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Implications of the Changing Pattern of Landcover of the Lagos Coastal Area of Nigeria

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Abstract: Lagos, like most other coastal cities is associated with many of the consequences of such ecological relationships, which include physical alterations and destruction of coastal habitats, flooding, erosion, pollution and continued threats from rising sea levels. Thus, in order to ensure sustainable coastal area management, techniques are required that provide cost effective means for mapping and monitoring landcover change and impacts. In this study, the aim was to evaluate the attendant socio-economic and environmental implications of the changing pattern of landcover change associated with the Lagos coastal zone. The observed (1986-2002) and predicted (2002-2027) rapid and continuing landcover change in the Lagos coastal area have multifarious implications on the residents and inhabitants of the area and on the entire Lagos residents in general; which is a consequence of the multiple impacts (positive and negative) that affect the ability of biological systems to support human needs. Some of the positive impacts of landuse/cover change include the continued increase in food and fibre production, resource use efficiency, wealth, livelihood security, welfare and human well-being. However, the undesirable and negative impacts of landcover change include massive alterations of biogeochemical cycles (e.g. nitrogen, carbon and water), ecosystem processes, earth-atmosphere interactions, loss of biodiversity and soil degradation at different spatial and temporal scales. For instance, the expansion of the developed landcover into the swamp landcover type would have destructive consequence on the ecological biodiversity of the area and an attendant reduction in the livelihood of those that depend on these vegetal resources.

Key words: Change · coast · GIS · implications · landcover · pattern

INTRODUCTION

Lagos, the capital of Lagos State (Fig. 1), which was created in 1967, served as the capital of Nigeria up till December 12th, 1991. Lagos has grown spatially from a traditional core settlement of about 3.85 sq km in 1881 to a huge metropolis of over 1,183 sq km. Metropolitan Lagos constitute about 33% of Lagos State, with 455 sq km of the metropolis being water bodies, wetlands and mangrove swamps [1].

Although Lagos State is the smallest State in terms of landmass in Nigeria, yet it has the highest population, which is over five percent of the national estimate. The population of Lagos, as shown in Table 1 rose from about 20,000 in 1850 to 7.71 millions in 1990, 13.4 millions in 2000 and estimated at over 20 millions by 2015 [1]. The high urban rate of Lagos (Fig. 2) is accounted for not by natural increase alone but more importantly by rural-urban

Table 1: Population growth rate of Lagos, 1866-2004

Census year	Total population (Million)	Annual rate of growth (%)
1866	0.012	-
1871	0.028	2.70
1881	0.037	2.40
1891	0.032	-1.30
1901	0.042	2.50
1911	0.074	5.70
1921	0.100	3.10
1931	0.126	2.30
1950	0.354	3.30
1963	0.952	14.00
1975	3.300	20.50
1980	4.390	5.50
1990	7.740	5.50
1995	10.290	5.50
2000	13.400	5.05
2004	15.000	5.05
2015	20.200	3.61

Sources: Lagos State Ministry of Economic Planning and Budget [1]

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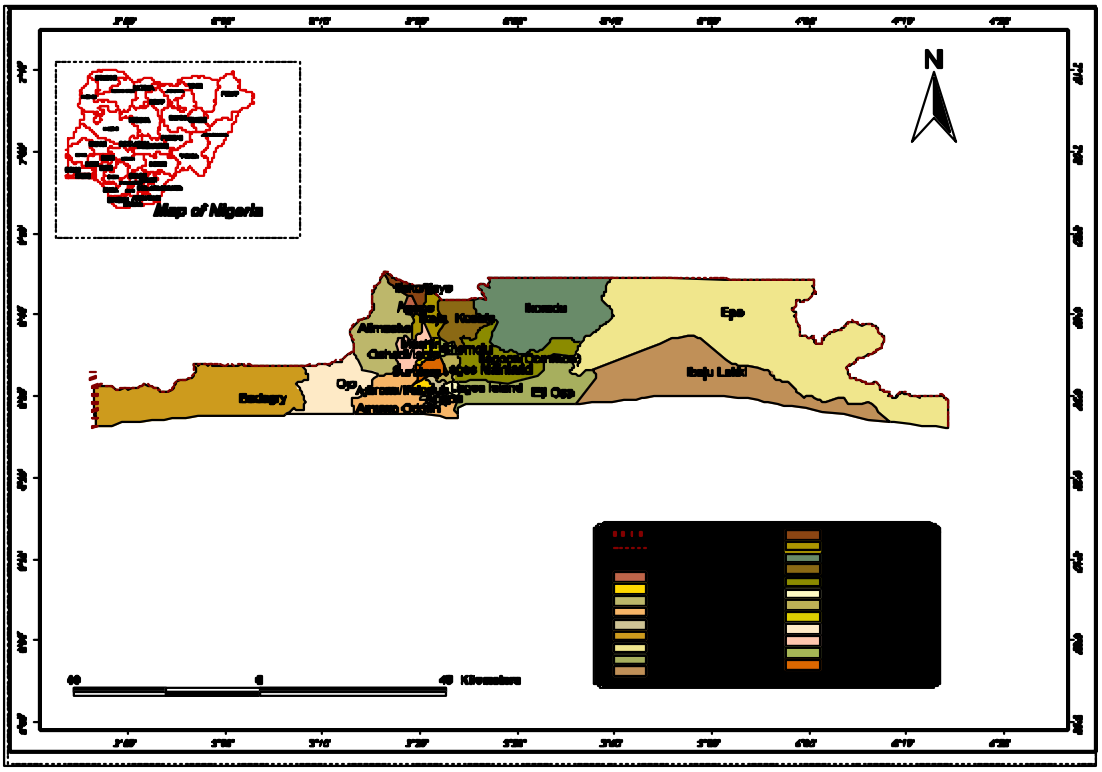

Fig. 1: Administrative map of Lagos showing 20 local governments

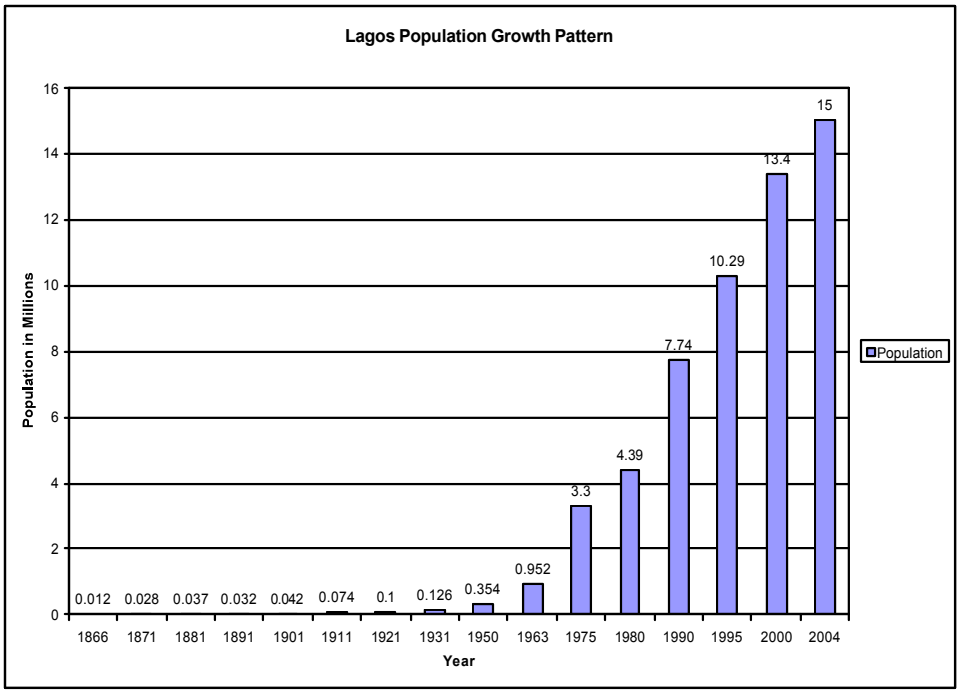

Fig. 2: Lagos population growth pattern

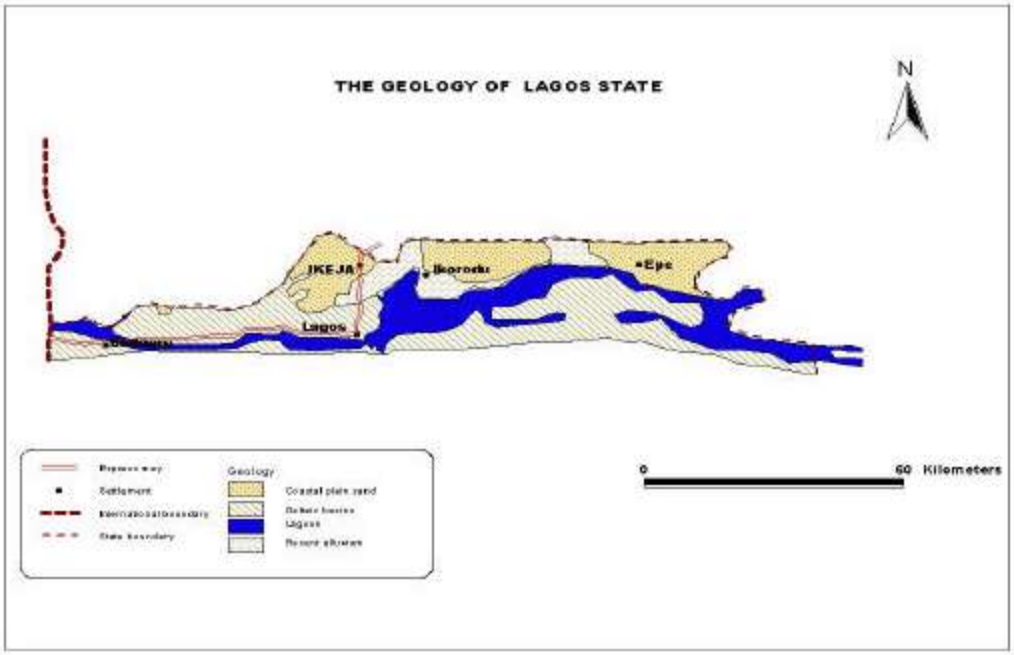

Fig. 3: The geology of Lagos state

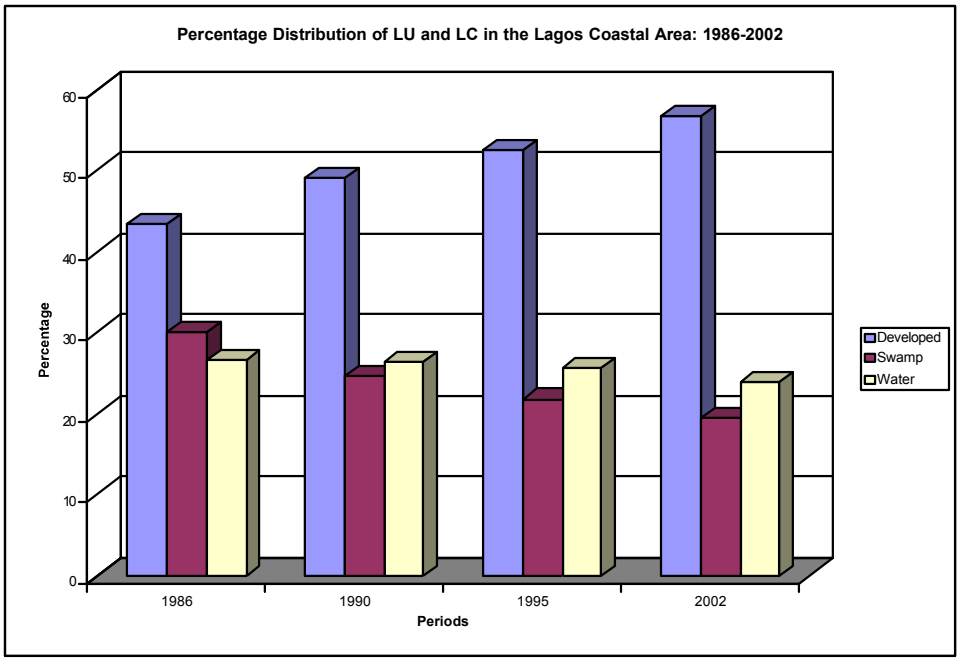

Fig. 4: Percentage distribution of landcover change: 1986-2002

Table 2: Lagos Coastal Area Landcover Distribution for 1986, 1990, 1995 and 2002

	1986		1990		1995		2002	
Land cover	Area (km^2)	Area (%)	Area (km^2)	Area (%)	Area (km^2)	Area (%)	Area (km^2)	Area (%)
Developed	85.44	43.36	96.53	48.98	103.54	52.54	111.89	56.78
Swamp	59.24	30.06	48.59	24.66	42.97	21.80	38.31	19.44
Water	52.39	26.58	51.95	26.36	50.56	25.66	46.87	23.78
Total	197.07	100.00	197.07	100.00	197.07	100.00	197.07	100.00

migration which contributes about 75% to the growth of Lagos.

The rate of population growth is about 300,000 persons per annum with a population density of 20,000 per sq km. The implication of this rapid population growth on the landcover and landuse cannot be over-emphasised. This is why land matter continues to constitute a major physical challenge to the Government of Lagos State. This is further compounded by the peculiarity of the physiography of the State; which is characterized by many creeks, lagoons and mangrove swamps (Fig. 3). This meant that additional land provision to meet the increasing pressure brought by the increasing population would have to be sought from the swamp and water landcover categories.

Thus, in order to appreciate the implications of the changing pattern of landcover along the Lagos coastal area, the study undertook a historical analysis of the landcover of the study area over a 16-year period (1986-2002).

METHODS

Turner *et al*. [2] described landcover as the biophysical state of the earth's surface and immediate subsurface. Also, landcover is a material manifestation of natural, social and economic processes (landuse) on the Earth's surface [3]. An increasingly common application of remotely sensed data is for change detection. The use of multispectral reflectance data for mapping landuse and landcover has become an integral component of contemporary land use studies [4]. The process of multispectral mapping of the landscape consists of drawing boundaries around geographically located classes that are homogeneous, or acceptably heterogeneous [5]. Remotely sensed data have since been demonstrated as particularly appropriate for the production of landuse and landcover maps. Satellite remote sensing provides cost-effective multi-spectral and multi-temporal data and turns them into information valuable for understanding and monitoring land development patterns and processes and for building land use and land cover data sets. On the other hand, GIS technology provides a flexible environment for storing, analyzing and displaying digital data necessary for change detection and database development [6].

The landcover distributions for the time periods in this study were derived from the different multi-source and multi-date remote sensing data. While Landsat TM data were use in the mapping of the landcover distribution for the years 1986, 1990 and 2002; SPOT data was used for deriving the 1995 landcover. Essentially, three main landcover categories (developed, water and swamp) categories were recognized; based on the character of the physiography of the study area (Fig. 3), scale/resolution (30 m) of the imageries used and the availability of ancillary information. These hindered the further breakdown of the classes into secondary and tertiary levels of landcover classification (usually adopted in hierarchical landuse/landcover classification schemes). In this study, developed landcover consist of such landuse as residential, industrial, commercial, transportation and related man-made use; swamp landcover comprises of natural vegetation cover (coastal thicket, mangrove, gallery vegetation and grassland) and agricultural land (made up of cultivated and fallow ground). The water category is made up of the ocean, lagoons, streams and other naturally occurring water bodies.

DISCUSSION OF FINDINGS

Table 2 gives a breakdown of the change analysis results as derived from the imageries for the four periods under study. From the table it is seen that while the developed landcover is rapidly increasing, the other two landcovers are declining. The same sets of imageries were used in predicting landcover change in the area up to year 2027 [7].

In 1986, the developed category accounted for 85.44 km^2 (43.36%) out of the 197.07 km^2 study area. Swamp landcover constitute about a third, 59.24 km^2 and 30.06% respectively, of the total area. The water landcover occupies the lowest area (52.39 km^2 or 26.58 percent of the

area). The landcover distribution for the Lagos coastal area for the year 1990 shows that the developed category still occupies the largest proportion of about a half of the total area 96.53 km^2 (48.98%). Swamp area comprised 48.59 km^2 (24.66%), while the water category make up the remaining 51.95 km^2 (26.36%).

The land cover distributions of the Lagos coastal area for the year 1995 shows that the developed category continued to show increasing prominence with its 103.54 km^2 (52.54%) coverage. The swamp has diminished to 42.97 km^2 (21.80%) of the total area and the water category make up the rest area of 50.56 km^2 (25.66%). The 2002 landcover distribution of the study area shows the developed landcover occupy 111.89 km^2 (56.78%) of the total area, while the swamp category has further diminished in area extent to 38.31 km^2 (19.44%) coverage. The water category cover the rest 46.87 km^2 (23.78%) of the study area.

The general pattern shown in this analysis is the increasing conversion of the swamp landcover category to the developed category (Fig. 4). The rate at which this conversion is taking place is so phenomenal requiring urgent plan of action. This observed pattern of landcover change have so much economic, social, environmental and planning implications for the management of the Lagos coast. For instance, the conversion of about 35.33% area extent of swamp into mainly the developed landcover within 16 years means that the whole of the swamp landcover may be lost in less than 40 years if there is no direct and urgent intervention in the drivers of change. The implications of this on the ecological biodiversity and the livelihoods of those dependents on the resources of the coast cannot be over-emphasised.

According to Mitchell [8], changes on the surface of the earth are attributable to either natural or anthropogenic forces. The directly human-induced conversion of landcover due to underlying forces of demographic, economic, technological, policy/ institutional and cultural or socio-political factors are of the most visible of global changes over the last three centuries [9]. According to Geist *et al*. [10], landuse/landcover change is driven by a few high-level causes or syndromes, such as: (a) resource scarcity leading to an increase in the pressure on resources, (b) changing opportunities created by markets, (c) outside policy intervention, (d) loss of adaptive capacity and increased vulnerability and (e) changes in social organization, in resource access and in attitudes.

In the case of the Lagos coastal areas, the changing pattern of landcover may be explained by a group of factors, which include urbanization, industrialization, economic, housing development, increasing value of real properties, increasing interest in real properties investment as a result of the uncertainties associated with stocks and savings in the country, devaluation of the Nigerian currency and inconsistencies in economic and fiscal policies affecting other forms of investment. The combined effect of all these on the changing patterns along the Lagos coast are visible.

IMPLICATIONS OF THE CHANGING PATTERNS OF LANDCOVER IN THE LAGOS COASTAL AREA

The patterns of the landcover change along the Lagos coastal area have multifarious implications on the residents and inhabitants of the area and on the entire residents and the environment (fauna and floral resources) in general. In terms of physical planning, there would be a need to provide commensurate infrastructure and amenities, such as good road networks, sewage and drainage networks amongst others to sustain the increasing population. The appalling infrastructural state of infrastructure in Lagos is a reflection of the increasing population pressure and attendant resource over-exploitation.

There are direct and indirect economic implications of the changing pattern of landcover. The loss of the swamp category of landcover and increasing erosion of the coast implies a reduction in the available land for economic activities, thereby reducing the means of livelihood of those who depend on the land. Another economic implication of the loss of mangroves and other coastal vegetation is the loss of breeding ground for many fish species and a consequent reduction in fish population and catches. Beside the reduction of income for those who are into fish farming, the cost of fish in the open market has also gone beyond the ability of many homes. Since fish is the cheapest source of protein, it may be expected that many household would not be able to meet their protein intake requirements. The direct impact of such would be the prevalence of protein-deficiency related diseases and increasing cost of providing health facilities for the affected population. Such impoverishment is responsible for the general decline in the standard of living of most Nigerian.

Other implication associated with the increasing loss of the swamp landcover is in the area of hazards. UNEP [11] had argued that since mangroves and other coastal wetlands provide protection for coastal environment, then a reduction in them would endanger and increase

risk along the coastline. The perennial flooding of the Lagos coastal area has been exacerbated by the depletion of the mangroves and the wetlands. Quantifying the extent of risk which the Lagos coastal area is exposed to would be a challenging venture considering the level of physical development that is taking place along the Lagos coast.

The continuing landcover change in the Lagos coastal area have multifarious implications on the residents and inhabitants of the area and on the entire Lagos residents in general (animal and vegetal resources) (Table 2). As has been shown earlier, land expansion in the area is been met through the modification of the existing landcover pattern and the occupation of fragile lands. For instance, the expansion of the developed landcover into the swamp landcover types would have destructive consequence on the ecological biodiversity of the area. This is in addition to exposing the coast land to a higher influence of coastal flooding which is already very high in the area.

In addition, landcover change is increasingly recognized as a major driver of environmental change, while its multiple impacts may be associated with positive or negative influences that affect the ability of biological systems to support human needs [9]. From experience, while the positive impacts are in the short-run, the negative impacts increases with time from the short-to the long-run. Some of the positive impacts of landcover change include the continued increase in food and fibre production, resource use efficiency, wealth, livelihood security, welfare and human well-being. However, the undesirable and negative impacts of landcover change which are very profound include massive alterations of biogeochemical cycles (e.g. nitrogen, carbon and water), ecosystem processes, earth-atmosphere interactions, loss of biodiversity and soil degradation at different spatial and temporal scales.

According to Awosika [12], the cutting down of mangroves for firewood and construction of houses has been blamed for the depletion of about 50% of the mangroves in Nigeria. Other impacts of the indiscriminate harvesting of mangroves in the long run beside the destruction of fishery resources habitat and attendant socio-economic consequences include its detrimental impacts on agriculture and coastal tourism. In addition, landcover changes directly affect the habitat of insect vectors of infectious human diseases e.g. Malaria, African Trypanosomiasis and Dengue fever. Increased vulnerability to a variety of health risks ranks high among health concerns related to landcover change. Similarly, there are many negative impacts that would result from the increasing rapid change into developed landcover categories, which are related to infrastructural provisions for the rapid increasing population. Furthermore, many natural processes would be altered as a result of the occupation of fragile lands, thereby increasing the hazardousness of the Lagos coastal area.

The results of the landcover changing pattern as revealed in this paper provided a pointer to the need for all tiers of government to put in place appropriate planning regulations to guide the direction of future growth and changes in the landcover of the Lagos coastal area in the overall interest of both the inhabitants and the physical, fauna and floral environment.

CONCLUSIONS

Landcover change is an inevitable outcome of man-environment interactions. However, while gradual landcover change may be acceptable, particularly from naturally-induced drivers, rapid landcover change with its attendant negative socio-economic and environmental consequences would be unacceptable.

Since the driving forces of future landuse/landcover would be demographic changes, economic growth and technological development [13], then it behoves on man (the initiator of these changes) to be well guided in its developmental activities. One such requirement necessary for guided and control development is through the understanding of landcover change patterns.

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