An Assessment of the Changes in the Landscape of Ogudu-Oworonshoki Development Prone Area of Lagos Metropolis, Nigeria

J. OBIEFUNA
Department of Architecture, University of Lagos
Akoka, Yaba, Lagos, Nigeria

S. IDRIS
Lagos State Ministry of Physical Planning, Alausa, Ikeja, Lagos

N. UDUMA-OLUGU
Department of Architecture, University of Lagos
Akoka, Yaba, Lagos, Nigeria

Received: August 19, 2011 Accepted: September 15, 2011 doi:10.5539/jsd.v4n5p82

Abstract

Landscape assessment is the analysis of the evolution of a landscape, an examination of the basic natural and human processes with ecological interrelationships which jointly shape that landscape and determine values for its uses. This paper is an assessment of the landscape of Ogudu-Oworonshoki development prone area on the north-east of Lagos Metropolis. It utilized the analytical tool of ArcGIS with topographic maps and Ikonos imagery to examine changes in the land use/land cover of the area over a period of 40 years from 1965 to 2004. Existing landscape which are suitable and compatible with the landscape of the area were identified through analysis of their conformity with the physiographic units. Results show that the landscape of the area has been gravely altered as urban development, mostly residential, displaced natural land, mostly wetland from 141.90 ha to 38.20 ha in 2004 at the annual rate of 2.60 ha. The implication of the results and findings are highlighted.

Keywords: Landscape, Landscape assessment, Land use compatibility, Sustainability

1. Introduction

Land is one of the resources of the ecosystem central to the existence of man. The quantity and quality of land, water as well as the sun at the disposal of nations often determine their potential wealth while actual prosperity depends on their ability to effectively manage these resources. Mismanaged, these resources may be irretrievably lost while national wealth and well-being are proportionately diminished (Simmonds, 1983). Sustainable resource management is based on detailed information, comprehensive analysis with objective evaluation of environmental factors, its ultimate goal being to blend natural laws with human endeavours. Landscape assessment as an aspect of resource management is germane to effective planning and sustainable development. Its essence is to determine the capability and sustainability of an area for different uses giving necessary consideration to its fragile components. Sustainable development in any area ought to be based on considerations of its natural environment through landscape analysis and assessment. As urged by Simmonds (1983), each human settlement is best conceived as an integral component of the natural site and landscape environs.

Lagos Nigeria, a coastal former capital city and the economic/commercial nerve center of the nation is beset with problems typical of such large cities of the world. Urban sprawl and its attendant demand for space is among such problems. While the city's ecosystem offers vast opportunity for its development, unrestrained and insensitive development has impacted negatively on it thereby curtailing its potentials. Indiscriminate reclamation of wetlands, encroachment on river banks and lagoons, deforestation poor spatial planning and land speculation (Abegunde,1988; Oduwaye, 2009)are some of the ills unleashed on nature in full view of the state's physical planning and environmental laws. For consequence, flooding, loss of biodiversity, ocean surge with rising sea levels, pollution, increasing urban slums and squatter settlements (Makinwa-Adebusoye, 1988; Ojo, 1988; Onokerhoraye, 1988) are some of the manifestations of this unrestrained demand for space and exploitation. Indeed according to Grandy (2006), this sprawling city which is now beyond its original lagoon setting is composed of a loose federation of districts whose interaction is at times choked by traffic gridlock.

Specifically in Ogudu - Oworonshoki area, one the rapidly urbanizing districts of the metropolis, urbanization has led to intense reclamation of the Lower Ogun River wetlands. These wetlands which occupied 82.45% of the area in 1965 had reduced to 36.31% in 2005 mostly due to anthropogenic actions (Odunuga & Oyebande, 2007). Parts of the area are also among the districts frequently afflicted with flooding and exhibiting signs of degraded environmental quality.

Research efforts on urban conditions of the metropolis have focussed on the physical and environmental challenges of conflicting land uses, unsightly cityscape, poor aesthetics, traffic congestion and others (Abegunde, 1988; Grandy, 2006; Oduwaye, 2009). However, the assessment of the landscape, its pattern and changes either at district or metro level has featured minimally in these efforts. Landscape patterns as seen in Landscape ecology strongly influence ecological processes (McGarigal et al. 2002), just as the structure of landscapes is directly related to their functional capability and overall environmental quality (Demers, 2000; Fasona et al. 2007). There is an urgent need therefore to focus our planning and development strategies, in Ogudu - Oworonshoki area particularly to accord natural processes or ecological relationships their due consideration.

This study is an assessment of the characteristics of the landscape of Ogudu - Oworonshoki, a development prone area of Lagos metropolis showing signs of deteriorating environmental quality. The objective was to determine the changes on the landscape which have occurred over the years and how these may have affected the physical and environmental quality of the area. Specifically, the extent and rate of change in land use/land cover (LULC) over a period of forty years (1964 – 2004) were determined. Also, it examined the landscape/physical parameters and their capability for various land uses as well as the conformity of existing uses. The study was performed in 2006.

2. The Study Area

The study area covers residential settlements of Ogudu, Ifako/Gbagada Ikosi and Oworonshoki, comprising of Kosofe and Somolu Local councils, an area on the north-east of Lagos metropolis. Proximity to Lagos Island and the construction of both Oworonshoki Expressway and Third Mainland Bridge facilitated the growth and development of these settlements. A total of 210.20ha of land and water bodies were delineated based on the homogeneity of their landscape/physical characteristics. The area is located between Latitude 6^o 22'N and 6^o 52'N; Longitude 2^o42' E and 3^o 22'E. The major river is the Agboyi Creek, which is a tributary of Ogun River. Much of the area is part of the Lower Ogun River flood plain as well as wetlands of the north-west part of Lagos Lagoon.

3. Materials and Methods

The integration of remote sensing and GIS has made it possible for the systematic inventory and assessment of land resources and degradation over space and time for interventions to safeguard the health of ecosystems (Fasona et al. 2007).

Major sources of data used in the study were analog topographic maps of 1964 (scale 1:50,000) and 1984 (1:25,000) together with digital 2004 high resolution Ikonos imagery of the area. The topographic map of 1964 provided the baseline data. The two maps, both based on aerial photographs of 1963 and 1983 respectively provided the land use/land cover for those periods while those of 2004 were manually interpreted from Ikonos 1m resolution panchromatic imagery. Manual, on-screen digitizing with visual identification and field verification has been shown by Fuller et al. (2006), Maxa and Botstad, (2009) to provide reliable interpretation of high resolution imageries. Physical data such as topography, soils, vegetation and surface hydrology which were crucial to modeling land use suitability were derived from topographic maps and available soil reports.

Pre-processing encompassed the entire process of map scanning, on-screen digitization, image interpretation, geo-referencing and registration to produce digital data. This was subsequently imported into GIS environment for necessary manipulation and analysis. For verification of information from the maps and imagery, ground truthing was undertaken in March – April 2006.

4. Data Analysis

Three major analysis were performed namely change detection, physical or landscape parameter analysis as well as suitability and conformity analysis. Change detection is a standard analysis for assessing the spatial and temporal changes in the landscape, land use/ land cover of an area (Taiwo and Areola, 2009; James et al. 2007;

Oluseyi, 2006). This analysis was performed by overlaying the maps generated for each of the years. The extent and rate of change in land use /land cover over 40 years from 1964 to 2004 at twenty (20) – year intervals were extracted. Land cover classes used especially for 1964 were simply natural land (vegetation), developed land and water body. This was because although wetlands constituted about heavily 80% of natural land in 1964, it was not possible to correctly classify them apart as wetlands were represented as point features not polygons on this map. The 1984 maps showed them as such while they were extracted as polygons from the 2004 imagery. For land use, developed land was further classified into different uses to clearly highlight the direction of change (Figs. 1a, b, c, 2a, b, c). Apart from identifying the nature of change, this analysis along with physical parameters served as basis for suitability/compatibility analysis of emerging uses. Some of the physical or landscape parameters analyzed were topography, vegetation, soils and surface hydrology. Based on them, the area was classified into three physiographic units namely; the coastal alluvium plain (32.67% of the area); the sedimentary lowland adjacent to the plain (62.88% of the area); and the north-east isolated highland (4.44% of the area). Figure 3 and Table 1 summarizes the locations and characteristics of the physiographic units.

These physical parameters further formed the basis for the assessment of the level of compatibility of various land uses in 2004 (Table 2). The result was outlined in a matrix of suitability of existing uses in the physiographic units (Table 3 and 4). Sustainability analysis was performed for according to Mcharg (1992), each area has an intrinsic suitability for certain land uses while some areas lend themselves to multiple coexisting land uses. Conformity analysis was finally performed by overlaying existing landuse map (2004) with the instability map and physiographic units to derive areas of conformity (fig. 6 and Table 7).

5. Results and Discussions

The proportion metric is one of the basic landscape metrics for assessing changes in the landscape composition over time (James et al 2007). It assists in assessing the composition ratio of different land use/ land cover as a percentage of the spatial extent of the landscape under consideration in both the baseline and assessment data.

Thus Table 5 and 6 with Figs 4 and 5 summarizes the metrics of land cover and land use changes from 1964 to 2004.

Most of the losses in land cover were recorded by natural land, a good proportion of which were wetlands, while phenomenal increases were recorded by developed land. Natural land which was 141.90 ha or 67.50% of the total land area in 1964 decreased to 78.60ha or 37.39% in 1984 and to 38.20ha or 18.17 % in 2004. Conversely, developed land which was 24.40ha or 11.61% in 1964 encroached on natural lands increasing to 87.30 ha or 41.53% in 1984 and further to 127.30ha or 60.56% in 2004.

Between 1964 and 1984, more rapid land development at the rate of 3.15 ha/year and loss of natural land at the rate of 3.17 ha/year were recorded. Lower rates of development and loss were recorded between 1984 and 2004 at the rate of 2.0ha/year and 2.02 ha/year respectively. Overall, between 1984 and 2004, 103.70ha of natural land, mostly wetlands, were lost to development at an annual rate of 2.60ha or 1.23%. This rate of loss generally tallies with the findings in Odunuga and Oyebande (2007) of rate of loss of wetlands to development in this area of 1.15% annually.

Water body remained fairly stable over the period occupying 20.90% in 1964 and 21.26% in 2004. As aerial photographs for earlier dates were not available, it was not possible to determine if the slight addition is as a result of channelization works. Land use change over the period followed the same pattern as land cover exhibiting distinct temporal and spatial variation. Similar continuous increase in built-up area with increased diversification at the expense of natural land use or wetlands was recorded. In 1964, three major uses comprising water body, wetlands and residential uses were identified. These however increased to seven in 1984 and nine (9) in 2004 with the introduction of uses for circulation, public, commercial, open spaces and modified (reclaimed) land. Residential land use (built-up), the most prominent and which covered 11.8ha or 5.6% of the area in 1964 increased to 65.7 ha or 31.3% in 1984 and rose further to 96.50 ha or 45.9% in 2004. Remarkably, houses on stilts which occupied 12.5ha or 5.9% in 1964, marginally rose to 14.3ha or 6.8% in 1984, declining to 3.6ha or 1.7% in 2004. This decrease was deemed perhaps to have occurred through some reclamation of wetlands and replacement with more formal residential houses. Circulation comprising of highways and streets which was virtually non-existent in 1964 covered 3.8ha or 1.8% in 1984 and rose to 4.9ha or 2.3% in 2004. Generally as evident from the land cover analysis, residential expansion as the most dominant use in this area is the one which displaced or impacted severely on the wetlands.

From Table 3 and 4, it is evident that of the three physiographic units, the best location for sitting residential use is on the isolated highland. This is the most suitable location where this use would have had the least impact on the landscape. The area of course is currently occupied by Ogudu residential area. The next most suitable residential location is the low sedimentary land. Most of the residential settlements of Bariga, Ifako/Gbagada, Ikosi/Alapere and Oworonshoki are situated on this. The least suitable residential location is the Coastal alluvium plain which covers most of Agboyi Creek and straddling Oworonshoki settlement. Interestingly, this is the location of the large tract of reclaimed land by the state authorities and currently lying fallow. It is also noteworthy that residential development pressure on the northern portion of Oworonshoki is on the coastal alluvium plain (wetlands).

Commercial, institutional and recreational uses are all suitable in all physiographic units. However, from Table 5, the Suitability Rank Table, conservation, recreation/park are the most suitable for the coastal alluvium plain and low sedimentary land while residential is ranked most unsuitable. The reality on ground is vastly different from these results hence the observed negative impact on landscape of the area.

Table 7 and Fig. 6 summarize the spatial coverage of conformed and non-conformed uses along with areas of vegetation or wetlands. About 139.8ha or 66.5% of the total land area was occupied in 2004 by uses **not** conforming with the physical parameters of the area and consequently not suitable. Generally the proportion of the land where existing land uses conform with suitable uses to where they do not is 1:8 while it is 1:8:3 inclusive of remaining vegetated areas. This shows that substantial part of this landscape has been somewhat misused with little left for conservation. Most of the coastal alluvium plain is occupied by non-conforming uses with some patches of vegetated wetlands still left. It should be added that since the study was concluded, the southern tip of Oworonshoki settlement mostly covered by vegetation has been besieged by residential development.

6. Implications and Conclusions

From these analyses, it is evident that the landscape of Ogudu/Oworonshoki area was composed mostly of wetlands which had been vastly encroached upon by various developments. Between 1964 and 2004, these developments have reduced natural land/wetland coverage from 141.90ha to 38.20ha at the rate of 2.60ha per year. This remaining land is principally occupied by wetlands. About 66% of the total area was occupied in 2004 by non-conforming uses unsuitable for the area.

These findings have implications for flooding/loss of biodiversity loss, conservation/urban area infrastructure and development control. One established physical impact of unrestrained wetland development and degradation is flooding besides biodiversity loss. Generally, increased urbanization inevitably leads to increased impervious surfaces and potentially more runoff delivery. Wholesale depletion of wetlands with increased urbanization will result in loss of flood withholding capacity of wetlands, consequently increasing the risk of flooding for these settlements. Incessant flooding which has been experienced in parts of Agboyi Creek and Oworonshoki can be attributable to developments on wetlands.

The remaining undeveloped sections are primarily wetlands of the Lagos Lagoon and Ogun River tributary (Agboyi Creek). Policy and actions to commit these to conservation will help to enhance the lean green infrastructure and ecological capital of the metropolis. There is need prior to this for studies to establish the threshold of wetlands necessary for the continued maintenance of ecological goods and services in this area.

Development control can only possibly be exercised in the remaining undeveloped portions. The action of the state authorities in this regard has shown direction in the proper sand-filling of the Ogun Foreshore (Fig. 2a, b, c) before 2004. With recent flood events in this area however, the desirability of any further development even on this reclaimed area should be deeply studied. State policy should be made to discourage land speculation on development of remaining wetlands.

Finally, it can be concluded that the landscape and wetlands of Ogudu/Oworonshoki area have been vastly altered; the rate of reclamation over the years has been high. These actions impact negatively on the physical and ecological environments of the area. It is recommended that the state authorities established standards for wetland reclamation, where this must necessarily occur to minimize adverse effects.

References

Abegunde M. A. A. (1988). Shoreline erosion and land-use management on the active sandy barrier beaches around Lagos: A new focus for coastal environmental management in P. O. Sada & F. O. Odemerho (eds). *Environment issues and management in Nigerian development*. Evans Bros (Nig. Publishers) ltd.

Demers, M. N. (2000) *Fundamentals of Geographic Information System*, 3rd ed. John Wiley & Sons, Chichester, U.K.

Department of Soil Sciences, OAU, Ile-Ife (1982). Semi – Detailed Soil Survey of Osun Ona and Ogun River Basins. OAU. Ile-Ife.

Fasona, M., Omojola A., & A. Onyeahialam (2007). Mapping Land Degradation and Forest Resource Loss from Fused Landsat TM and Nigeria. Images in some Parts of the Southwest Coast of Nigeria. *Proceedings of Symposium on Remote Sensing for Environmental Change Detection,* eds. Owe M. & Neal C. IAHS Publication 315, pp. 110 – 118.

Federal Ministry of Agriculture and Natural Resources (1990). The Reconnaissance Soil Survey of Nigeria 1: 650,000.00. FMANR.

Fuller, L. M. Morgan, T. R., & S. S.Aichele (2006). Wetland Delineation with Ikonos High Resolution Satellite Imagery, Fort Cust Training Center, Battle Creek, Michigan.US as Scientific Investigation Report. 2006 – 5051. 8p.http://pubs.water.usgs.gov/sir/2006/5051.

Gandy, M. (2006). Planning, anti-planning and the Infrastructure crisis facing metropolitan Lagos. *Urban Studies*. 2006, 43 (2):371 – 396.

James, G. K. Adegoke, J. O., Saba, E., Nwilo, P. C., & J. Akinyede (2007). Satellite –Based Assessment of the Extent and Changes in the Mangrove Ecosystem of the Niger Delta". *Journal of Marine Geodesy*, **30**, pp. 249 – 267.

Jensen, J. R. (2007). *Remote Sensing of the Environment: An Earth Resource Perspective* 2nd ed. Pearson Prentice Hall, Upper Saddle River, NJ.07458. 2007.

Makinwa-Adebusoye, P. K. (1988). Managing the urban environment: A strategy for upgrading Olaleye – Iponri slum in Lagos. In P.O. Sada & F. O. Odemerho (eds*). Environment issues and management in Nigerian development*. Evans Bros (Nig. Publishers) ltd.

Maxa, M. & P. Bolstad (2009). Mapping Northern Wetlands with High Resolution Satellite Images and Lidar. *Wetlands* **29(1),** pp. 248 – 260.

McGarigal, K. Cushman, S. A. Neel, M. C. and E. Ene (2002). FRAGSTATS: A Spatial Pattern Analysis Program for Categorical Maps, Version 3.3 Build 5. Amherst: University of Massachussetts; http://www.umass.edu/landeco/research/fragstats/faq/fragstats_faq.html.

McGrarigal, K., Cushman, S. A., Neel, M. C. & Eneh, E. (2002). FLAGSTATS:A spatial pattern analysis program for categorical maps, version 3.3 Build 5. University of Massachusetts; http://www.umass.edu/landeco/research/flagstats/fag/fragstats_faq.html.

Mcharg, I. L. (1992). *Design with Nature*. John Wiley & Sons. Inc.

Odunuga, S. & Oyebande, L. (2007). Change Detection and Hydrological Implications in the Lower Ogun River Flood Plan, S. W. Nigeria. *Proceedings of Symposium on Remote Sensing for Environmental Change Detection*, eds. Owe M. & Neal C. IAHS Publication 316, pp. 91 – 99.

Oduwaye, A. (2009). Challenges of sustainable physical planning and development in metropolitan Lagos. *Journal of Sustainable Development*. 2009. 2 (1): 159 – 171. www.ccsenet.org/journal.html.

Ojo, O. (1988). Urbanization and Thermal problems in tropical cities: The Lagos experience, in In P.O. Sada & F. O. Odemerho (eds*). Environment issues and management in Nigerian development*. Evans Bros (Nig. Publishers) ltd.

Oluseyi F. (2006). Analysis of Traditional Urban Land Use Change from Remote Sensing Data: A Case Study of Ibadan, City. Map Africa". 2006. Available at http://www.gisdevelopment.cet/proceedings/mapafrica/2006/Technology.

Onokerhoraye, A. G. (1988). Case studies of urban slums and environmental problems. In P.O. Sada & F. O. Odemerho (eds*). Environment issues and management in Nigerian development*. Evans Bros (Nig. Publishers) ltd.

Rubenstein, H. M. (1996*). A Guide to Site Planning and Landscape Construction.* 4th ed. John Wiley & Sons Inc.

Simmonds, J. O.(1983). *Landscape Architecture: A Manual of Site Planning and Design.* McGraw Hill Corp.

Taiwo, O. J. & O. Areola (2009) A Spatial Temporal Analysis of Wetland Losses in the Lagos Coastal Region, Southwestern Nigeria Using Multi-Date Satellite Imagery. *Paper Presented at IGARSS Annual Conference Cape Town, South Africa*, Sept. 2009.

Table 1. Descriptive Analysis Of The Physiographic Units.

UNITS	%COVERED	TOPOGRAPHY		SOIL				HYDROLOGY				VEGETATION
		Landform	Elev (m)	Slope (%)	Description	Chemical Properties	Physical Characteristics	Surface Drainage	Aquifer Type	Water Table (m)	G/W Potential & /Quality	
Coastal Alluvium Plain		Nearly Levelled coastal marshy land	0-5	0-2	Very deep and poorly drained	Highly acidic, low CEC, low BS percentage	Poorly compacted, very low land bearing capacity	Creek, rivers & lagoon	Partially unconfined aquifer	1.5-9	High potential & low quality	Mangrove forest
Low sedimentary land		Undulating marshy low land	5-15		Deep and poorly drained	Slightly acidic, low CEC, very high BS	Fairly compacted, low load bearing capacity	Seasonal streams, rivers	Confined & partially unconfined aquifer	1.5-9	High potential & low quality	Mangrove forest
Isolated highland		Isolated hill bounded by lowlands	15-23		Deep and well drained	Highly acidic, high CEC, low BS	Well compacted, high load bearing capacity	Flood channels	Confined aquifers	9-15	High potential & high quality	Mangrove forest/tropical rain forest

Table 2. Compatibility Of Uses With The Physiographic Units.

				TOPOGRAPHY		SOIL		HYDROLOGY		
USE	UNITS	ELEV.	SLOPE	COMPACTNESS	LOAD BEARING CAPACITY	SURFACE DRAINAGE	GROUND WATER	VEGETATION	SCORES	% OF x/35
RESIDENTIAL	a	1	4	1	1	1	1	1	10	28.6
	b	2	5	2	2	2	2	1	16	45.7
	c	5	4	4	5	4	4	2	28	80
AGRICULTURAL	a	2	4	2	3	2	2	1	16	45.7
	b	4	4	5	3	3	4	2	25	71.4
	c	3	3	3	3	2	3	3	20	57.1
INDUSTRIAL	a	2	4	1	1	1	1	1	11	34.4
	b	4	4	2	2	2	2	1	17	48.6
	c	5	2	4	4	4	4	3	26	74.3
COMMERCIAL	a	2	4	4	3	3	3	2	18	51.4
	b	2	4	4	3	3	3	2	21	60
	c	4	3	4	5	3		3	25	71.4
INSTITUTIONAL	a	1	5	1	1	2	2	1	13	37.1
	b	2	5	2	3	3	3	2	20	57.1
	c	5	4	4	4	3	4	3	27	77.1
RECREATIONAL/OPEN SPACES	a	1	3	4	4	1	4	2	19	54.3
	b	2	3	5	4	4	3	3	24	68.8
	c	5	5	5	5	4	3	3	30	85.7
CONSERVATION/ PARK	a	5	5	3	3	5	5	5	31	88.6
	b	5	5	3	3	5	3	5	29	82.9
	c	5	5	3	3	3	3	3	25	71.4

1 – very incompatible 3-no relation 5- very compatible a - coastal alluvium plain

4- compatble b - low sedimentary land c –i solated highland

Table 3. Decision Table On Suitability Of Uses In The Physiographic Unit.

Units	**Residential**	**Agricultural**	**Industrial**	**Commercial**	**Institutional**	**Recreational and open spaces**	**Conservation/parks**
Coastal Alluvium	N.S	N.S	N.S	N.S	N.S	S	V.S
Low sedimentary	N.S	S	N.S	S	S	S	V.S
Isolated highland	V.S	S	S	S	S	V.S	S

Decision range: <50---------------- N.S Where, N.S. Not Suitable

>=50 but < 80------S SSuitable

>=80----------------V.S V.S Very Suitable

Table 4. Suitability Rank Table.

Rank	**COASTAL ALLUVIUM**	**LOW SEDIMENTARY**	**ISOLATED HIGHLAND**
1	Conservation and park	Conservation and park	Recreational/open spaces
2.	Recreational/open spaces	Agricultural	Residential
3.	Commercial	Recreation/Open spaces	Institutional
4.	Agricultural	Commercial	Industrial
5.	Institutional	Institutional	Conservation/park and Commercial
6.	Industrial	Industrial	Agricultural
7.	Residential	Residential	-

Table 5. Metrics on Land cover Changes 1964, 1984 and 2004.

Year	1964		1984			2004			
Land cover	Area Covered (Ha)	% of the Total	Area Covered (Ha)	% of the Total	Rate of Change Per year/ha	Area Covered (Ha)	% of the Total	Date of Change Per Yr	
Water body	43.90	20.90	44.30	21.08	-	44.70	21.26	-	
Natural Cover	141.90	67.50	78.60	37.39	-3.17	38.20	18.17	-2.02	2.60
Developed Land	24.40	11.61	87.30	41.53	3.15	127.30	60.51	2.0	2.60
Total	210.20	100	210.20	100	-	210.20	100	-	-

Table 6. Land use classification and changes in the study area.

Land use	Land use Code	1964	1984			2004	
Water body		Area (ha)	% of total	Area (ha)	% of total	Area (ha)	% of total
	1	43.9	20.9	44.3	21.1	44.7	21.2
Wetland	2	141.9	67.5	78.6	37.4	38.2	18.2
Residential (sum)	3	24.3	11.6	80.0	38.1	100.8	47.6
a) Built up							
b) Scattered	3a	11.8	5.6	65.7	31.3	96.5	45.9
c) Stilted houses	3b	12.5	5.9	14.3	6.8	3.6	1.7
	3c	-	-	-	-	0.7	0.3
Circulation	4	-	-	3.8	1.8	4.9	2.3
Public/Semi Public	5	-	-	2.6	1.2	5.8	2.8
Commercial	6	-	-	0.3	0.1	1.0	0.5
Open space	7	-	-	0.6	0.3	1.1	0.5
Modified land (sum)	8	-	-	-	-	13.7	6.5
a) Excavated	8a	-	-	-	-	2.2	1.1
b) Reclaimed							
	8b	-	-	-	-	11.5	5.5

Table 7. Summary Of % Of The Area Covered By Natural Vegetation, Confirmed And Non-Confirmed Uses

	Natural vegetation	Conformed uses	Non-Conformed uses
% of the total land mass covered	24.8	8.7	66.5

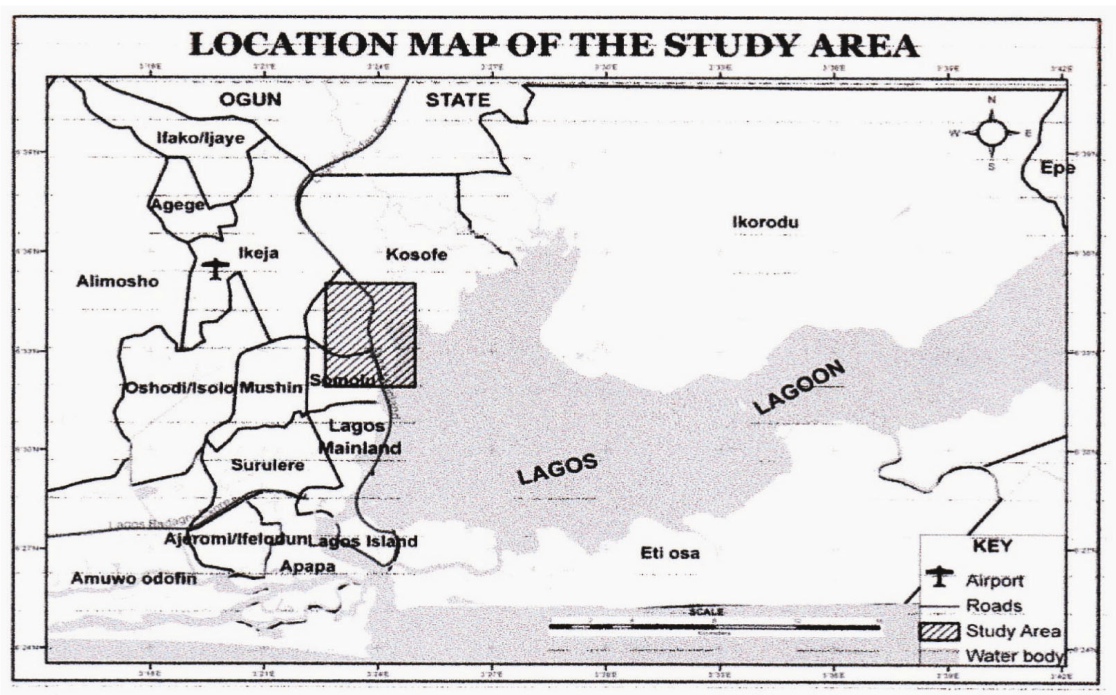

Figure 1. Location map(source:Federal surveys topographic series,1984/85)

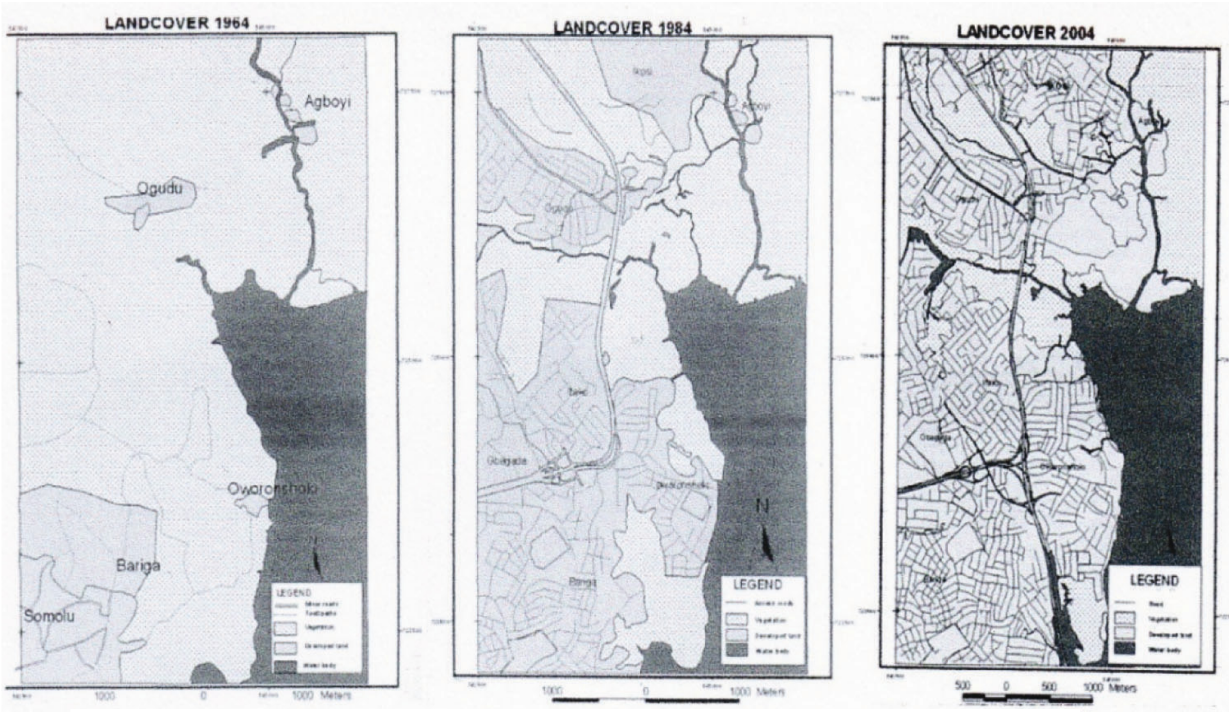

Figure 1a,b,c Land cover 1964,1984 &2004

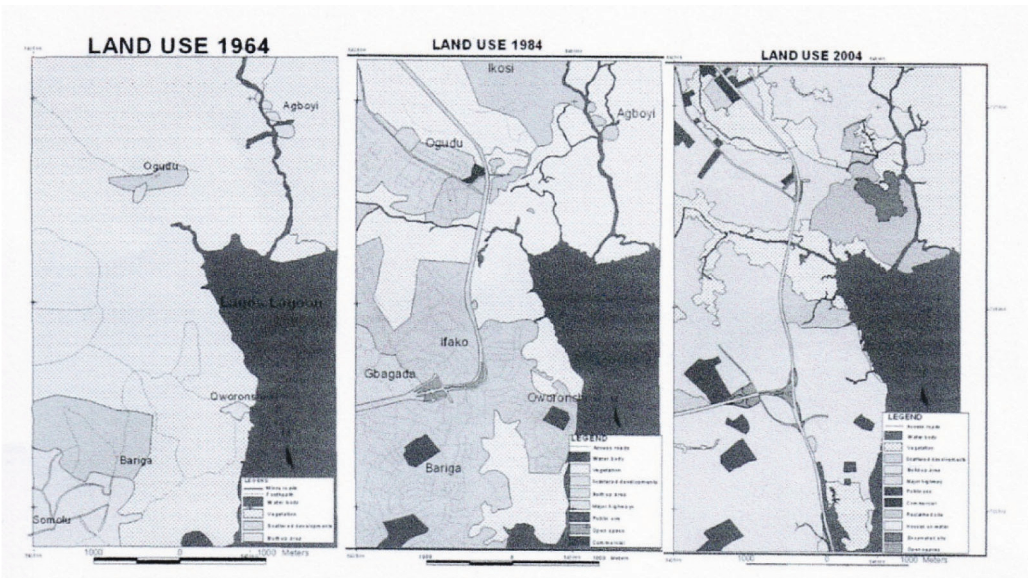

Figure 2a, b, c. Land cover 1964, 1984 &2004

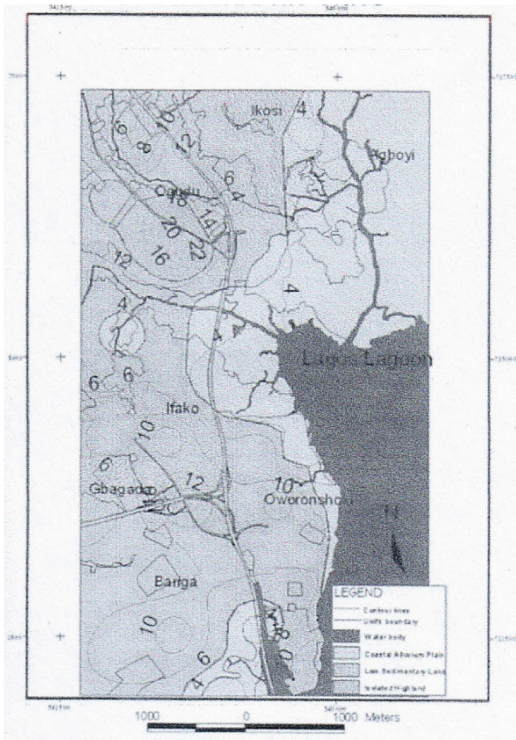

Figure 3. Physiographic units

Change in Land Cover of the Study Area

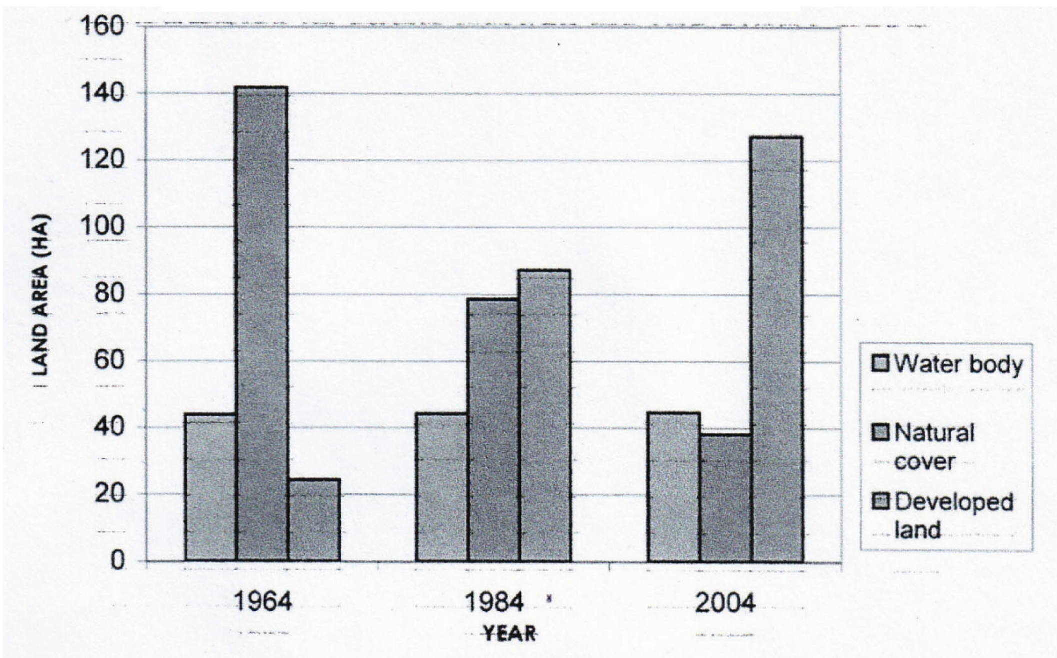

Figure 4. Histogram of land cover

Land Use Changes/Classification of the Study Area

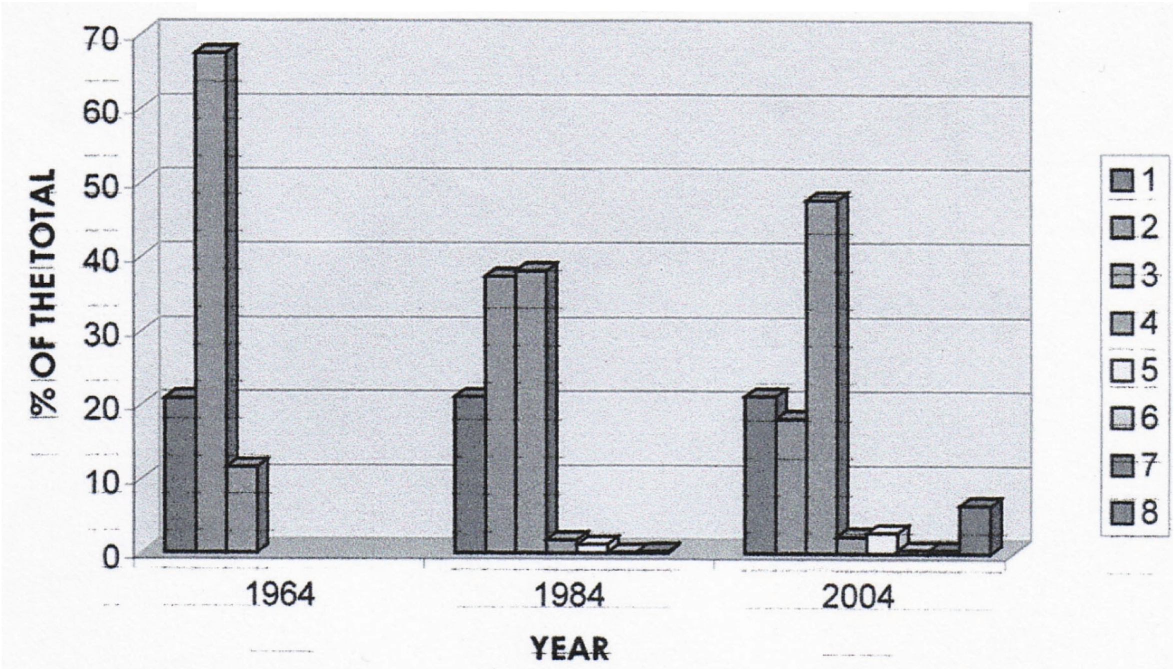

Figure 5. Histogram of land use change

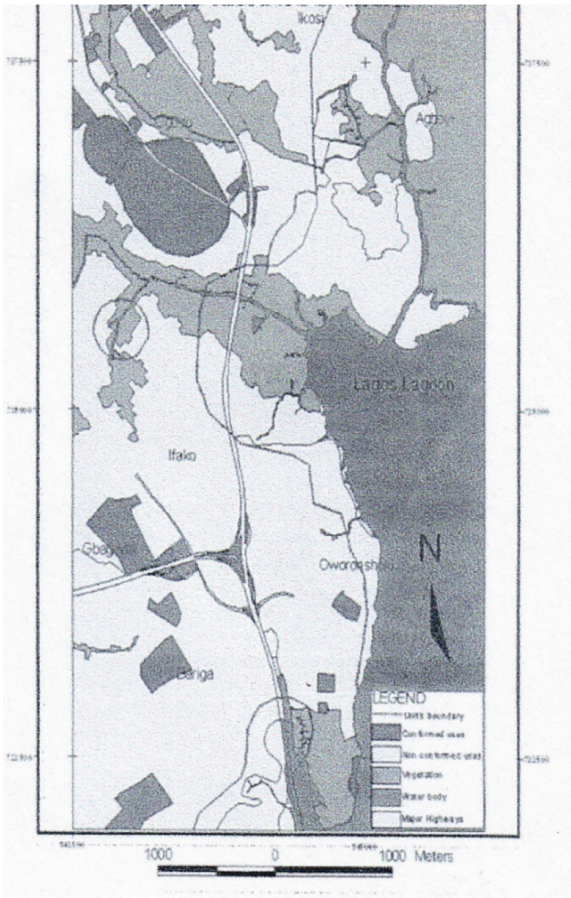

Figure 6. Conformity map