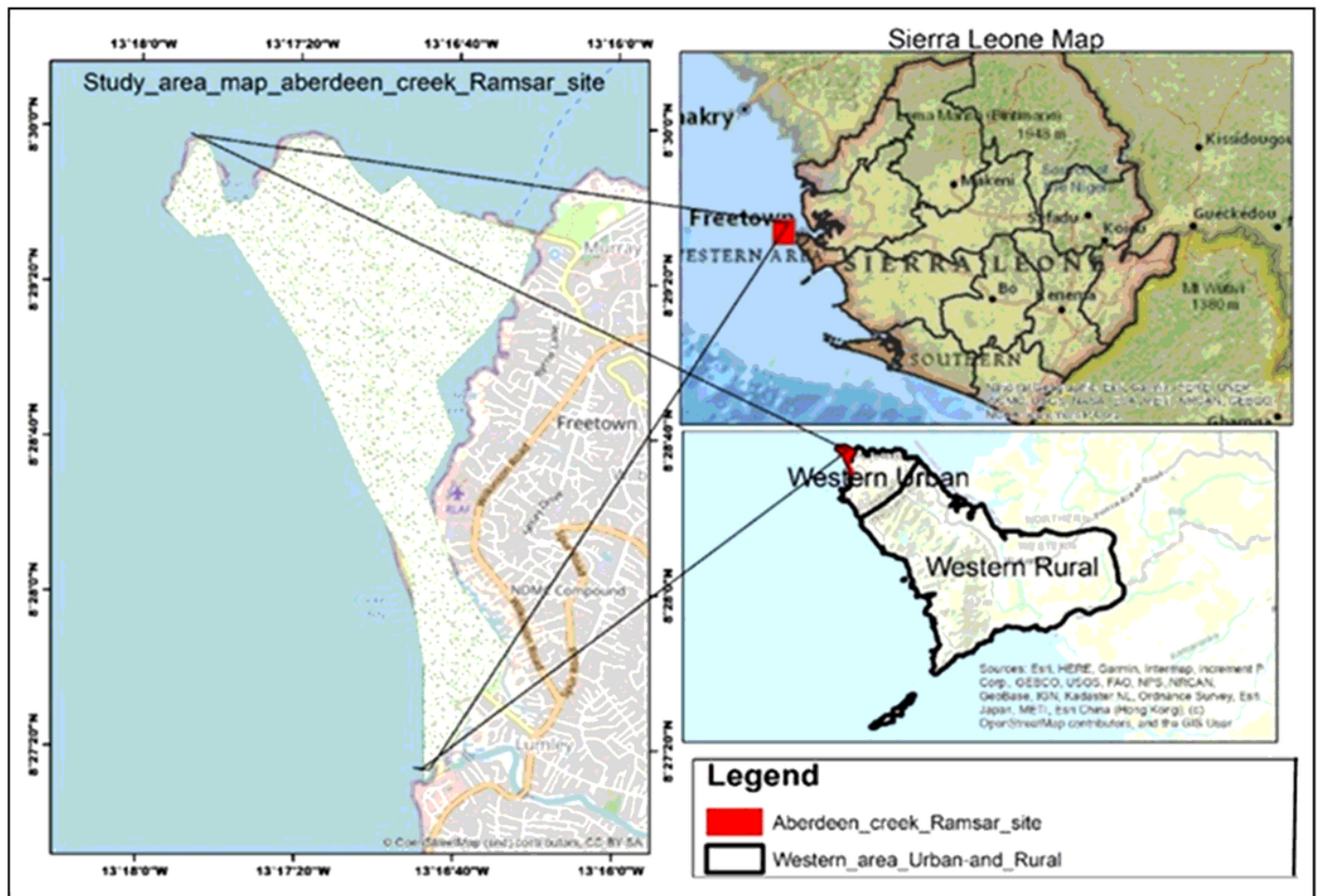


Figure 1

Map showing the location of the Aberdeen Creek, Sierra Leone River Estuary

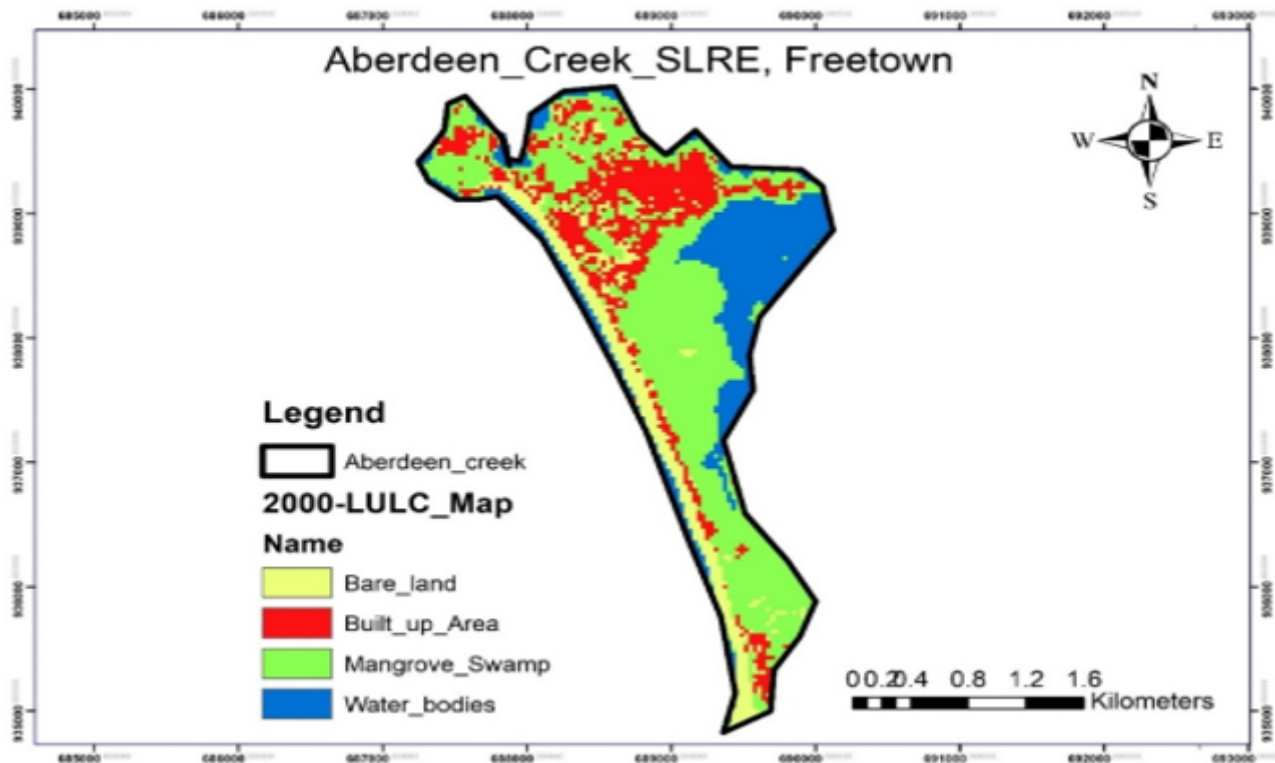


Figure 2

Classified Land use and Land Cover Change of the 2000. There are abundant mangroves, built up was minimal, bare land minimal and waterbodies relatively intact.

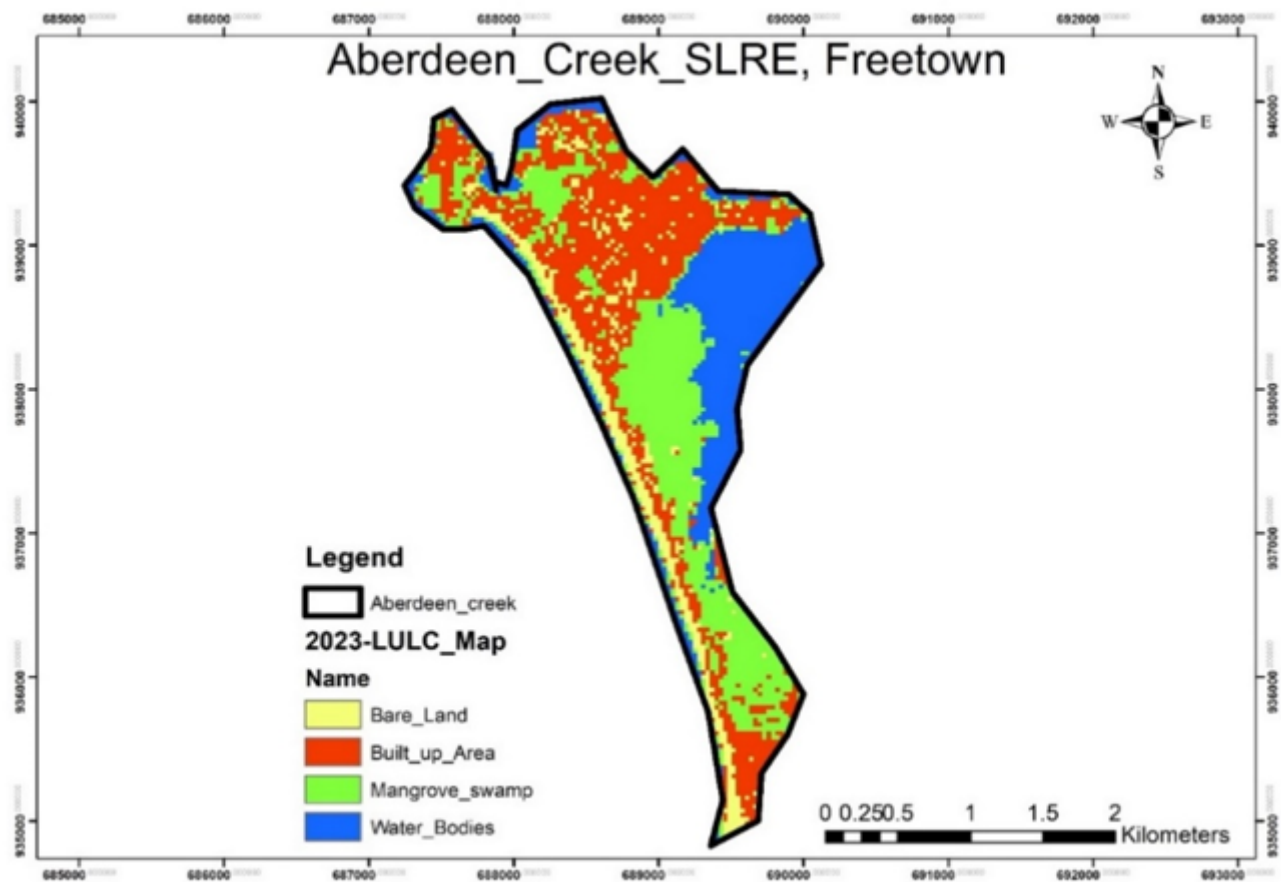


Figure 3

Classified Land use and Land cover of the Year 2023. Built up areas have taken over the mangrove vegetation, bare land increases for recreational purposes and roads, and water bodies reduced.

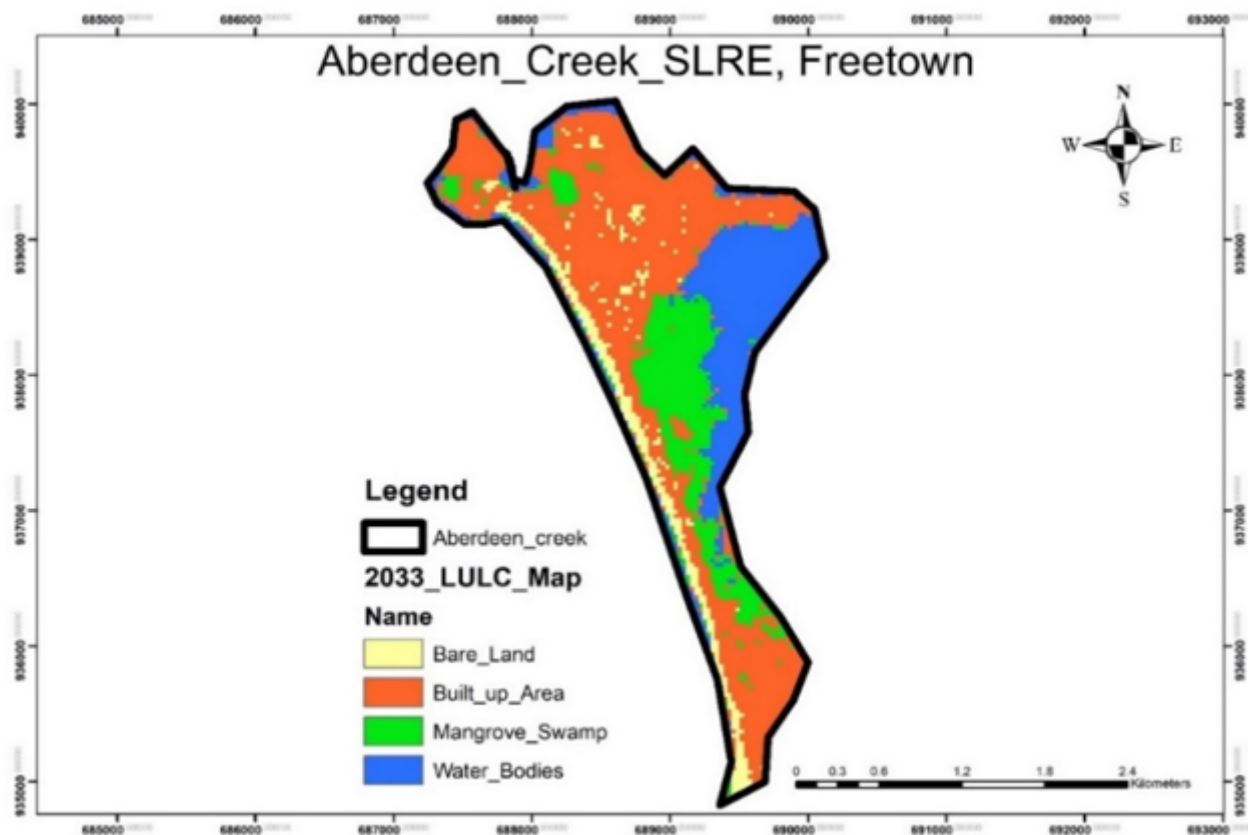


Figure 4

Classified Land use and Land cover of the Year 2033. Built up areas shall accelerate, mangrove decrease, bare land decrease and water bodies seriously affected and polluted.

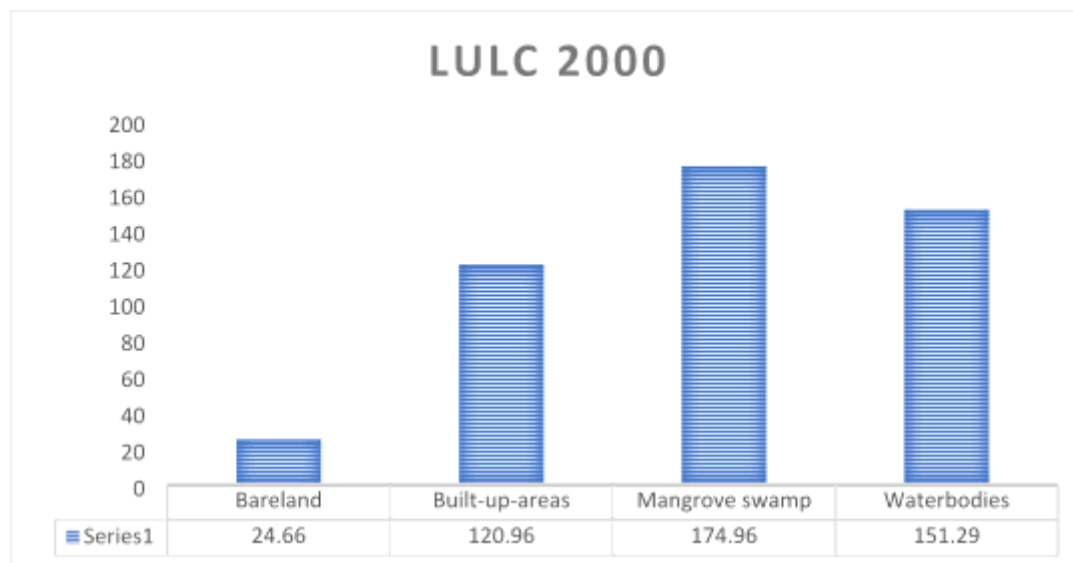


Figure 5

The four-land use and land cover classification for the year 2000. the highest LULC rare during that period was the mangrove removal, seconded by waterbodies and built up third (ha).

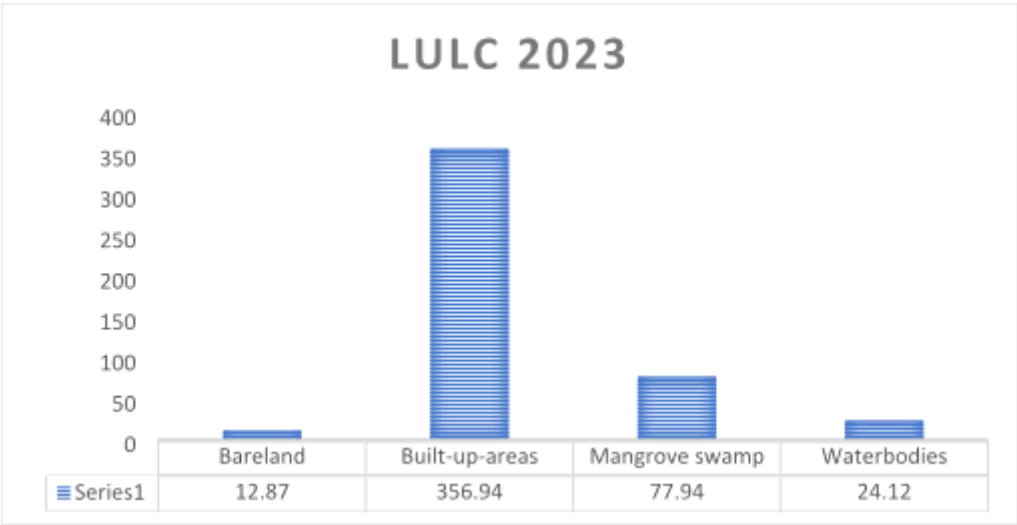


Figure 6

The four Land use and Land cover classification for the year 2023. The above result shows that built up area has overtaken mangrove clearance (ha).

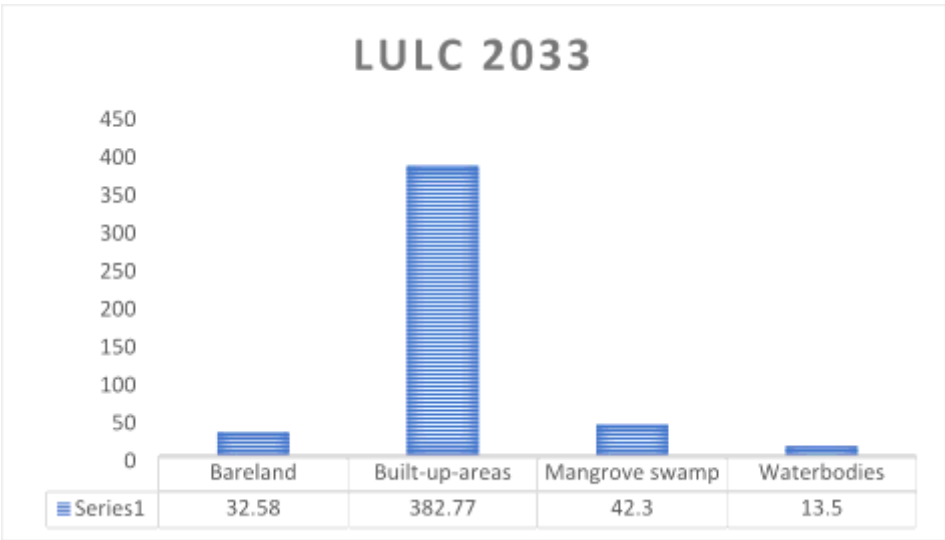


Figure 7

The four Land use Land cover classification for the year 2033. The year 2033 will see the highest rate of LULC due to the intense quest for housing, mangrove will reduce drastically (ha).



Figure 8

Photograph taken from field visit in September 2023 showing various degrading activities; (a) shows a high-rise structure deep into the wetland, (b) shows a runoff and waste discharge water, (c) shows a dumping site and informal settlement within the creek, (d) shows a massive construction.