DYNAMISM OF LANDSCAPE TRANSFORMATION IN IBIONO-IBOM, AKWA-IBOM STATE, NIGERIA

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ABSTRACT

Studies have shown that information on landscape transformation is an important benchmark data set because of its value as an environmental change indicator. Therefore, dynamism of landscape transformation over a 34-year period are analysed for a case study in Ibiono-Ibom, Akwa-Ibom State, Nigeria. The study adopted a mixed method consisting of remote sensing and GIS-based analysis, and semi-structured interviews covering 400 households while factors contributing to landscape structures and changes are studied. The results point out three main driving factors responsible for the landscape transformation in the study area: agricultural practices which lead to intensification of forest resources, riparian vegetation, vegetated wetlands and non-vegetated wetlands; urbanization which modifies the structure and morphology of the landscape, and finally, population growth directly related to massive infrastructural development which encroached on all other land spaces. GIS-based analysis of remotely-sensed data showed that built-up area had increased by 7535.2 ha between 1986 and 2020; shrub and arable land by 1343.9 ha and light forest decreased by 4998.3 ha. While bare-land reduced by 1522.1 ha; vegetated wetland reduced by 1092 ha; water body coverage reduced by 168 ha and non-vegetated wetland size also reduced by 2029.4 ha. Analysis of household survey results revealed that the perceptions of respondents validate the observed patterns during the remotely-sensed data analysis phase of the research, with 54 % (n=400) of respondents reporting a decline in agricultural land use, and 19.3 % (n=400) observing a decline in forest areas in the study area. Furthermore, agricultural intensification, urban development, timber exploitation, firewood collection and increase in settlements were identified as the proximate drivers of these observed landscape transformation dynamics in the study area. The study concluded that the variation in landscape transformation of the study area are clear indication of the extent of biodiversity loss and ecosystem degradation in the study area.

Keywords: Biodiversity loss; Dynamism; ecosystem status, degradation, landscape transformation

INTRODUCTION

Human activities have significantly affected landscape ecology through fauna habitat destruction and biodiversity reduction. This has greatly increased the need to detect and predict the associated changes in the ecological functioning of the environment (Naem *et al.*, 1999; Lambin *et al.*, 2003). Human alterations of the terrestrial surface are unprecedented in their pace, magnitude and spatial extents. Out of these alterations, none is more important than changes in land cover and land use (Meyer & Turner, 1994; Dimyati *et al.*, 1996). Land cover may be described as the biological and physical features that cover the surface of the earth while land use is the use to which a given land cover is put in order to derive some benefits (Adeleke & Orimoogunje, 2016). Thus, land use/land cover change is a key driver in global environmental changes (Vitousek, 1992; Bajocco *et al.*, 2012; Adeleke *et al.*, 2017). In particular, land use/land cover (LULC) changes in tropical regions are of major concern due to the widespread and rapid changes in the spatial distribution and characteristics of the tropical forests (Meyer & Turner, 1994; Houghton, 1994; Barros & Albernaz, 2014). Land cover change is one of the most important variables of environmental change and represents the largest threat to ecological systems (Murdiyarso *et al.*, 2012). Land use study has become a central component in current strategies for managing natural resources and monitoring environmental changes (Verhoeven & Setter 2010; Awoniran *et al.*, 2014). Previous studies have shown that human land use is a formidable agent of change, shaping the spatial distribution of land cover and affecting fundamental ecological processes such as hydrological/climatological regimes, bio-geochemical cycling as well as the persistence and extinction of species (Vitousek *et al*, 1997; Wakawa *et al.*, 2018). The impacts of these environmental problems are serious both in the short and in the long term. In the short term, food security, human vulnerability, health and safety are at stake; in the long term, the viability of earth is being threatened (Olaleye *et al.*, 2009). In the Nigerian tropical rainforest zone for instance, a major agent of change in land use is the rapidly increasing population. This has subjected vast expanse of the unprotected landscape to intensive human activities (Salami *et al.*, 1999; Wakawa *et al.*, 2018). According to, Lambin *et al.* (2005), neither population nor poverty alone constitutes the sole and major underlying causes of land cover change worldwide. Rather, peoples' responses to economic opportunities, as mediated by institutional factors within the interplay of local, national and global forces, drive land cover changes.

From the ongoing, it is obvious that the LULC change is linked in complex and interactive ways to other global environmental changes, human actions and environmental feedbacks at multiple and temporal spatial scales. In fact, studies have shown that land cover change was the most significant regional anthropogenic disturbance to the environment (Roberts *et al.*, 1998; Adeleke *et al.*, 2017). Thus, both LULC changes are essentially products of prevailing interacting natural and anthropogenic processes and activities (Ademiluyi *et al.*, 2008). Land use and land cover change, climate change, and other environmental changes all interact to affect natural resources. In the face of rapid environmental changes, land surface ecology/ecologists play a vital role in sustainable land management by providing insights into the consequences of land use choices for the ecosystem and consequently, the region. However, participation of ecologists in land use decisions is usually made difficult by the political context in which these decisions are made.

In essence, knowledge of land use dynamics is essential in examining various ecological and developmental consequences of land use changes over a space of time. Studies have shown that land use mapping and change detection are relevant inputs in decision-making process, most especially in implementing appropriate policy responses (Fasona & Omojola, 2007). Therefore, land use change detection allows for the identification of major processes of change and, by inference, the characterization of land use dynamics.

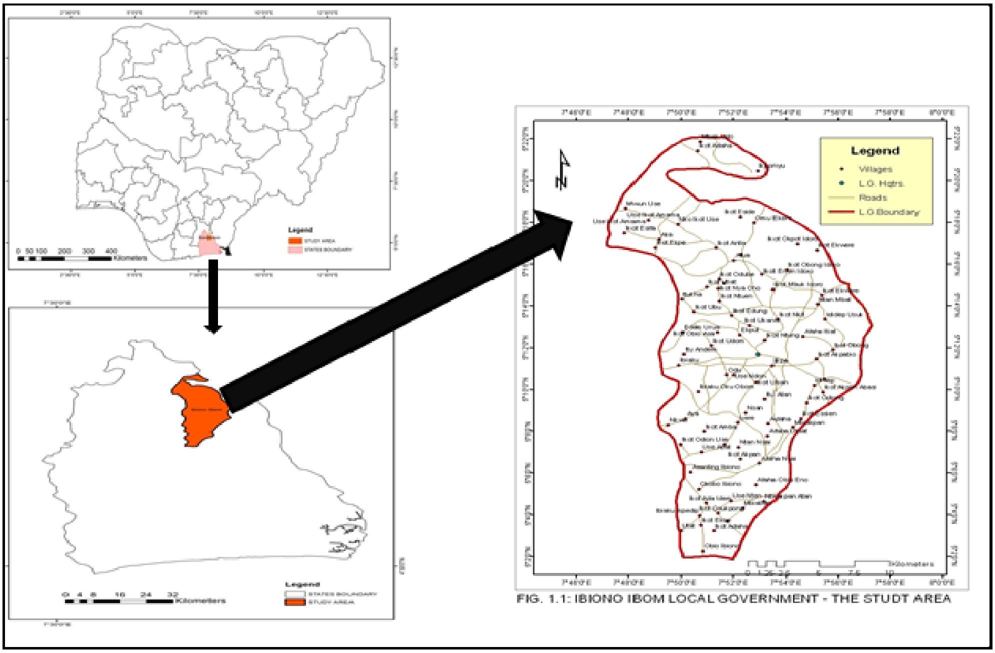
In view of the above, both LULC changes are products of prevailing interacting natural and anthropogenic processes. As a matter of fact, LULC change and land degradation are therefore driven by the same set of proximate and underlying elements central to environmental processes, change and management. These proximate and underlying elements influence biophysical and a wide range of socio-economic and ecological processes (Desanker *et al.*, 1997; Verburg *et al.*, 2002; Fasona & Omojola, 2007; Badiru & Olaoye, 2015). Therefore, this study seeks to examine the dynamics of landscape transformation in Ibiono Ibom, Akwa-Ibom State, Nigeria, with a view to ascertaining anthropogenic activities responsible for biodiversity alterations and provided a baseline data for future environmental sustainability.

MATERIALS AND METHODS

Study Area

The study was conducted in Ibiono-Ibom, located in Akwa-Ibom State, South-southern part of Nigeria bordering Cross River State in the North, Itu Local Government Area in the East, Ikono in the West and Uyo in the South. The study area covers a geographical area of 35,487 ha and lies between longitudes 07°45'E and 08°00'E and latitudes 05°02'N and 05°23'N (Figure 1) (Udeagha *et al.*, 2013).

Fig. 1: The study area inserted in Nigeria and Akwa-Ibom (Ibiono Ibom Local Government)



It consists of nine clans, 33 groups and 193 villages, with population of about 385,145 (NPC, 2016). The relief of the area is rough, and the terrains intensely-dissected with a landscape comprising steep-sided hills, valleys and narrow-crested sandstone ridges. The hills and ridges of this region are separated by flood-prone lowlands which are remnants of the West-East extension of the Enugu-Okigwe escarpment which terminates at Arochukwu. The slopes are greatly ravaged by erosion and landslides, especially during the rainy season. The drainage network is not dense, as rivers are few and distant apart with wide interfluves. The main drainage system is the Ikpa-river and other small rivers are Ikpanya, Ididep Usuk, Ntan Mbat, Use Ikot Oku, Ikot Obong, Afaha Nsai, Edem Urua and Aka Ikot Udo Eno. Ibiono lbom LGA is underlain by sedimentary formations of Late Tertiary and Holocene ages consisting of coastal plain sands, now weathered into lateritic layers. The climate of Ibiono-lbom is characterized by two seasons, namely, the wet season and the dry season. The rainy season begins about March-April and lasts until mid-November with a total annual rainfall of about 3500 mm. The dry season begins in mid-November and ends in March. Temperatures are relatively high throughout the year, with the mean annual temperature varying between 26°C and 36°C. Relative humidity varies between 75 % and 95 %, with the highest and lowest values in July and January respectively. The existing climatic factors would have favoured luxuriant tropical rainforests with teeming populations of fauna and extremely high terrestrial biomass. However, the vegetation in the area is largely altered as a result of incessant human activities. The native vegetation has almost been completely replaced by secondary re-growths of predominantly wild oil palms, woody shrubs and a variety of grass undergrowth. Farmlands mixed with oil palm and degraded forests predominate characterised the area. However, a few primary forest relics are found in isolated sacred forests and river courses. The lowland and valley areas are composed of alluvial soil, which favours the cultivation of crops like, cocoyam, cassava, etc.

Data Acquisition and Preprocessing

Studies have shown that geospatial and remote-sensing data are reliable sources for understanding and ascertaining the drivers of landscape transformation (Orimoogunje, 2005). Therefore, in this study, the topographical map of the study area that was produced in 1965 was used as baseline information while change detection analysis using multiple sets of spatiotemporal Landsat images for 1986, 2000, 2015 and 2020 was used to establish and confirm landscape transformation in Ibiono-Ibom (Table 1). ArcGIS 10.5 and ILWIS 3.3 software were used to perform standard image processing techniques, including extraction, geometric correction, atmospheric correction, topographic correction, image enhancement and subsetting. The four images were also registered to a common Universal Transverse Mercator (UTM) co-ordinate system, Zone 32, with World Geocoded System (UTM WGS 84) projection parameters using the GOECALC software for the conversion.

Table 1: Detailed Information on Satellites Images used in this Study

Satellite	Path / Row	Date of acquisition	Spatial Resolution (m)	Source
Landsat Image	188/56	19/12/1986	28.5m	GLCF, University of Maryland, USA. Downloaded from www.glcf.com
Landsat Image	188/56	17/12/2000	28.5m	GLCF, University of Maryland, USA. Downloaded from www.glcf.com
Landsat 8 OLI_TIRS	188/56	2015-01-17	30 m	USGS
Landsat 8 OLI_TIRS	188/56	2020-01-31	30 m	USGS

Procedures of Data Analysis and Image Processing

The Topographic map of 1965 was sourced, processed and transformed into a GIS environment to serve as reference and baseline information data coupled with Landsat Thematic Mapper and Enhanced Thematic Mapper Plus (TM/ETM^+) satellite imageries of 1986 and 2000, Landsat 8 “OLI_TIRS” 2015 and 2020. The choice of the satellite images of 1986, 2000, 2015 and 2020 were to examine the landscape transformation that occurred within the interval of 34 year in the area. Maps of the study area were created from the satellite images of Akwa-Ibom region using visual image interpretation technique. The coordinates of some villages and important features in the study area were recorded with Geographical Positioning System (GPS), which was used as ground control points for accurate training and classification. A field survey exercise was conducted in the study area to familiarize and observe the major types of LULC for training selection. This is an important aspect of landscape transformation mapping because it aids the process of LULC classification by associating the ground features to a specific type of LULC with the relevant spectral characteristics. The ground data was also used to assess the accuracy of the LULC maps produced at the end of the analysis. The satellites images for the study area were classified using hybrid (supervised) classification algorithms because the area is accessible. A maximum likelihood classification algorithm was performed on each satellite image adopting Anderson’s level 1 classification (Anderson *et al.,* 1976). A classification scheme of 8 classes was developed based on the understanding of the study area terrain and the author’s *a priori* knowledge of the study area. The 8 LULC classes were categories as bare-land, built-up, light forest, riparian forest, shrub and arable land, vegetated wetland, water body and non-vegetated wetland (Table 2).

Table 2: Land Use Land Cover Class used in the Study

S/N	LULC Class	Code	Description
1	Built-up area	BUA	Residential, commercial and industrial, socioeconomic infrastructure
2	Water body	WB	Open water bodies such as rivers, streams and ponds
3	Shrub and arable land	SAL	All cultivated agricultural lands - cultivated lands where food crops like cassava, yam, maize etc are grown, fallow lands - shrubs, herbaceous plants, seedlings and saplings that compete and grow together in an interlocked manner.
4	Light forest	LF	Secondary forests and regrowth’s with small trees. Tree-like growths and climbers are also found in this class.
5	Bare land	BL	Bare rock outcrops, major or minor roads that are unpaved.
6	Non-vegetated Wetland	WL	Lands where the water table is near or above the surface, water-logged areas with no vegetation.
7	Vegetated Wetland	VW	Wetlands covered with aquatic plants, mostly mangrove and raffia palm, cultivated wetlands.
8	Riparian Forest	RF	Occur along river courses. May be evergreen, with considerable number of woody plants.

Accuracy assessment was determined using the kappa coefficient, overall accuracy, producer and user accuracy and the error matrix in line with Liu *et al*., (2007), Congalton & Green (2009) and Munthali *et al*., (2019). The annual rate of LULC change was also determined using the standard procedure established in the literatures (Puyravaud, 2003; Teferi *et al*., 2013; Batar *et al*., 2017; Adeleke *et al*., 2017) while equation 1 was adopted to provide a benchmark for comparing LULC changes between the period under study.

$$r = \left(\frac{1}{t_2 - t_1}\right) \times \ln\left(\frac{S_2}{S_1}\right) \quad (1)$$

From the equation: r is the annual rate of change for each class, and S_1 and S_2 are areas of each LULC class at t_1 and t_2 respectively.

Socio-Economic Data

A well-structured questionnaire was used in a face-to-face interview with the main goal of collecting information focusing on the proximate driver of landscape transformation and to ascertain the correlation between the inhabitant's socio-economic status and the environmental implications of changes in the study area. For the purpose of questionnaire administration, a sample size of 400 persons derived from the 2006 total population of 188,605 persons (NPC, 2006) was selected and the questionnaires administered to them. The sample size of 400 persons was obtained through the application of Taro Yamane's sample size selection formula for a finite population (Uzoagulu, 1998).

$$n = \frac{N}{1+N\,(e)^2} \quad (2)$$

where n = sample size
N = finite population of the study area
e = level of significance (0.05)

The study employed a simple random sampling method to select respondents for the household interviews. The study area was divided into three zones: A, B, and C.

- Zone A: Central Ibiono comprising Oko-Ita (the local Government headquarters) and the adjoining villages.
- Zone B: Northern Ibiono comprising Idoro and other adjoining villages
- Zone C: Southern Ibiono comprises of Ikot Adaidem and other adjoining villages.

This study was in line with previous studies such as Mertens & Lambin (1999), that detailed studies of the selected sample areas should lead to the identification of generic trajectories and processes of land use change, which could then be carefully generalized at broader scales.

RESULTS AND DISCUSSION

Patterns of landscape Transformation

In accordance with image processing, Figures 2 to 5 shows the details spatial representation of LULC types from 1986 to 2020. The detailed proportionate of coverage of each of the eight classes extracted in Ibiono-Ibom from 1986 to 2020 of LULC change trends are grouped in Table 3. These are:

- Land use types whose areal extent had increased in the year under study; and
- Land use types whose areal extent had decreased in the year under study.

The first group includes those land use types whose areal extent has increased between 1986 and 2020. The land use types whose areal extent has increased between 1986 and 2020 include the built-up area from 2,187.4 hectares (6.16 %) in 1986 to 9,722.6 (27.4 %) hectares in 2020; bare-land from 5,241 hectares (14.77 %) in 1986 to 6, 377.3 hectares (17.97 %) in 2000; riparian forest from 2,610.7 hectare (7.36%) in 1986 to 3,433.9 hectares (9.68 %) in 2000 and 3,541.4 hectares (9.98 %) in 2020 respectively. Similarly, shrub and arable land increased from 12,196.8 hectares (34.37 %) in 1986 to 13,823 (38.95 %) and 15,306.7

hectares (43.13 %) in 2000 and 2015 respectively; vegetated wetlands increased from 641.8 (1.8 %) hectares in 2000 to 813.1 (2.29 %) and 1,454.9 (4.10 %) hectares in 2015 and 2020 respectively; while waterbody increased from 275.7 hectares (0.77 %) in 2015 to 319.2 hectares 0.9 %) in 2020. In sum total these land use types have grown tremendously in areal extent in the study area.

Fig. 2: Land use/land cover Classified Image map of the study area, 1986

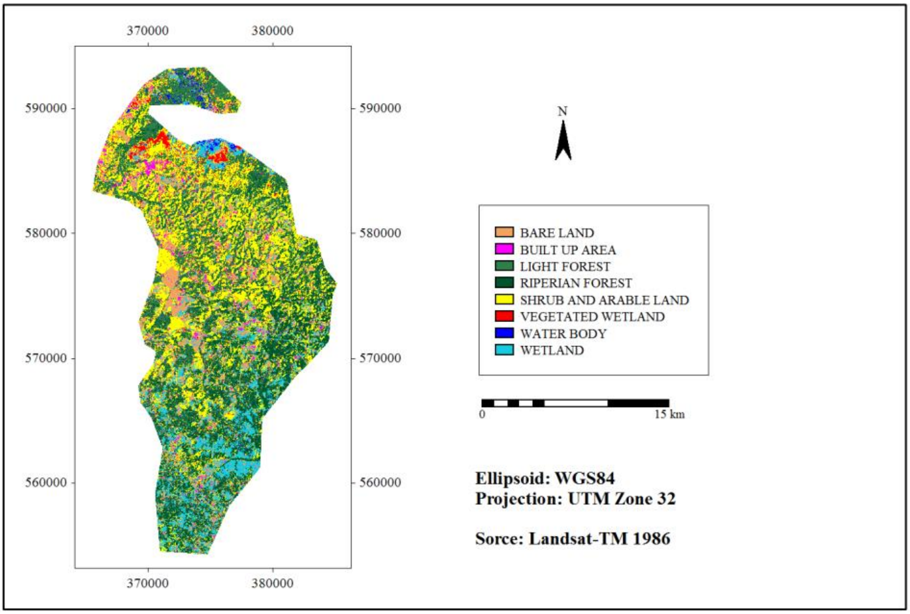


Fig. 3: Land use/land cover Classified Image map of the study area, 2000

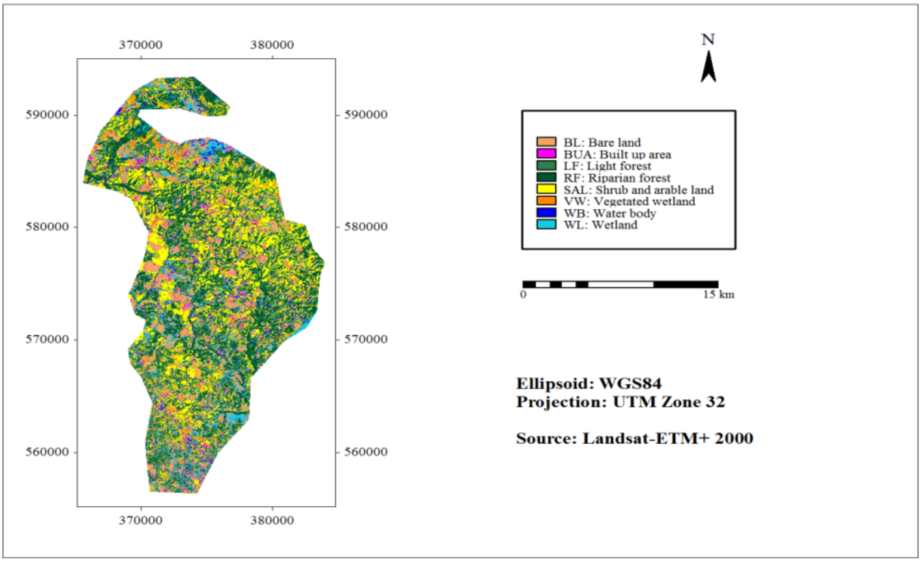


Fig. 4: Land use/land cover Classified Image map of the study area, 2015

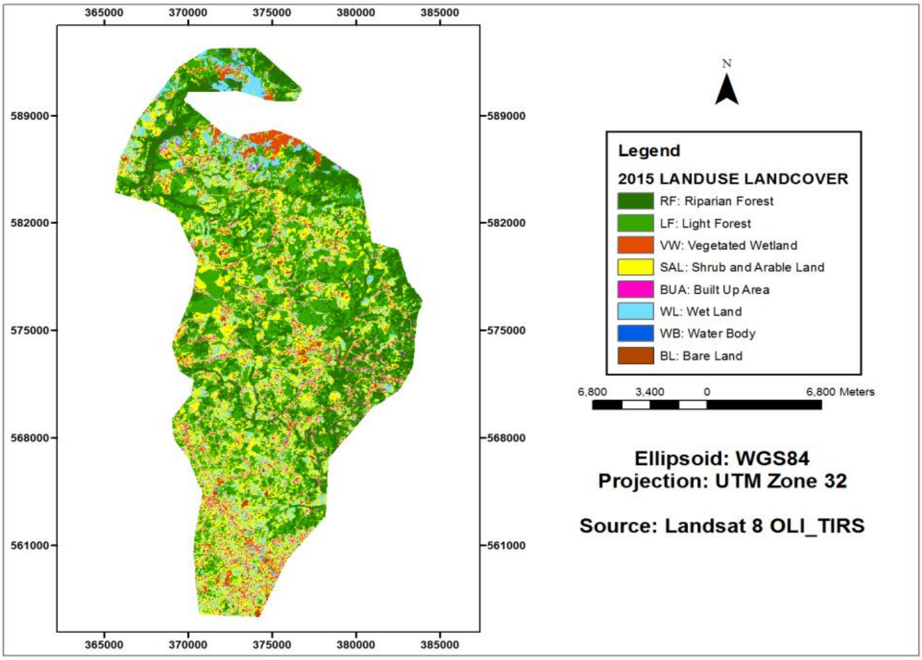
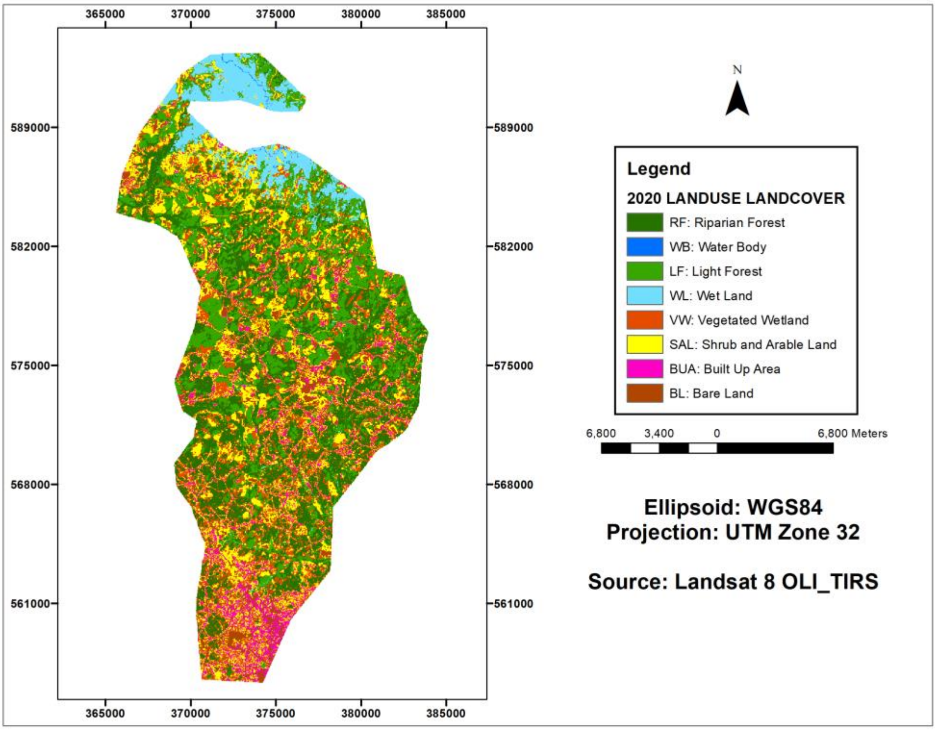


Fig. 5: Land use/land cover Classified Image map of the study area, 2020



It is evident from Table 3 that shrub and arable land which stand for all cultivated agricultural lands where food crops like cassava, yam, maize and so on are grown have shown a spectacular growth between 1986 and 2015. This pattern is influenced by many factors; one of which is that the vast majority of dwellers are poor, average income earners who depend on agriculture solely as their source of sustenance. This land covers unit has increased by more than 3.79 times its average coverage in 2020. This is an indication of land use intensification in the study area in form of intensive land cultivation with food crops in the study area as confirmed by field survey. Built-up area unit have shown the most consistent spectacular growth in the study area. The pattern of growth exhibited by built-up area in form of residential, commercial, industrial and socio-economic infrastructure is consistent with the observable pattern in many parts of the world. This pattern is influenced by many factors one of which is the migration from neighbouring settlements, which led to population growth and this is directly related to more infrastructural development in the study area (Table 6 and 7). As evident from socio-economic survey, road construction has led to land excavation for sand thereby creating man-induced gullies in the study area as confirmed by field survey. Consequently, this LULC has caused a decrease in forest land area, and since forests are habitats for fauna and also support a lot of flora species, the implication of this landscape modification in the study area is that there is a loss in both flora and fauna species as revealed by biodiversity inventory collected from the area (Appendix 1). It can therefore, be inferred that as forest are cleared for built-up, land cover and biodiversity is being affected, in the sense that, it led to flora reduction while the fauna species seek new habitats by migration as evident in respondent’s perception and the results of image analysis in Tables 4 and 5.

The second land use changes in the study area are those whose extent of coverage has decreased. By 1986 light forest had declined from 6,486.8 hectares (18.28 %) to 3,696 hectares (10.42 %) in 2000 and to 2,053 (5.79%) and 1,488.5 hectares (4.19 %) in 2015 and 2020 respectively. This trend is consistent with what has been described for many rural areas with forest resources in Nigeria (e.g. Ola-Adams, 1981; Orimoogunje, 2005) and other parts of the world (Williams, 1990). In Nigeria agricultural intensification destroys many forested areas. For instance, Ola-Adams (1981) reported that approximately 2,000 hectares of the western edge of Ogbesse Forest Reserve had been cut over and replaced by permanent agriculture. Orimoogunje (1999) reported that the pressure on the forest resources is due to the fact that there is shortage of land coupled with increase in population. From Tables 3, 4 and 5, it is evident that the vegetated wetlands and water bodies are not spared from the negative impacts of landscape transformation as a result of anthropogenic activities in the study area. For instance, in 1986 vegetated wetlands declined from 2,546.9 hectares (7.2 %) to 1,454.9 hectares (4.1 %) in 2020. Likewise, non-vegetated wetlands also declined from 3,729.6 hectares (10.5 %) in 1986 to 1,700.2 hectares (4.8 %) in 2020. This has negatively impacted native flora and fauna inhabiting that environment because once there is habitat fragmentation or destruction, it directly impacts the biodiversity negatively (Appendix I).

With regards to the study, at the beginning of the study period (1986), it is evident from Table 3 that shrub and arable land (that is agricultural land) unit was the most dominant LULC, covering 34.4 % of the total studied area, followed by light forest (18.3 %), barren land (14.8 %), non-vegetated wetlands (10.5 %), riparian vegetation (7.4 %), vegetated wetlands (7.18 %), built-up area (6.16 %) and water bodies (1.37 %). The trend continued up to 2020 with the exception of built-up areas. During the period under consideration (1986 to 2020), built-up areas substantially expanded almost fivefold (50.72 %), riparian vegetation expanded by almost two-fold (10.36 %), and shrub and arable land by onefold. Conversely, barren land, light forest, vegetated wetlands, water bodies and non-vegetated wetlands drastically decreased in the same period (Figure 5). These results is a direct pointer to the dynamism of landscape transformation in the study area, which if not strictly attended to, will continue to have grave implications for biodiversity components that are native to the study area.

Table 3: Areal extent of LULC Types in the study area between 1986 and 2020

Attributes of LU / LC type in the Study Area	LU / LC in 1986		LU / LC in 2000		LU / LC in 2015		LU /LC in 2020	
	Ha	%	Ha	%	Ha	%	Ha	%
BL	5,241.6	14.77	6,377.3	17.97	4677.1	13.18	3,719.5	10.48
BUA	2,187.4	06.16	4588.4	12.93	7294.5	20.56	9,722.6	27.40
LF	6486.8	18.28	3696.0	10.42	2053.0	05.79	1,488.5	04.19
RF	2,610.7	07.36	3,433.9	09.68	3044.2	08.58	3,541.4	09.98
SAL	12,196.8	34.37	13,823.0	38.95	15,306.7	43.13	13,540.7	38.16
VW	2,546.9	07.18	641.8	01.80	813.1	02.29	1,454.9	04.10
WB	487.2	01.37	373.0	01.05	275.7	00.77	319.2	00.90
NVL	3729.6	10.51	2553.6	07.20	2,022.7	05.70	1,700.2	04.79
Total	35,487	100.0	35,487	100.0	35,487	100.0	35,487	100.0

N.B: B.L = Bare land, B.U.A = Built up area. L.F = light forest. R.F = Riparian forest. S.A.L = Shrub and arable land. VW = Vegetated wetland, WB = Water body and NWL = Non-vegetated Wetland

Table 4: LULC Change Trends between 1986 and 2020

LU LC Types	Between 1986 - 2000			Between 1986 - 2015			Between 2015 - 2020			Between 1986 &2020		
	1986 (%)	2000 (%)	LULC % ▲	2000 (%)	2015 (%)	LULC % ▲	2015 (%)	2020 (%)	LULC % ▲	1986 (%)	2020 (%)	LULC % ▲
BL	14.77	17.97	3.20	17.97	13.18	-4.79	13.18	10.48	-2.70	14.77	10.48	-4.29
BUA	06.16	12.93	6.77	12.93	20.56	7.63	20.56	27.40	6.84	06.16	27.40	21.24
LF	18.28	10.42	-7.86	10.42	05.79	-4.63	05.79	04.19	-1.60	18.28	04.19	-14.09
RF	07.36	09.68	2.32	09.68	08.58	-1.10	08.58	09.98	1.40	07.36	09.98	2.62
SAL	34.37	38.95	4.58	38.95	43.13	4.18	43.13	38.16	-4.97	34.37	38.16	3.79
VW	07.18	01.80	-5.38	01.80	02.29	0.49	02.29	04.10	1.87	07.18	04.10	-3.08
WB	01.37	01.05	-0.32	01.05	00.77	-0.28	00.77	00.90	0.13	01.37	00.90	-0.47
NVL	10.51	07.20	-3.31	07.20	05.70	-1.50	05.70	04.79	-0.91	10.51	04.79	-5.72
TOTAL	100.0	100.0		100.0	100.0		100.0	100.0		100.0	100.0	

B.L = Bare land, B.U.A = Built up area. L.F = light forest. R.F = Riparian forest. S.A.L = Shrub and arable land. VW = Vegetated wetland, WB = Water body and NWL = Non-vegetated Wetland

LULC % ▲ = Annual Percentage change in LULC

Table 5: LULC Change (Ha) and Annual Rate of Change of the Study Area

Attributes	Between 1986 and 2000			Between 2000 and 2015			Between 2015 and 2020			Between 1986 and 2020		
of LULC	Ha	Ha	ARC %	Ha	Ha	ARC %	Ha	Ha	ARC %	Ha	Ha	ARC %
BL	5,241.6	6,377.3	2.75	4677.1	3,719.5	-1.15	6,377.3	4677.1	-4.65	5,241.6	3,719.5	-11.66
BUA	2,187.4	4588.4	10.37	7294.5	9,722.6	1.44	4588.4	7294.5	6.95	2,187.4	9,722.6	50.72
LF	6486.8	3696.0	-7.88	2053.0	1,488.5	-1.61	3696.0	2053.0	-8.82	6486.8	1,488.5	-50.05
RF	2,610.7	3,433.9	3.84	3044.2	3,541.4	0.76	3,433.9	3044.2	-1.81	2,610.7	3,541.4	10.36
SAL	12,196.8	13,823.0	1.75	15,306.7	13,540.7	-0.61	13,823.0	15,306.7	1.53	12,196.8	13,540.7	3.55
VW	2,546.9	641.8	-19.30	813.1	1,454.9	2,91	641.8	813.1	3.55	2,546.9	1,454.9	-19.04
WB	487.2	373.0	-3.74	275.7	319.2	0.73	373.0	275.7	-4.53	487.2	319.2	-14.38
NVL	3729.6	2553.6	-5.30	2,022.7	1,700.2	0.87	2553.6	2,022.7	-3.50	3729.6	1,700.2	-26.71
Total	35,487	35,487		35,487	35,487		35,487	35,487		35,487	35,487	

B.L = Bare land, B.U.A = Built up area. L.F = light forest. R.F = Riparian forest. S.A.L = Shrub and arable land. VW = Vegetated wetland, WB = Water body and NWL = Non-vegetated Wetland

LULC ha ▲ Change in LULC (Ha)

Table 6: Perceived LULC Change Transition (n = 400)

SN	LULC Transformation	Frequency	Percentage	Cum. Percentage
1.	Agricultural lands to Road	125	31.25	31.25
2.	Fallow land System to Intensive Cultivation	107	26.75	58.00
3.	Agricultural lands to Built-up area	91	22.75	80.75
4.	Forests to Farmlands	63	15.75	96.50
5.	Forests to Built-up Area	14	3.50	100.0
	Total	400	100	

Table 7: Perceived Proximate Drivers of LULC Changes in the Studied Area (n = 400)

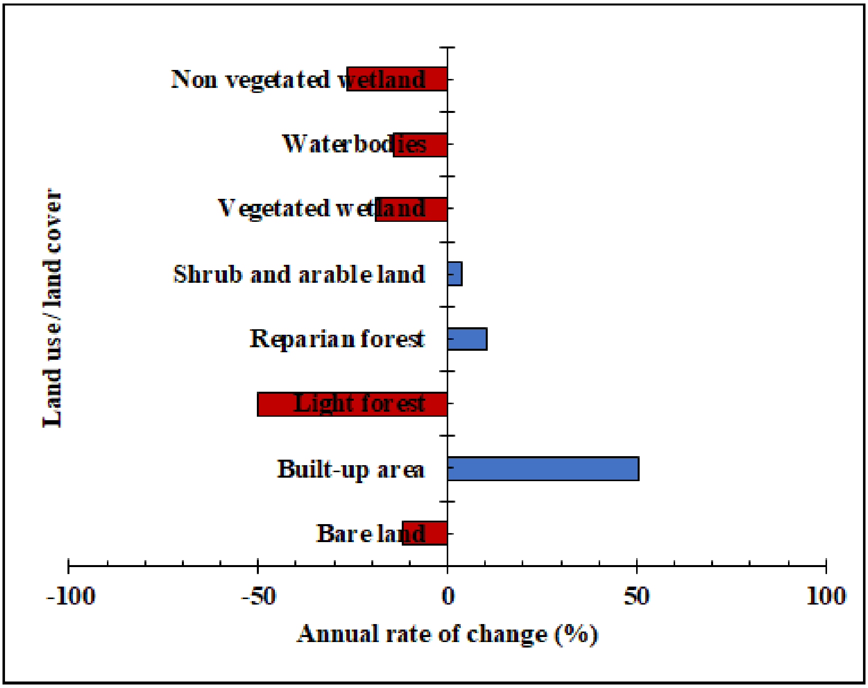
SN	Proximate Factors	Frequency	Percentage	Cum. Percentage
1.	Urban Development (Urbanization)	140	35.00	35.00
2.	Agricultural Intensification	64	16.00	51.00
3.	Timber Exploitation	114	28.50	79.50
4.	Firewood collection	20	5.00	84.50
5.	Increase in Settlements	62	15.50	100.0
	Total	400	100	

Landscape Transformation Trends Between 1986 and 2020

Tables 4 and 5 shows the LULC change transition and their corresponding percentages from one LULC class to another in comparison with the total area of each LULC class from 1986 to 2020. It is obvious that all LULC class has undergone changes in the study area while the changes and conversions cut across the whole study area. During the study period, it is evident from Tables 4 and 5, that the majority of barren land has been converted to built-up area (9,722.6 ha) and agricultural land (13,540.7 ha) while vegetated wetland, water bodies and non-vegetated wetland has been converted to riparian forest (3,541.4 ha). The results further show that three LULC has transited into four LULC patterns. For instance, 31.3 % and 22.8 % of the respondents perceived that agricultural land has been transformed to roads and built-up area respectively while 15.8 % and 3.5 % of the respondents perceived that light forest landscape has been transformed to agricultural lands and built-up areas (Table 6).

With respect to proximate drivers of landscape transformation in the study area, the respondents identified urban development (35 %) as the most important underlying driver contributing to landscape transformation followed by timber exploitation (28%), agricultural intensification (16 %) and increase in settlements (15 %) respectively (Table 7). In conclusion, Figure 6 is the proportionate area of coverage of each of the eight classes extracted in the Ibiono-Ibom from 1986 to 2020 of landscape transformation trends which validated the household survey results reported by the respondent's perception patterns analysis.

Fig. 6: Net change in LULC classes between 1986 and 2020



Landscape Transformation and Biodiversity Status

On the strength of the foregoing dynamism of landscape transformation in Ibiono-Ibom, there are serious consequences on the flora and fauna resources of the region as shown by fieldwork and respondents perception survey coupled with biodiversity status inventory.

Regarding flora, many valuable timber species, such as Iroko (*Milicia excelsa)*, Mahogany (*Khaya spp*.), Black Afara (*Terminalia ivorensis)*, Mimusuos (*Baillonella toxisperma)*, White Afara (*Terminalia superba)*, Cedar (*Lovoa trichilloides)*, Ebony, and many more that used to be very common in the study area are now extremely scarce, and are at the brim of extinction as reported by the respondents. Virtually all the household interviewed (n=400) agreed that most of the economic trees mentioned here are difficult to come by, as a result of population growth, urbanization, increase in built-area, and so on.

Regarding fauna, it was reported that several wild animal species have become extinct, critically endangered and endangered as a result of their body parts and meats (which are of economic value). In addition, habitat framentation and increase urbanization has equally constituted to their endangerment. From the biodiversity inventory, extinct species include Leopards (*Panthera pardus*), Bushcow (*Smustsia pangolins)*, African giant pangolin (*Trichechus senegalenensis*) while the critically endangered are Chimpanzee (*Pan troglodytes)*, Drill (Mandrillus *leucophaeus)*, Gorilla (Gorilla gorilla diehli), Preuss's monkey (*Cercopithecus preussi)*, Red-bellied monkey (*Cercopithecus erythrogaster)*, Sclater's guenon (*Cercopithecus sclateri)*, Wild dog (*Lycaon pictus)*. From the respondents perception and the biodiversity inventory, the endangered fauna species include African elephant Loxodonta africana, Cheeta Acinonyx jubatus, Red eared guenon (*Cercopithecus erythrotis)*, Pygmy hippopotamus (*Hexaprotodon liberiensis)*, African pygmy squirrel (*Myosciurus pumilio)*, West African mantee (*Trichechus senegalensis)*, Spotted-necked otter (*Lutra maculicollis)* are the one's identified during the field survey. From the foregoing, as a result of landscape transformation due to LULC change several flora and fauna species have become endangered, critically endangered and some extinct. Therefore, the dynamism of landscape transformation in the study area has local, national and international ecological implications on biodiversity status if the present trends are not reversed.

Implications of the study

There was evidence of instability among the various land uses classified in the study area between the year under review (1986 to 2020), as there was no particular land use in the area and during the periods that maintains the same status. Findings from this study which was also corroborated by other schorlars, revealed that the dynamics of the LULC change was mainly due to the influence of man, in his quest to meet his insatiable needs (Orimoogunje, 2005; Orimoogunje *et al.,* 2009; Orimoogunje, 2010). This quest to satisfy daily needs has formed the bane of degradations and alterations in the environment and the consequences of which includes the threatening of man existence on the planet earth as a result of landscape transformation. Accordingly, the most affected land covers in the present study are the forest related land uses, due to their usefulness and importance in meeting the economic yearning and aspirations of man. This has however led to immense loss of forest land to the cultivation of crops, expansions of human habitations, industrial developents and creation of transportation networks. All these activities are not without consequences, both on the man; the influencer and the environment which suffer distruption as a result of man's influences. The influence of man have greatly affected the carying capacity of the environment, such that every land use type could not perform their natural functions optimally. Forested related land use types are hardly found in their natural forms anymore. Several schorlarly journals are awashed with disturbing statistics of their degradations (Orimoogunje, 2005; Orimoogunje *et al.,* 2009). Meanwhile, the most disturbing is the fact that the degradations of forests are still ongoing in virtually all locations on earth.The situation is not different in the study area as, all the forest related covers of the region experienced much ground loss. Vegetated Wetlands experienced loss of about 1,092ha (42.88 %), and Non-vegetated

Wetland 2,029.4 ha (54.41 %) respectively. The implication of loss due to forest cover of such magnitudes will be too much for a region to cope with if nothing is done to prevent such occurrences in the future. Forest loss of such extent is known to impact the environment negatively and could contribute to the environmental issues of global warming (Barros & Albernaz 2014; Tijani *et al*., 2011). Even gains in the areal extents of shrub and arable Land (1343.9 ha) was indirectly a loss to the environment, and to the forest related covers, as it meant more forest loss via conversion to both land uses due to their usefulness for food production. Also, for the fact that lands which were initially meant for agricultural productions are taken over by Built up and Bare land, there will be a corresponding, if not increased demand for more farmlands (i.e Shrub and Arable Lands). Therefore, there will be more forests-related land loss, even though the loss of forest lands have always being a continous saga through the activities of man with regard to; lumbering, settlements development, fire wood gathering, and other land degradation induced activities of man on the environment. Whereas, changes in land cover represents significant threat to ecosystem sustanability, particularly when the naturally vegetated forms give way to anthropogenic activities (Orimoogunje, 2010).

CONCLUSION

The study investigates landscape transformation dynamism in Ibiono Ibom area of Akwa-Ibom State, Nigeria with a view to ascertaining both the direct and indirect influence of land use alterations on the environment. The alterations of the environment are mainly due to the activities of man in his attempts at earning a living through the transformation of the environment to serve his purposes. Hence, entrenching changes which most often are irreversible on the landscape, for example creation of permanent impervious surfaces such as built up areas and others though not permanent but with serious implications on the environment. The investigation was to a large extent holistic as it combines extensive field observation and investigation with the analysis of Landsat satellite data sets that cover the period 1986 to 2020, as well as GIS instrumentation. The results show that land use changes in the study area have drastically caused changes in the status of the inventorised classes of land within the period under study. The most affected and degraded land classes being the forest related covers, though there was loss in the areal extent of arable/shrub land, but that in itself was a pointer to correspondent loss of forest lands. This finding confirms the view of previous scholars that as more farmlands are lost to built-up, forest lands will suffer more loss to cater for farming needs of the inhabitants. The dynamics of the landscape transformation characteristics of the area as shown in the study area between 1986 and 2020 are clear indications of the extent of the loss and effects on the environment. It is important to note the implications of full-scale forest decimation and fauna habitat loss on the economy viz-a-viz human pressure and shrinking space per individual. In essence, human settlements and farmlands are found to be on the increase while light forest, wetland and water bodies were decreasing at a very high rate. This is so because human societies derived essential products from the environment for their living and well-being which necessitated forest decimation. On the global scale, the effects of the loss will go beyond the domain of biodiversity loss which is essential for global food security and nutrition and also serves as a Safety-Net to poor households during time of crisis. The outcome of this study has provided a spring board for such investigations in the tropical environments to take off. Also, it equally demonstrated the importance and value of geospatial information to the evaluation and assessment of landscape transformation with specific reference to land use / land cover change.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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Appendix I: Biodiversity Status Inventory in the study area

FLORA				
S/N	**Botanical name**	Extinction	Critically Endangered	Endangered
1	Bambusia vulgaris (schrad. Ex Wend)	-	-	-
2	Albizia zygia (DC.) Macbr.			X
3	Aningeria robusta (A. Chev.)			X
4	*Anthonotha macrophylla (P. Beauv.)*		X	
5	Baillonella toxisperma		X	
6	Baphia nitida (Lodd.)			X
7	Brachystegia eurycoma (Harms)			X
8	Ceiba pentandra (L. Gaertn)		X	
9	Chromolaena odorata (L.) King & H. Rob			X
10	*Cissus quadrangularis (Linn.)*	-	-	-
11	Coelocaryon botryoides (Vermoesen)		X	
12	Coelocaryon preussii (Warb.)			X
13	*Cola argentea Schott and (Endl.)*		X	
14	Combretum micranthum (G. Don.)			X
15	Combretum zenkeri (Engl. & Diels)			X
16	Costus afar (Ker-Gawl.)	-	-	-
17	Coula edulis (Baill.)		X	
18	Daniella ogea (		X	
19	*Dioscorea bulbifera (Lin*			X
20	Diospyros ebenum	X		
21	Dracaena sp. (Linn.)			X
22	Elaeis guineensis (Jacq.)			X
23	Erythrina senegalensis (Linn.)		X	
24	Ficus exasperate (Linn.)			X
25	Garcinia kola (Heckel)			X
26	*Garcinia mannii (Linn.)*			X
27	Glyphaea brevis (Spreng.)			X
28	Gmelina arborea	-	-	-
29	Hippocratea africana (Wild.)			X
30	Irvingia gabonensis (Hook. f.)			X
31	Khaya spp.	X		
32	Lovoa trichilloides		X	
33	Maesobotrya dusenii (Pax.)			X
34	*Milicia excelsa*	X		
35	*Musanga cercopoides (R. B) r*		X	
36	Newbouldia leavis (Seeman ex Bureau.)			X
37	*Oncoba spinosa (Forssk)*			X

38	Pentaclethra macrophylla (Benth.)			X
39	Terminalia ivorensis		X	
40	Terminalia superba		X	
41	*Uapacea esculenta (Crantz)*			X
FAUNA				
S/N	**Botanical name**	**Extinction**	**Critically Endangered**	**Endangered**
1	Acinonyx jubatus			X
2	Bos primigenius indicus	X		
3	*Cercopithecus erythrogaster*		X	
4	Cercopithecus erythrotis			X
5	Cercopithecus preussi		X	
6	*Cercopithecus sclateri*		X	
7	Gorilla gorilla diehli		X	
8	Hexaprotodon liberiensis			X
9	Loxodonta africana			X
10	Lutra maculicollis			X
11	*Lycaon pictus*		X	
12	Mandrillus leucophaeus		X	
13	Myosciurus pumilio			X
14	*Pan troglodytes*		X	
15	Panthera pardus	X		
16	*Smustsia pangolins*	X		
17	Trichechus senegalenensis			X
18				