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SPATIAL ANALYSIS OF URBANIZATION ON RATE OF WETLAND LOSS IN PORT HARCOURT METROPOLIS

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ABSTRACT
Urbanization is usually accompanied with the alteration or destruction of the ecosystem, including wetlands. The rate of urbanization in Port Harcourt Metropolis and loss of wetland calls for proper evaluation in order to ascertain the rate and actual amount of wetlands lost to urbanization so as to arrest or reduce to barest minimum this ugly trend. Data were collected through satellite imagery of the study area and GPS. The data were analyzed using Geographic Information System techniques (GIS). The findings showed that the major land-use types identified in the study alongside wetlands include built up area, water bodies, farmland/sparse vegetation. The findings from the study revealed that in 1990 wetland occupied a spatial extent of 123.23 km^2 (26.89%) of the land use of the study area. Consequently, in the year 2020, there was dramatic change as wetland size reduced to 44.61 km^2 (9.74%) of the total land-use of the study area. Conversely, built up area (Urban sprawl) increased dramatically in 1990 from 85.14 km^2 (18.58%) to 213.09 km^2 (46.50%) in 2020. This concludes that urbanization and variation in wetland loss will continuously have an inverse relationship and wetlands in the verge of being completely lost with time due to urban expansion or urban sprawl. The study recommended that adequate and continuous monitoring of wetlands by use of satellite and remote sensing should be encouraged in the study area.

Keywords: Spatial analysis, Urbanization, Wetland loss, Port Harcourt Metropolis

INTRODUCTION
Scholars attribute wetlands to lands that are transition between terrestrial and aquatic systems where the water table is usually at, or near the surface and the land is covered by shallow water (Ramsar, 2012: Gomez-Bageethun & Barton, 2013; Millennium

Ecosystem Assessment, 2015). Wetlands ecosystem are important from conservation and sustainable management viewpoints because of their rich diversity of flora and fauna. Tangible and intangible diverse resources and products of wetland functions such as fodder, fishes, fuel wood, non timber forest products, ecotourism, and flood control. Wetlands have historically provided a source of income and livelihood for human beings.

In spite of the significant role of wetlands to the environment, most of the world's wetlands have been lost due to series of human activities most especially urbanization. Most members of the public regard wetland as unproductive and unhealthy lands. This view has led to over half of the world wetlands being degraded. For instance, New Zealand has lost up to 90 per cent of her marshy terrain, while more than 70 per cent of the wetlands in Europe have disappeared whereas, the figures are not available in Nigeria. This tremendous loss is a serious concern to human being and the environment (Albakri, Duqqah, & Brewer, 2013). Despite the imminent or impending ecological danger posed by the continuous degradation and loss of wetlands in Port Harcourt due Urbanization, very little is being done to prevent the destruction and promote their conservation. This is manifestly evident as Nigeria is not among the group of nations in which degradation of wetlands has been prohibited out rightly. No concrete plan of action has been put in place to prohibit the degradation, forestall loss and ensure the sustainable development of wetlands (Obia, 2015). This could be attributed to lack of adequate information on the high rate of wetland loss in the study area. It is in the light of this that the study focused on assessing urban growth and rate wetland loss in Port Harcourt Metropolis.

Statement of the Problem

The rate at which urbanization is taking place in Port Harcourt Metropolis leaves much to be desired, especially in wetland loss. Most of the places in the area are turning into mega cities with the consequent effects on the ecosystem, and the wetlands have been more at the receiving end. It therefore becomes very imperative to ascertain the actual amount and rate of wetlands being lost to urbanization in the area so as to sprawl up policy makers to understand the extent and rate of wetland loss occasioned by urbanization in order to provide sustainable approach to mitigate this pending ecological disaster. Hence the study has the following objectives, to:

i) Classify the land-use and land cover spatial distribution pattern of the study area in 1990-2020.

ii) Evaluate the rate of settlement growth in Port Harcourt Metropolis between 1990-2020.

iii) Examine the relationships between urban growth and wetland loss in the study area (1990- 2020)

LITERATURE REVIEW

Concept of Wetland

Wetlands are ecosystems characterized by the presence of those plants (hydrophytes) that are adapted to the life in the soils formed under flooded or saturated conditions (Mitsch & Gosselink, 2015). They are ecosystems that arise when inundation by water produces soils dominated by anaerobic processes, which in turn, forces the biota and particularly rooted plants to adapt to flooding (Mitsch & Gosselink, 2015). McCarteny, Rebelo, Senaratna,Sellamuttu and De Silva (2010) assert that wetlands are sinks into which surface water or groundwater flows from a surrounding catchment. Water occurs at or close to the ground surface in such areas. Mironge (2005), described wetlands as the interfacial ecosystem located between terrestrial ecosystem and

aquatic ecosystems leading or manifesting to acetones (as traditional elements between terrestrial and aquatic ecosystems).

Within the landscapes, they are "natural harvesters" of rainwater. On the other hand, Kadziya and Chikosha (2013), defined wetlands as lands where saturation with water is the dominant factor determining the nature of the soil development, types of soil development and the types of plant and animal community living in the soil and on the surface, and generally includes swamps, marshes, bogs etc. These definitions depict wetlands as an ecosystem with services that are very important to the sustenance of both the surface and groundwater resources of the earth. Desta, Lemma and Fetene (2012) pointed out that wetlands (even in the Niger Delta region) are among the ecosystems most vulnerable or susceptible to uncoordinated anthropogenic activities. Thus, Ohimain, Deslippe and Roister (2014) attributed loss of wetlands to lack of understanding of wetlands values, misguided policy, unenforceable environmental laws and regulations. This has therefore led to the narrowing of flow channels of streams which provide sources of water, transportation and other economic gains. Loss of wetlands equally leads to diminishing and potential extinction of substantial water resources like Pygym Hippopotamuses, fishes, offing or periwinkle and other sea foods in water bodies across the Niger Delta region (McDonald, Vujadinovic & Stokjvic, 2014).

Wetlands can be considered the most biologically diverse of all ecosystems, serving as a home to a wide range of plant and animal life (Ramsar, 2012). At a world wide scale, they provide us with services worth trillions of US Dollars every year. Ajibola, Oloyede, Atere, (2011) emphasized that much of the world's wetlands have been lost due to series of increasing human

activities which cause the degradation of this important subsystem of the general ecosystem that plays vital role in the sustenance of livelihood of the people. Man's delimitation and perception of wetlands as waste lands, disastrous realms, custodians of diseases and obstacles to meaningful development is presumably responsible for the consequent sale, alteration/destruction, conversion, reclamation, and actual loss of wetlands into other land-uses (Mironge, 2005). These alterations and destructions are further worsened by the absence of detailed or comprehensive inventory, compilation and/or publication on the state of Nigeria's wetlands. The large influx of industries have led to urban growth and expansion into wetland because of need for land and new housing (Obinna, Owei & Mark, 2010). Furthermore, Odine (2011) emphasized that poor understanding of economic and productive values of wetlands is a contributory factor to perceiving wetlands as wastelands, warranting or deserving massive destruction.

Urbanization

Urbanization is a socio-economic and political changes or alterations that lead to urban concentration and growth of cities, changes in the behavioral patterns of land use and infrastructural facilities that trigger the change or transformation from rural to metropolitan pattern of organization and governance. Urbanization is also a shift from a rural to urban society. It involves an increase in the number of people in the urban area during a particular period (World Bank, 2010). Increasing urban growth around finite space leads to encroachments into wetlands, alteration of watershed, disruption of fishing activities and diminishing capacity of the wetland ecosystem. Urban growth and wetland diversity interact in multifaceted and complex ways (McDonald *et al.*, 2014). Such interactions when in defiance to ecosystem services directly lead to habitat loss and

fragmentation (Gomez-Baggethun & Barton, 2013). It can also lead to degradation and decline of woodlands and associated wildlife, and dispersal of habitat configuration and connectivity (Desalegn & Healey, 2015). Universally, urban expansion occurs faster in low-elevation coastal zones and islands, which are biodiversity-rich (Giineralp & Seto, 2013). Unethical urban expansion processes apart from diminishing the size, quality and function of wetlands ecosystem processes and services, equally dislodging the animal and plant species in that area (Finlayson, Ji, & Weilert, 2017).

Urbanization and Wetland Loss

According to Wali (2015), urban development in wetland ecosystems for human settlement, agriculture and industrial development is one of the biggest threats to wetland conversion and management. He concluded that there is need for wise use of wetland resources and improvement of institutional arrangement so that wetland policies can be fully integrated into the planning process across all disciplines. Bamidele (2010) carried out a descriptive survey on the threats to sustainable utilization of coastal wetlands in Nigeria by collecting information on anthropogenic factors. The Study revealed that urbanization, dredging of canals, placement of pipelines and flow lines, and oil pollution are proximate threats to coastal wetlands. Sustainable urban development as management and effective policy framework entails engaging in urban physical development with adequate considerations given to the implication of such development on the ecosystem, especially on the protection of wetlands or biodiversity hotspots which require coordinated efforts to achieve sustainable development across cities, provinces and even countries (McDonald, Vujadinovic & Stokjvic, 2013). An unprecedented rate of urban growth and expansion into wetlands in Port-Harcourt need critical examination in a view to ensuring adequate planning and sustainable utilization.

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METHODOLOGY

Description of the Study

The study was carried out in Port Harcourt Metropolis, Rivers State. Geographical coordinates of Port Harcourt are $4^0$49'27'N and $7^0$21'E. The climate of Port Harcourt metropolis falls within the sub equatorial belt. Temperature and humidity are high throughout the year. The area is marked by two distinct seasons; the wet and the dry seasons, with 70 percent of the annual rains falling between April and August, while 22 percent is spread in the three months of September to November. Rainfall is adequate for all year round crop production in the state. In Port Harcourt Metropolis, maximum monthly temperature ranges from 28^0c to 33^0c, while the mean minimum monthly temperatures are in the range of 17^0c to 24^0c. The mean monthly temperature is in the range of 25^0c to 28^0c. Relative humility is high in the state, throughout the year and decreases slightly in the dry season. The area predominantly lies in a flat terrain consisting of levels of gently undulated sandy plains but without areas of isolated depression. The soil type consists mainly of poorly-drained silt clays mixed with sand, which is geologically classified under the Benin formation. This soil is organic in nature. There is also mangrove swamp alluvial soil found north to the coastal sediments zone and they are brownish on the surface

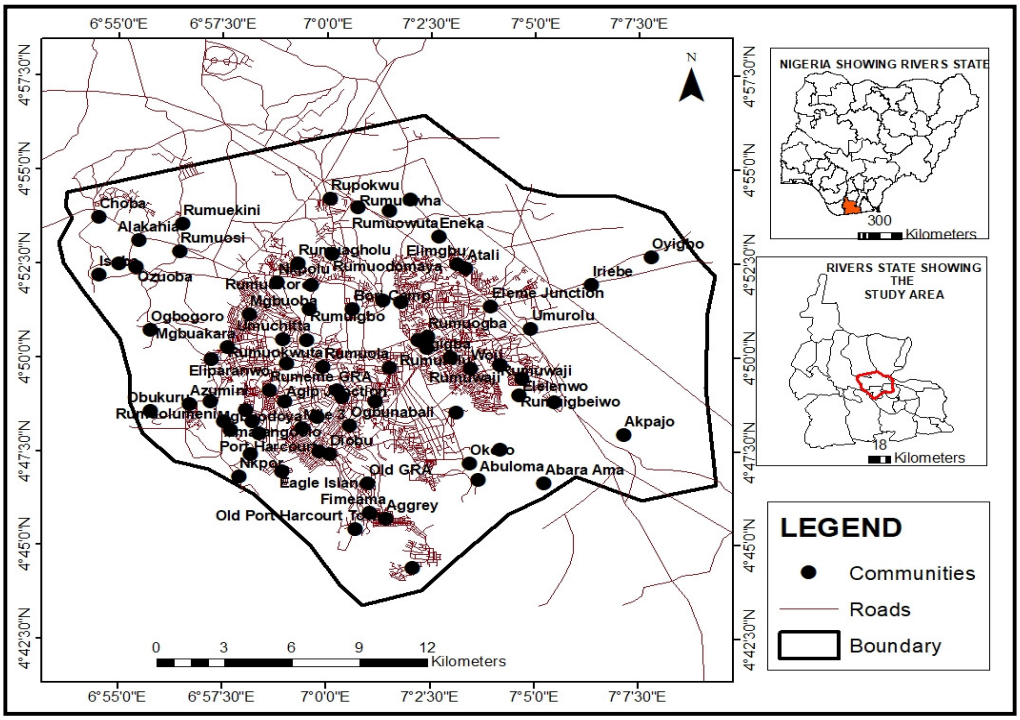

Figure 1: Map of the Study area

Source: Nigeria Local Government Administrative Map, 2021

Port Harcourt metropolis is influenced by urbanization or urban sprawl, where by smaller communities are beginning to merge together to form a megacity. As at 2009 her population was about 2 million (Nwankwoala, 2012).

Nature and Sources of Data

The study employed the use of both primary and secondary data. The primary data consist mainly of GPS data while secondary data comprise mostly of satellite imagery, digital maps and related literatures. The study made use of 1990, 2000 and 2020 Landsat imageries of Port Harcourt Metropolis at 30m by 30m resolution, acquired from National Space Research and Development Agency. Reconnaissance survey was carried out to ascertain and ground truth the wetland locations. Global Positioning System (GPS) was used to determine the coordinates of wetlands in Port Harcourt Metropolis.

Method of Data Analysis and Presentation

Classification of Land-use/Land cover Spatial Distribution Pattern in 1990, 2000 &2020

Training sites were created on each imagery whereby, similar spectral reflectance was captured and grouped together to generate signature file for the classification. Maximum likelihood supervised classifications were performed in ERDAS IMAGINE 9.2 on the landsat imagery. The per-pixel supervised classifications grouped satellite image pixels with the same or similar spectral reflectance features into the same information categories. The purpose of this imagery in this study is to serves as guideline for land use/land cover classification and mapping of the area in order to authenticate the result apart from accuracy assessment. The description of each of the classes is shown in Table 1. The classified land-use imagery were then converted into vector format to calculate the area of land-uses which included wetlands in each year in squared kilometers using spatial query module in ArcGIS 10.8. Descriptive statistics was used to explain the values of wetland and other land-use change and their percentage change per year under consideration. Results were presented using maps, tables and graphs.

RESULT AND DISCUSSION

Classification of land use and land cover Spatial Distribution Pattern in the study area

The land-use/cover was classified based on the 1990, 2000 and 2020 landsat imageries of Port harcourt Metropolis as shown in the maps below.

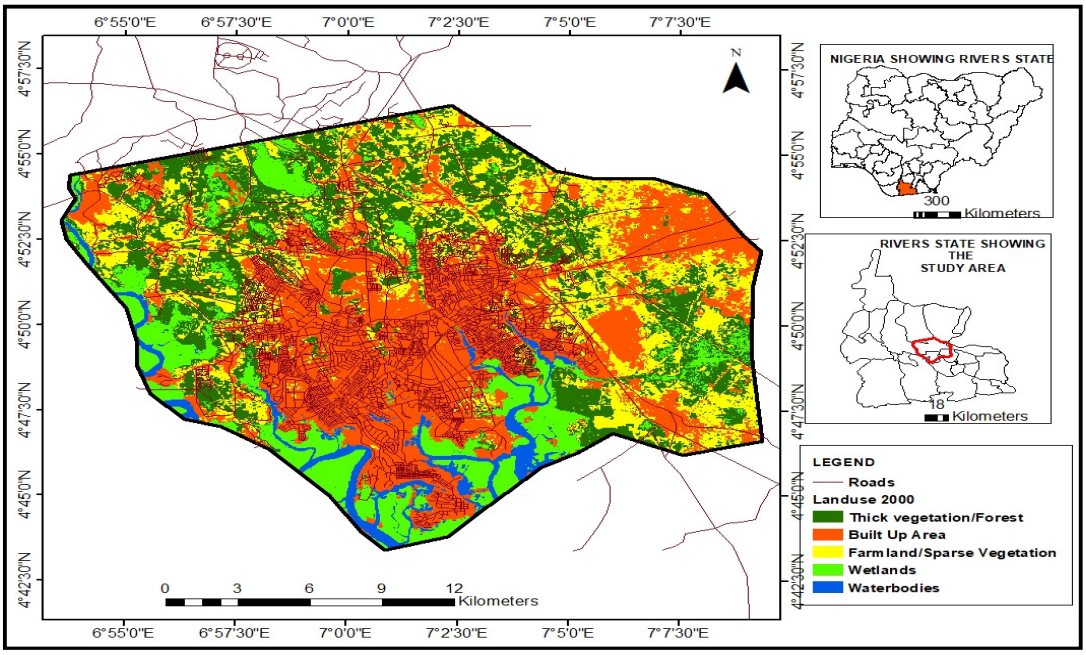

Figure 2: Land-use/ land cover map of the study area 1990
Source: Researcher's Fieldwork / GIS Analysis 2012

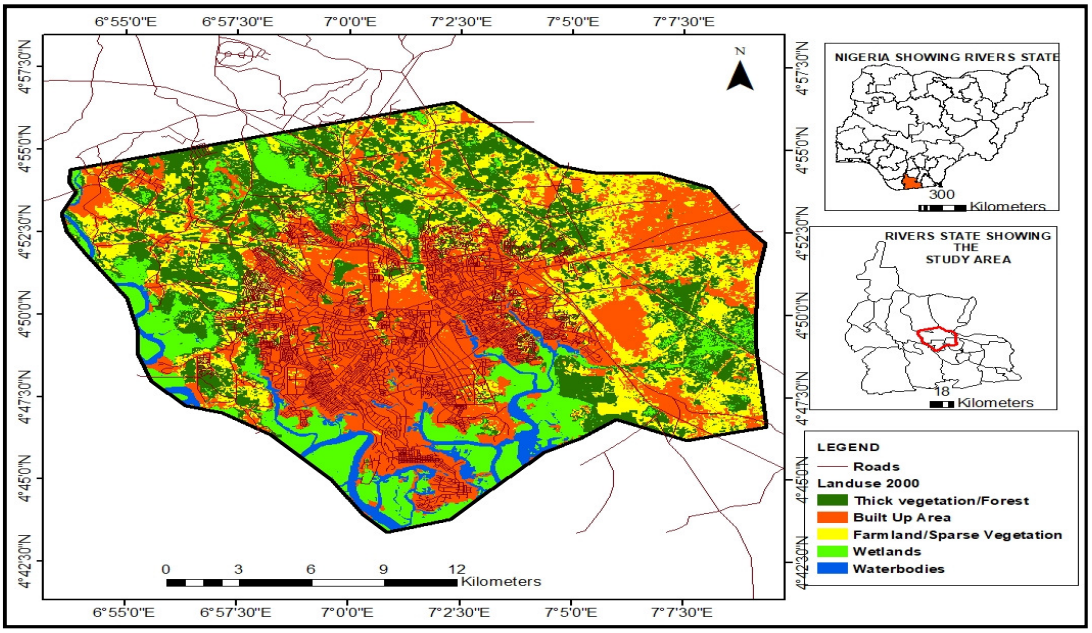

Figure 3: Land-use/ land cover map of the study area 2000
Source: Researcher's Fieldwork / GIS Analysis, 2021

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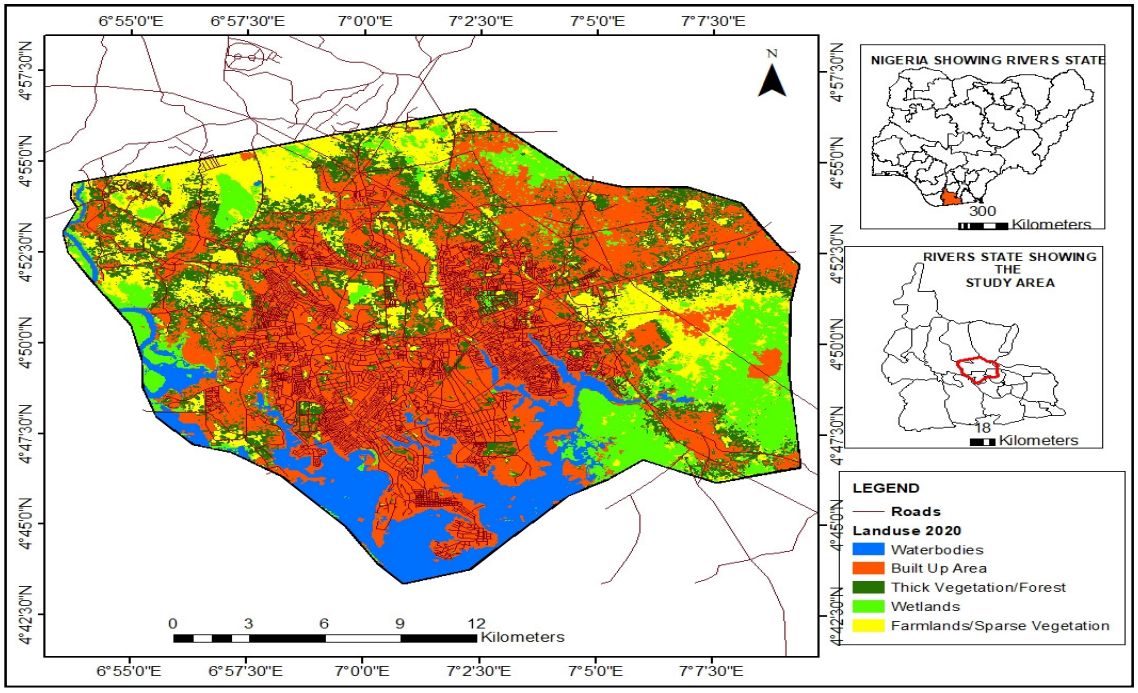

Figure 4: Land-use/ land cover map of the study area 2020
Source: Researcher's Fieldwork / GIS Analysis, 2021

The major land-use types identified in the study area alongside wetlands included built up area, water-bodies, farmland/sparse vegetation and thick vegetation in 3-epochs from 1990 to 2020 (Figure2- 4).

Table 2: Land-use/ Land cover Spatial Analysis in 1990, 2000, and 2020

Landuse	1990 (km^2)	Percentage (%)	2000 (km^2)	Percentage (%)	2020 (km^2)	Percentage (%)
Thick vegetation	119.52	26.08	103.92	22.68	89.13	19.45
Built Up Area	85.14	18.58	167.53	36.56	213.09	46.50
Wetland	123.23	26.89	76.41	16.68	44.61	9.74
Water bodies	28.25	6.17	19.96	4.36	48.62	10.61
Farmland/Sparse vegetation	102.08	22.28	90.4	19.73	62.77	13.70
Total	**458.22**	**100.00**	**458.22**	**100.00**	**458.22**	**100.00**

Source: Researcher's Analysis, 2021

Table 2 shows that in 1990 the thick vegetation recorded 119.52 km^2 (26.08%) while built up area recorded 85.14 km^2 (18.58%), wetland occupied a spatial extent of 123.23 km^2 (26.89), water bodies occupied 28.25 km^2 (6.17%) and 102.08 km^2 (22.28%) for farmland/sparse vegetation. Furthermore, the results for the year 2000 showed that the thick vegetation had decreased to 103.92 km^2 (22.68%), built up area had increased to 167.53 km^2 (36.56%) wetland size decreased to 76.41 km^2 (16.68%); water bodies also decreased to 19.96 km^2 (4.36%); while farmland/sparse vegetation decreased to 90.40 km^2. Consequently, in year 2020, changes were also observed as thick vegetation further decreased to 89.13 km^2 (19.45%) built up area increased to 213.09 km^2 (46.50%); wetland size reduced to 44.61 km^2 (9.74%); water bodies recorded 48.62 km^2 (10.61%) and farmland/sparse vegetation recorded 62.77km^2.

The analysis reveals that the wetlands recorded the highest spatial extent in 1990 and closely followed by the thick vegetation land use and the least was water bodies. In addition, in the year 2000, it was observed that highest spatial distribution was recorded in built up area and closely followed by the thick vegetation land-use. Wetland recorded only 16.68% of the total spatial extent of the entire area. Wetland in the year 2020 decreased more while the highest was recorded in the built up area.

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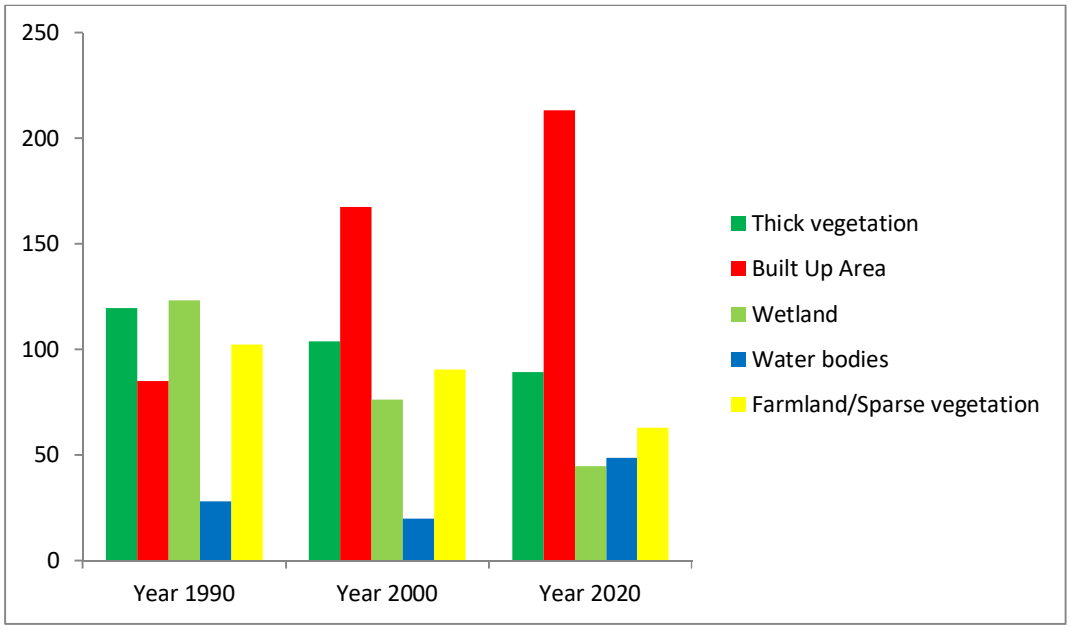

Figure 5: Land-use Change in Port Harcourt Metropolis from 1990 to 2020

Table 3: Percentage (%) Change in Land-use/Land cover Between 1990 and 2020

Landuse	1990 (km^2)	2000 (km^2)	Change (km^2)	% Change	2000 (km^2)	2020 (km^2)	Change (km^2)	(%) Change	Total Change (1990-2020) (km^2)	Total % Change (1990-2020)
Thick vegetation	119.52	103.92	-15.60	-13.05	103.92	89.13	-14.79	-14.23	119.52	89.13
Built Up Area	**85.14**	**167.53**	**82.39**	**96.77**	**167.53**	**213.09**	**45.56**	**27.20**	**85.14**	**213.09**
Wetland	**123.23**	**76.41**	**-46.82**	**-37.99**	**76.41**	**44.61**	**-31.80**	**-41.62**	**123.23**	**44.61**
Water bodies	28.25	19.96	-8.29	-29.35	19.96	48.62	28.66	143.59	28.25	48.62
Farmland/ Sparse vegetation	102.08	90.40	-11.68	-11.44	90.40	62.77	-27.63	-30.56	102.08	62.77
Total	**458.22**	**458.22**			**458.22**	**458.22**				

Source: *Researcher's Analysis, 2021*

Table 3 shows the rate of wetland loss in the study area (1900, 2000, and 2020). The size of wetland loss in the study area in 1990 was 18.58km^2 covering 26.89 percent of the study area. In 2000 wetland loss continue in size to 36.56km^2 covering 16.68 percent of the study area, while in 2020 wetland loss stood at 46.50km^2 covering 9.74 percent. However, there was dramatic reverse of built up land use. In 1990 the study shows that the size of built up area was 84.14km^2 covering 18.58 percent of the study area. In 2000 built up area continue in size to 167.53km^2 covering 36.56 percent of the study area, while in 2020 built up area recorded 213.09km^2 covering 46.50 percent of the study area. The findings from the study revealed that in 1990 wetland occupied a spatial extent of 123.23 km^2 (26.89%) of the land use pattern of the study area. Consequently, in year 2020, there was dramatic change as wetland size reduced to 44.61 km^2 (9.74%) of the total land-use spatial pattern of the study area. This change in spatial distribution of wetland is in line with the work posited by Tijani, Olaleye and Olubanjo (2011),that anthropogenic drivers and human motivated factors such as change of land-use activities, especially urbanization are the emerging threats to wetland loss. This continuous loss of wetland to other land-uses portends seriously environmental issue such as flooding, climate change, and habitat fragmentation.

Evaluation of the Rate of Settlement Growth in the Study Area

Data in Table 4 shows the rate of settlement growth in the study area

Table 4: Rate of Settlement Sprawl in the Study Area

S/N	Year	City growth (Settlement)	
		Area (km^2)	Area (%)
1.	1990	85.14	18.58
2	2000	167.53	36.56
3	2020	213.09	46.50

Source: Researcher's Analysis, 2021

In Table 4 there was dramatic reverse in built up area. In 1990 the study shows that the size of built up area was 84.14km^2 covering 18.58 percent of the study area. In 2000 built up area doubled in size to 167.53km^2 covering 36.56 percent of the study area, while in 2020 built up area recorded 213.09km^2 covering 46.50 percent of the study area.

The relationships between urban growth and wetland loss in the study area (1990- 2020)

The table below shows the relationship between urban growth and wetland loss in Port Harcourt Metropolis

Table 5: Relationships between Urban Growth and Wetland Loss in the Study Area

S/N	Year	Urban growth Area(km^2)	Area (%)	Wetland loss Area(km^2)	Area (%)
1	1990	85.14	18.58	123.23	26.89
2	2000	167.53	36.56	76.41	16.68
3	2020	213.09	46.50	44.61	9.74

Source: Researcher's Analysis, 2021

Table 5 shows that in the periods under consideration, wetlands consistently decreased with increasing urbanization. Hence wetland decreased from land area of 123.23 km^2 in 1990 to 44.61 km^2 in 2020, whereas urban growth increased from total land area of 85.14 km^2 to 213.09 km^2 in 2020. This finding corroborate the studies conducted by McDonald *et al.*, (2013) and Wali (2015), that built up area has negative implication on wetland loss. Hence an inverse relationship exists between urbanization and wetland loss.

CONCLUSION

The effect of urbanization in wetland loss is glaring in Port Harcourt Metropolis. Wetlands have had consistent drastic decrease in size during the years under consideration. This has created imbalance in the ecosystem as can seen in the flooding and extinction of certain species in the study area, of which if drastic measures are not taken in the shortest possible time, an impending danger might be awaiting the people of the area and their environment. The study therefore recommend adequate and continuous monitoring of wetlands by making use of satellite and remote sensing techniques in the study area. Also, there should be wetland protection management through the use of land-use planning and wetlands conservation management. Furthermore, there is the need for well-coordinated and concise research conducted regularly, in a bid to checkmate imminent threats on wetlands, thereby promoting adequate wetlands assessment and conservation.

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