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Urban Growth Influence on Land Cover Dynamics across Obio/Akpor Port Harcourt, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author MO designed the study, performed the statistical analysis and wrote the protocol. Author EAU wrote the first draft of the manuscript. Authors EAU and DOC managed the analyses of the study. Author DOC managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The study examined urban growth and land cover dynamics across Obio/Akpor, Local Government Area Rivers State. Landsat images were derived for the period of 1986 which was regarded as the base year, 2010 and 2018. The images were imported and analyzed using the spatial analysis tools in the ArcGIS environment to determine the extent of growth induced by change in features (water bodies, swamp forest, other forest, and Anthropogenic/built-up) coverage across the region. Findings revealed that there was a continuous decrease in the areas covered by water bodies, swamp forest, and forest between the periods of 1986 through 2010. It also revealed an increase in anthropogenic activities during the same periods of 1986 through 2018. As at 2018, as compared to 1986 which serves as the base year, there was a noticeable decrease in land area covered by water, in the tune of 13.946 sq km in 2018 as against 20.433 sq km in 1986 amounting to 68 percent decrease in surface covered by water bodies. Also, as at 2018, as compared to 1986 there is a noticeable decrease in the surface covered by swamp and other forest types in the tune of 18.102 and 99.693 sq km respectively as compared to 4.,986 and 17.498 sq km of surface cover respectively. On the other hand anthropogenic altered surfaces had a level of increase in the

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area covered by Anthropogenic/built-up developmental activities as at 2018 amounting to a tune of 14.399 sq km of surface area altered by anthropogenic activities as at 2018 as compared to 38.267 sq km of surface cover altered by human activities as at 1986 which when compared gave an increase in area covered by anthropogenic activities indicating an increase of over 100 percent between the base year of 1986 through 2018.

Keywords: Environment; anthropogenic urban; images; surfaces; dynamics.

1. INTRODUCTION

Urbanization is a universal process, a consequence of modernization that involves divergent sequence of events in different countries and that which produces progressive convergence of activities and population [1]. Urban growth as a complex process is a result of a combination of manifold factors which include geographical location, natural population growth, rural-to-urban migration, infrastructural development, national policies, corporate strategies, and other major political, social and economic forces, including globalization [2]. In Africa, urbanization recently has gained additional momentum due to climate change and armed riot in rural areas. According to [2], urban population increases much faster than that in the rural areas. Africa in particular displays the highest urban growth rates in the whole world, growing by 3.4% each year. It mostly occurs when people move from rural to urban areas so that the proportion of people living in cities increases while the proportion of people living in rural areas diminishes resulting in modernization and industrialization which is often motivated by local and global economic factors and social changes thus, individuals and families take advantage of the opportunities of proximity, diversity and market place competition. At about the beginning of the 20th century, it was observed by the United Nations that urban population has been on a rapid increase globally at approximately 15 percent urban dwellers. In 2007, this number had increased, resulting in number of urban inhabitants surpassing that of the rural people globally which is estimated that global urban population in 2050 will tune up to three quarter of the world's population most especially in the developing world [3,4,5,6]. The [7] forecasted that African's population will double over the next 40 years and attain a total population of 2 billion persons in 2045. This figure is expected to be centred within the urban area resulting to a projection of 720 million cities dwellers during this period [8,9]. This situation is expected to be more pronounced in Nigeria as the most populated in Africa with a population of over 130 million persons occupying a land area of 923,000 sq km [7] and 193,392,517 million people as at 2016 [10]. As the nation grows in size, there is a tendency for an experience of expanding or diminishing trend in the status of each cover uses, as the previous land delineated or tagged rural abinitio would transform to an urban setting while the urban centers will expand to become metropolitan cities over time. This growth is forecasted to concentrate in the urban areas of Africa and will lead to greater urban rate of expansion with urban land cover growth of more than 12-fold between 2000 and 2050 in sub-Saharan Africa projected in some scenarios [8,9,11]. According to the 2014 revision of the World Urbanization Prospect, the population of urban areas are expected to rise to a projected figure of 6.34 billion in 2050 which is an increment of 2.46 billion making 66% rise. This increase will create higher demand on land resources, thereby changing land cover trend [12,13]. And change in the manner at which land is used which will vary from one socio economic setting to another and also, the purpose for such use also varies in respect to cultural environment and needs. This therefore, implies that changes in land cover occurs at various spatial levels and within various time periods which is subjected to material expressions, environmental and human dynamics and of their interactions among others, of which are mediated by land. The utilization of land for the various purposes results in both negative and positive changes in the environment. This induces uneven growth trend in urban development (the growth of city made up of a series of outward expansions of residential area separated by marked pauses). Individuals will then enforce changes in land use in the bid of meeting their daily needs and demand for economic development. The expansion in the construction of residential and commercial land uses will result in the development of periphery areas around metropolitan cities, impacting on the ecosystem, degrading air, water, forest resources, with visible social fragmentation and infrastructural outlay [14,15,16,17]. Cities in Obio/Akpor local government constitute the cities of Port Harcourt

sub urban area and are exemplified by a rapid spatial growth with some environmental consequences such as overcrowding, spread of infections, general filthy conditions and decaying environment. It is therefore necessary to incorporate planning in an adequate level in order to control and ensure the harmonious development and function efficiency of the uses to which the land is put into or used for. This can be sustainable with a proper understanding of the trend in land cover changes across the spatial extent of concern. The continued growth of our urban centers through the process of urbanization needs to be understood and the direction of growth determined so as to anthropogenic/built-up comprehensive plan to accommodate the future population of the urbanization process. [16 and 17] postulated that urbanization has an impact on land use driven human influence on the associated land cover pattern. The landuse and vegetation map of the study area drawn from satellite imagery in 1976 shows that the total anthropogenic altered/built-up area/space of the city and its environment was only 16.25 Km^2. By 1995, an updated edition of same map showed that the anthropogenic/built-up area of the region had increased to 282.25 $Km^{2,}$ indicating that the size of the city has increased by seventeen times in two decades [18]. This shows that the city and its region have witnessed an unprecedented growth. It is upon this that there is need to examine urban land cover dynamics, and growth direction in Obio/Akpor Local Government Area.

1.1 Study Area

The Study area is one of the 23 local governments of Rivers state, found in the south southern part of Nigeria, otherwise called the Niger Delta Region of Nigeria, located approximately between latitude 4°45" N through 4°56" N and longitude 6°52" E through 7°6" E. It has a general average elevation of less than 15.24 m above mean sea level [18]. It is bounded by Ikwerre & Etche Local Governments to the north, Port Harcourt & Eleme Local Governments to the south, Oyigbo Local Government to the east and Emohua Local Government to the west, as shown in Fig. 1.

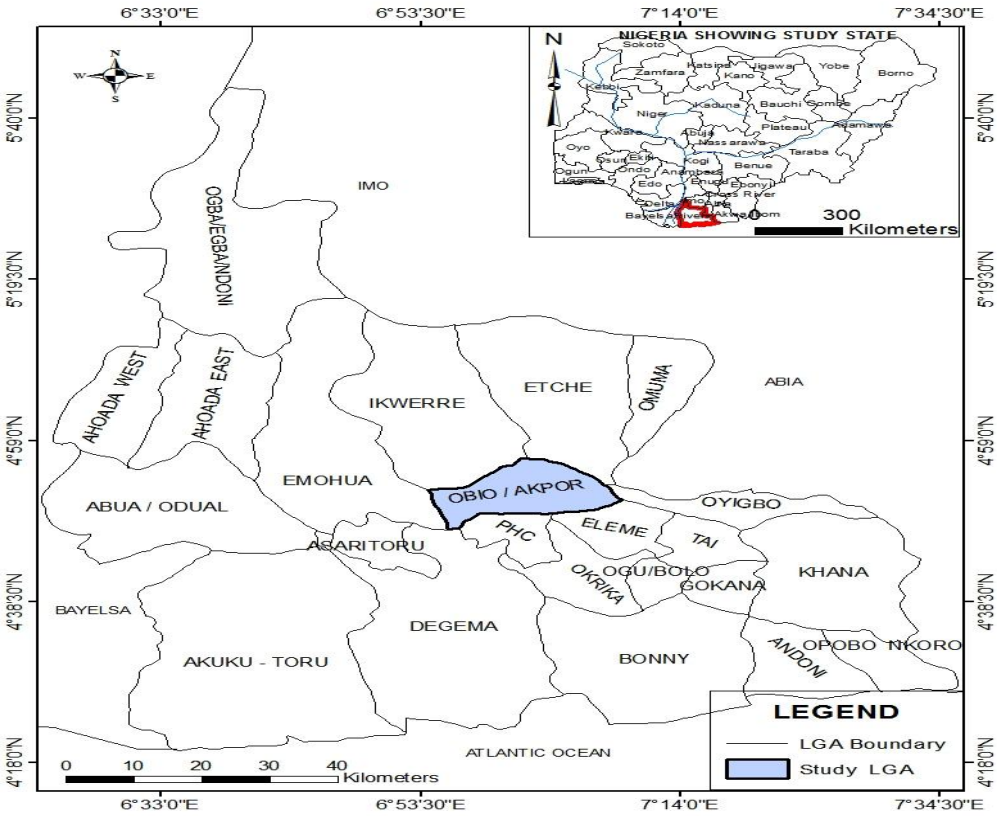

Fig. 1. Rivers state showing Obio/Akpor local government areas (LGAs)

Obio-Akpor LGA of Rivers State has a population of 283,294 persons, made up of 145,326 males and 137,968 females [17]. It is one of the major centers of economic activities in Nigeria, and a major city in the Niger Delta said to be the richest LGA in Rivers State. Consequent on rapid urbanization and the rising industrial and commercial growth of the city of Port Harcourt, more land areas are constantly converted to residential, commercial, industrial and other purposes to meet up with the demand of the growing population.

2. MATERIALS AND METHODS

The sources of data for this study were secondary data sources. The secondary source is mostly the data derived from the imagery which is Landsat imagery of the year 1986, 2010 and 2018 over the study area. The landsat imagery was derived from the Global landcover facilities and the earth explorer platform/facilities. The bands were collapsed into the composite band in the ArcGIS 10.4 environment and then the data was processed and classified using the supervised classification to differentiate the area covered by vegetation and anthropogenic/built-up or anthropogenic alterations in the study area. Under supervised classification, polygon for features were collated and named to represent the various features of the sampled population. The polygon digitizing methods was used to delineated features classes for concerned phenomena thereafter signatures were assigned to enable the classification and analyzed of the imagery using the maximum likelihood method to collect data of features classes with similar reflection. The features with similar reflections as sampled were identified and attached to the attribute outlined for that phenomenon. Thereafter, all feature class with same reflection were categorized as same and labeled within same context.

3. RESULTS AND DISCUSSION

The analysis shown in Fig. 4 reveals the state of urban development and impact (anthropogenic alterations) on land cover changes in the base year of 1986.

The Fig. 3 shows the pattern of land cover over the study area as at 1986 which is the base year for the study. From the Fig, as analyzed and presented, it was revealed that in the base year of 1986, forest cover in the study area occupies vast area of land cover in the study area as at 1986, next is swamp forest, anthropogenic/built-up areas and finally water body as shown in Table 1.

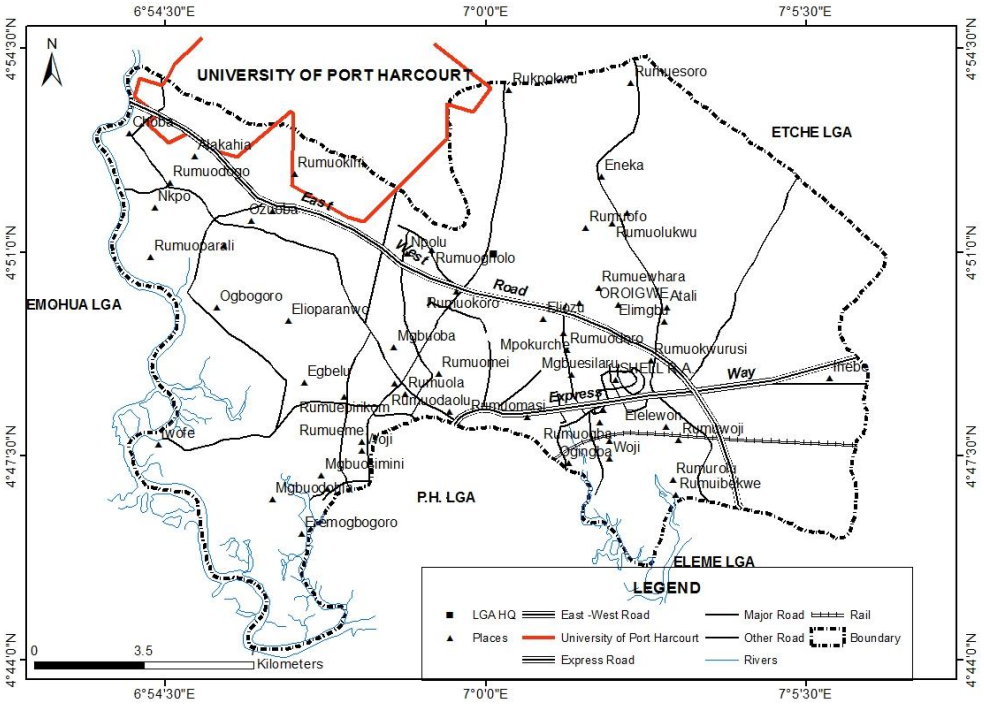

Fig. 2. Obio akpor local government showing communities

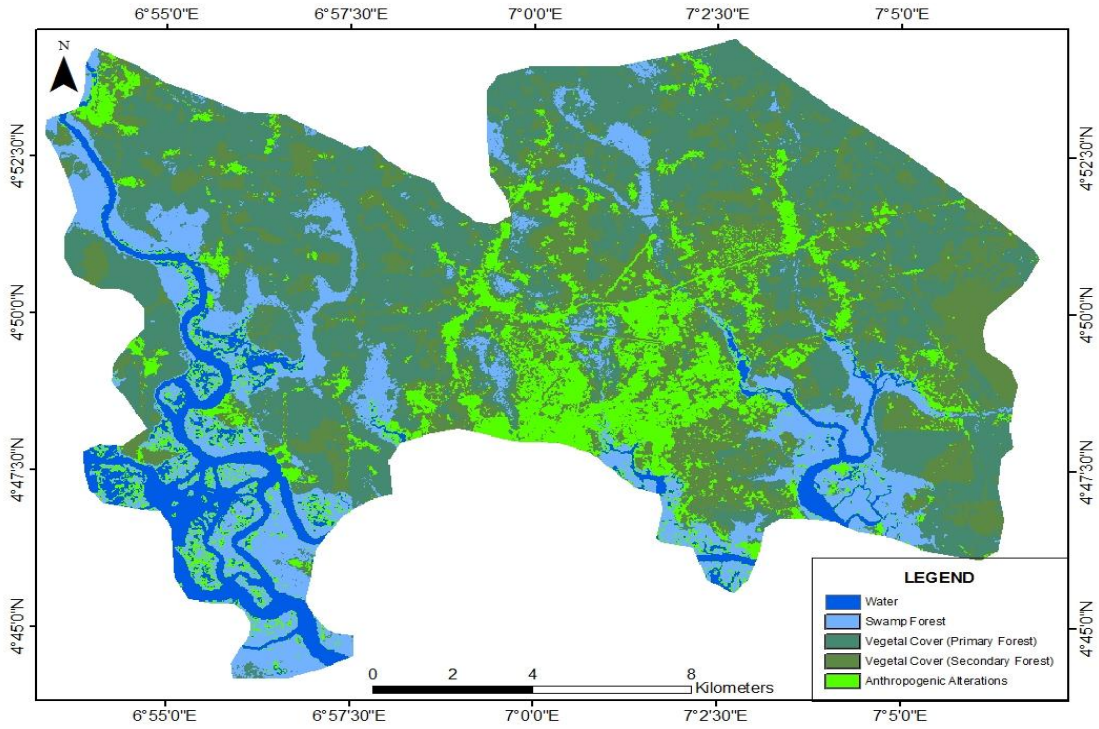

Fig. 3. Land cover map of Obio/Akpor lga as at 1986

Table 1. Land area coverage of features across the study area as at 1986

Features	Area covered in sq km	Percentage of land surface covered
Water	20.433	7
Swamp Forest	41.986	15
Forest	179.498	64
Anthropogenic Alterations	38.267	14
	280.142	100

The Table 1 shows the summation of data revealing the area coverage for each phenomenon as at the base year of 1986 for each of the features delineated for the study. From the analysis, water cover dominates 20.433 sq km of land area and represent only 7 percent of the entire land cover for the study area which is the least area coverage for a single feature in the study area as at the base year of 1986, swamp forest covers about 14.986 sq km of land area representing 15 percent of total land cover features across the study area, forest cover represents 64 percent of total land surface cover which is the largest single feature land cover across the study area in the tune of 179/498 sq km of total land surface cover in the study area as at the base year of 1986 and finally, there is a noticeable low level of anthropogenic impact on the study area as at the base year of 1986 revealing a total land area of 38.267 sq km of land covered by this single features representing 14 percent of land surface impact by anthropogenic activities in the study area as at the year 1986 which is the base year of the study. This gives a baseline analysis and understanding of the study area in 1986.

The Fig. 4 shows the pattern of land cover in the study area as at 2010 delineating the extent of change in land cover in relation to the base year as shown in Fig. 3. From the figure, and its analysis, it was revealed that forest cover in the study area still occupies almost 50 percent of the total land cover in the study area as at 2010 next is Anthropogenic/built-up areas which occupies 38 percent of the total land area in the study area followed by the total land area covered by swamp forest in the tune of 9 percent of the total

land area and finally water body which occupies only 5 percent of the total land cover area. This shows a diminishing trend from 7 percent previously recorded in 1986 to a loss of 2 percent in 2010 as shown in Table 4. Though, there is also a decline in forest cover from 179.498 sq km in the base year of 1986 to 133.936 sq km as at 2010 making a shift in forest cover to about 75 percent decline. Also from the analysis it was noticed that during the period of 1986 which is the base year to 2010 there is a decline in swamp forest from 41.986 sq km in 1986 which is the base year to 25.149 sq km making a decrease in swamp forest coverage to about 60 percent. From the analysis, there is an obvious increase in Anthropogenic/built-up area from 38.267 sq km as at 1986 which is the base year to 106.394 sq km as at 2010 making a rise in Anthropogenic/built-up land cover areas to over 100 percent (278) percent in the study area between the period of 1986 through 2010 as shown in Table 4.

Table 2 shows the summation of data derived for 2010 showing areas covered by water, swamp forest, forest and Anthropogenic/built-up areas. From the analysis, it is observed that there is level of increase or decrease in land cover facility of the study area which is caused by the unprecedented decline in area under one aspect of environmental cover to the other. From the analysis, forest cover occupies 48 percent of land cover followed by Anthropogenic/built-up area accounting for 38 percent and the swamp forest accounting for 9 percent total land cover.

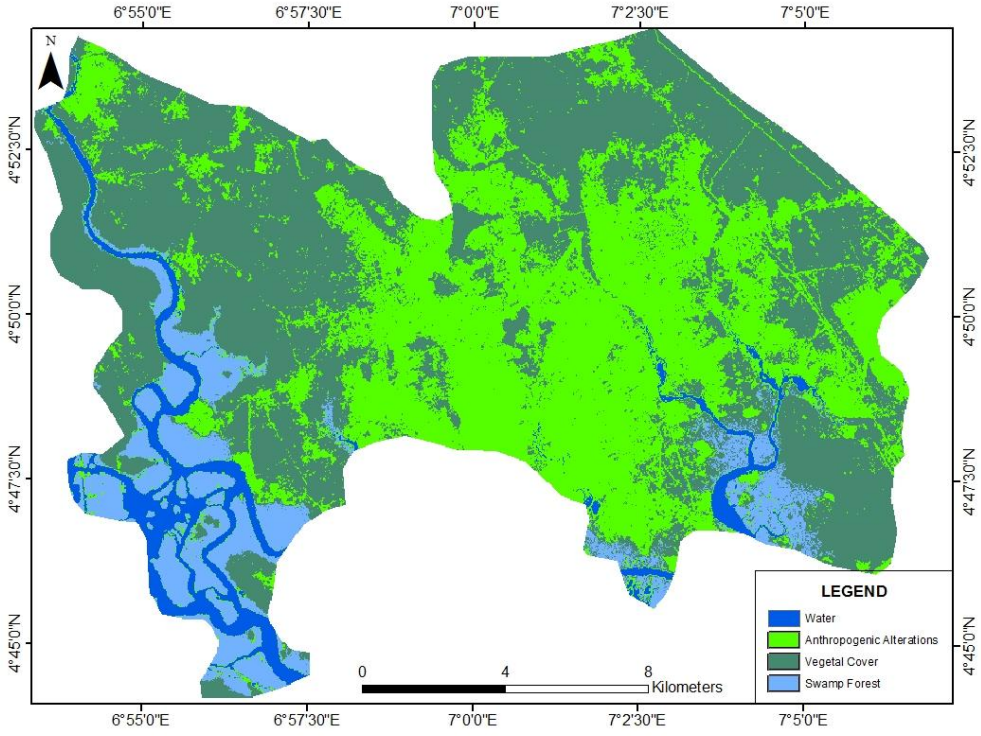

Fig. 4. Land cover map of obio/akpor LGA as at 2010

Table 2. Land area coverage of features across the study area as at 2010

Features	Area covered in sq km	Percentage of land surface covered
Water	14.662	5
Swamp Forest	25.149	9
Forest	133.936	48
Anthropogenic/built-Up	106.394	38
	280.142	100

Fig. 5 reveals the pattern of land cover across the study area as at 2018. From the analysis, there is visible increase in anthropogenic altered surfaces (Anthropogenic/built-up areas). The area anthropogenic/built-up could be seen to have evolved as a result of anthropogenic alterations and this has created a form of division (corridor) in the local government pushing apart the secondary forest to the east and west of the study area with pockets of secondary forest in the midst of the study area. Swamp forest coverage as observed in the region are tied to the southern parts of the study area with dominant influence in the south-south eastern part than the south-south western parts as displayed in Fig. 5.

Table 4 Summary Trend of Land Cover Changes in Obio/Akpor over the Period of 1986 (Base) through 2018.

The pattern of land cover across the study area as revealed in Table 3 derived from the analysis and presented shows the area covered by water bodies to represent the least of land cover coverage accounting for a total area of 13.946 sq km of land. Next in hierarchy is the area covered by swamp forest which covers 18.102 sq km of land area pursuing forest cover and anthropogenic/built-up area covering a total land area of 99.693 and 148.399 sq km respectively.

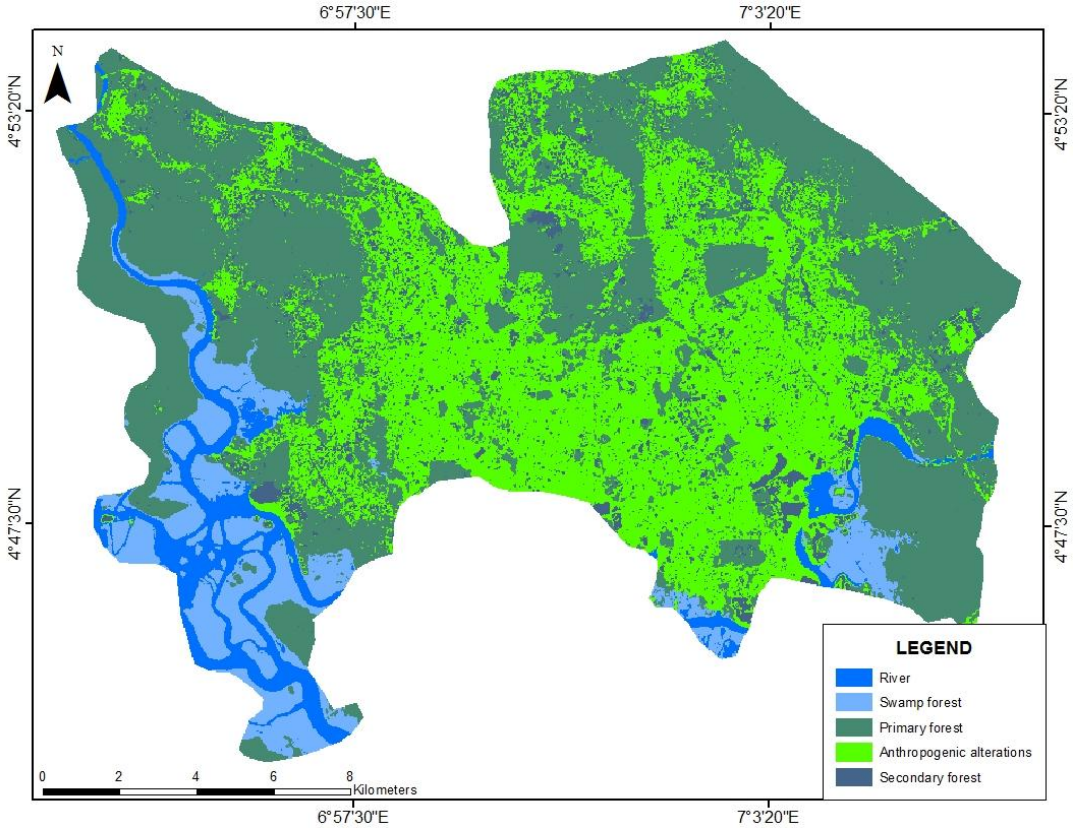

Fig. 5. Land cover map of Obio/Akpor as at 2018

Table 3. Land area coverage of features across the study area as at 2018

Features	Area covered in sq km	Percentage of land surface covered
Water	13.946	5
Swamp Forest	18.102	6
Forest	99.693	36
Anthropogenic/built-Up	148.399	53
	280.142	100

Table 4. Land cover change over the period of 1986 through 2018

Features	Area covered in sq km 1986	Percentage of land surface covered	Area covered in sq km 2010	Percentage of land surface covered as at 2010	Percentage change (increase or decrease) in land surface covered as at 2010	Area covered in sq km 2018	Percentage of land surface covered as at 2018	Gross percentage change in land surface covered between 1986 through 2018
Water	20.433	7	14.662	5	72 % (decrease)	13.946	5	68 % (decrease)
Swamp Forest	41.986	15	25.149	9	60 % (decrease)	18.102	9	43 % (decrease)
Forest	179.498	64	133.936	48	75 % (decrease)	99.693	48	56 % (decrease)
Anthropogenic/built-Up	38.267	14	106.394	38	278 % (increase)	148.399	38	388 % (increase)
	280.142	100	280.142	100		280.142	100	

The pattern of land cover across the study area during the period of 1986 through 2018 as revealed in Table 4, as shown in the analysis presented, shows a continuous decrease in the area of cover by water bodies, swamp forest, and forest between the periods of 1986 through 2010. It also revealed an increase in anthropogenic activities during the same periods of 1986 through 2018 as revealed in Table 4. As at 2018, as compared to 1986 which serves as the base year, there was noticeable decrease in land area covered by water, in the tune of 13.946 in 2018 as against 20.433 sq km in 1986 amounting to 68 percent decrease in surface covered by water bodies. Also, there is noticeable decrease in the surface covered by swamp and other forest types in the tune of 18.102 and 99.693 sq km respectively as compared to 41.986 and 179.498 sq km of surface cover respectively. On the other hand, anthropogenic altered surfaces had a level of increase in the area covered by anthropogenic/built-up developmental activities as at 2018 amounting to a tune of 148.399 sq km of surface area altered by anthropogenic activities as at 2018 as compared to 38.267 sq km of surface cover altered by human activities as at 1986 which when compared gave an increase in area covered by anthropogenic activities indicating an increase of over 100 percent between the base year of 1986 through 2018.

The line graph in Fig. 6(a) & 6(b) shows the trend of land cover features over the study area. From the analysis, there is a decrease in area covered by water bodies, swamp forest, and other forest as at 2010 though with an increase in area covered or impacted by humans. This trend in the areas covered across the years observed features that were maintained in 2018 still, with an increase in square meters of human impacted areas. From the analysis it is obvious that the activities of humans cuts across all forms of land cover bringing a reduction in the area covered by other features for the advantage of anthropogenic/built-up or human developmental activities.

The bar chart shows that water, swamp forest and forest of 1986 are higher than 2010 with a reverse in anthropogenic/built-up as at 2018. 2018 shows a general reversal of the trend of land cover from the base year of 1986 through 2010. In 2018, anthropogenic/built-up took the peak and stepped down in 2010 with the least step in 1986. This reveals a growing trend in human activities altering the environment and also expanding trend in population growth in the region. The population growth is believed to exert awesome pressure on vegetation and environmental sustainability resulting to constructions activities which uses up forest land and alters water ways. More construction activities could mean increase in demand for raw materials like timber which has lead to the exploitation and destruction of forests resources. The pressure for conversion of vegetation which provides many tangible benefits to the urban society and associated dependent ecosystem for developmental purposes is perceived very high leading to the loss of other features cover across the study area.

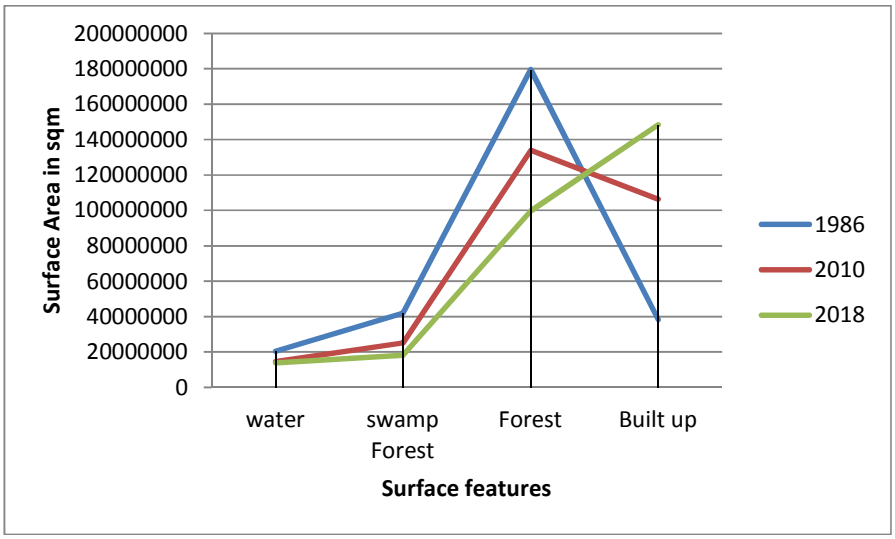

Fig. 6(a). Land cover trend between 1986 and 2010

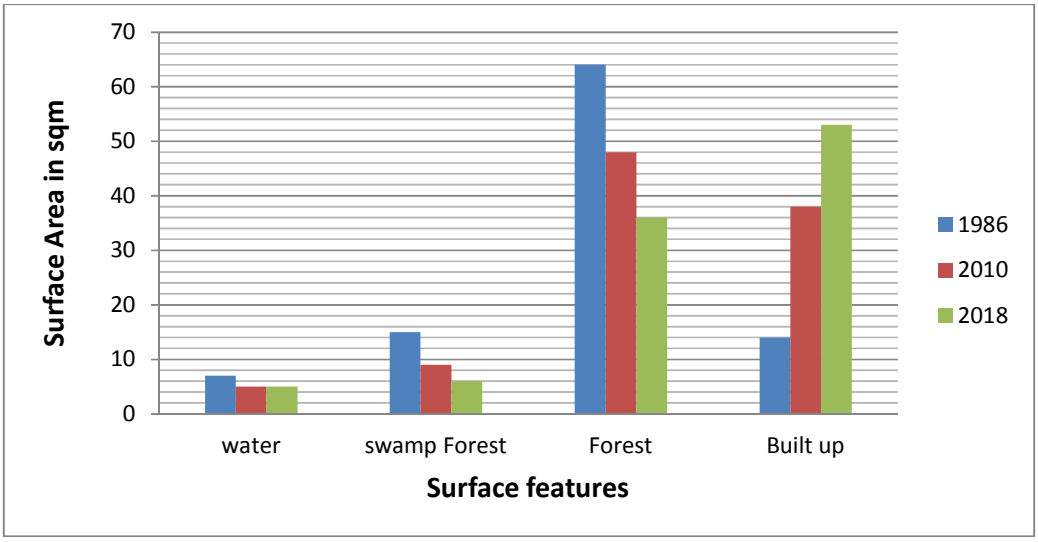

Fig. 6(b). Percentage change in land cover across the study area

3.1 Discussion

From the analysis of urban growth influence on land cover dynamics across Obio/Akpor Local Government between the periods of 1986, 2000 and 2018. It is revealed that the land cover of the area in question as at the base year of 1986 depicts forest dominance. There is also very little coverage by anthropogenic activities which made the rank of third place in land cover hierarchy within the study area. This trend could be attributed to the low level of mechanization and industrial inputs in the region and the early stage capital city growth status of Port Harcourt city. As at the year 2000, human activities have grown tremendously as shown in the image analysis for the year 2000. These changes gave anthropogenic activities induced benefits and advantages that lifted and increased anthropogenic activities from its previous position of third in the hierarchy of land cover as at 1986 to second in 2000 and observable in Fig. 4. This continuous growth paved the way for human dominance across the study area in the year 2018 giving a total of 148.399 sq km of land to the activities of humans. Grossly impacting on the forest (swamp and other forest) cover in the study area, given over 300 percent increase in area dominance which resulted in over 40 percent decrease in swamp forest and other forest cover within the area of focus. This trend did not exclude the conversion of wetlands for urban development as shown in accounting for over 40 percent decrease in area covered by water bodies across the study area.

4. CONCLUSION

The analysis of the rate of urban growth and land cover dynamics across the study area revealed that as at the base year of 1986, forest cover in the study area occupies vast area of land cover in the study area as at 1986 next is anthropogenic/built-up areas swamp forest and finally water bodies. This pattern of land cover occupation was altered as at 2010, as forest cover in the study area occupies almost 50 percent of the total land cover followed by anthropogenic/built-up areas which occupies 38 percent of the total land area, then the swamp forest occupying about 9 percent of the total land area and finally water bodies which occupies only 5 percent of the total land cover area as against 7 percent in 1986. This trend was furthered altered in 2018 with a visible increase in anthropogenic altered surfaces (anthropogenic/built-up areas) and further decrease in areas covered by water bodies, swamp forest, and other forest.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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