Geospatial Mapping of Wetlands Potential in Ilesa, Southwestern Nigeria

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Keywords: Wetlands: degradation; management; sustainable environment; GIS

SUMMARY

The study was designed to assess the ecological and socio-economic effects of wetland use and to map and generate the inventory of wetlands within Ilesa between 1986 and 2008; and to explore the causes of degradation of the wetlands. This was with a view to developing an integrated rehabilitation and management plan for sustainable environment in the study area. The study made use of data generated from Landsat TM 1986 and 1991 and ETM+ 2002 coupled with intensive fieldwork. The coordinates of features were also tracked with Global Positioning System (GPS). The satellite images covering the area were acquired and analyzed using ILWIS version 3.4 and AutoCAD Map R2. The observed changes were mapped and the results of the classification were prepared as different themes in a GIS mode using ArcView version 3.2. The result shows that the most significant contributor to wetlands degradation in the study area is the use of wetlands for settlement and agriculture. All these have got ecological and socio-economic consequences on the functioning of the wetlands. The study concluded that unless action is taken positively to influence the activities of people affecting wetlands, the consequences could be very serious.

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1. INTRODUCTION

Nigeria is a country richly endowed with both coastal and inland wetlands, which altogether cover about 3% of the country's land surface (Garnier, 1967). These wetlands are of ecological, economic, socio-cultural, scientific and recreational significance. Wetlands provide critical functions that are essential for sustainable development in many areas. According to de Groot (1992) ecosystem functions are defined as 'the capacity of natural processes and components of natural or semi-natural systems to provide goods and services that satisfy human needs".

According to International Training of Trainers on Wetland Management (ITTWM) (2009), wetlands are hugely diverse but whether they are ponds, marshes, coral reefs, peat lands, lakes or mangroves, they all share one fundamental feature: the complex interaction of their basic components – soil, water, animals and plants. Nevertheless, Nigeria's wetland resources are currently being threatened by certain anthropogenic and biogeophysical factors. Notable among such factors are population pressure, rapid urbanization, mining, pollution, uncontrolled tilling for crop production, over-grazing, logging, unprecedented land reclamation, construction of dams, transportation routes and other physical infrastructure, marine and coastal erosion, subsidence, ocean water intrusion, invasion by alien floral and faunal species, sand storm, desertification, and droughts. Human activities continue to adversely affect wetland ecosystems. The alarming rate at which the country's wetlands are vanishing obviously portends some dire consequences. In particular, wetlands destruction is affecting water supply and water resources management in various parts of the country. There is no gainsaying, therefore, that the degradation of wetland ecosystems in Nigeria increases the task of water resources management in the country.

The importance of wetlands is overwhelming whether one talks of economics, biological reserve, culture and ecology. Demand for wetlands for agricultural and other developmental purposes does lead to change in landuse/landcover of the landscape, while unsustainable use of wetlands, and the river basins as a whole, has led to the disruption of natural hydrological cycles. This has often resulted in higher frequency and severity of flooding, drought and pollution. The degradation and loss of wetlands and their biodiversity imposes major economic and social losses and costs. Therefore ITTWM (2009) appropriate protection and allocation of water to wetlands is essential to wetlands to enable these ecosystems to survive and continue to provide important goods and services to local communities. Therefore, purposeful study of wetland ecosystems is essential in the study area where wetlands are being lost due to anthropogenic activities. Thus, the study area wetland resources need to be properly identified and mapped and present a proposal on how it can be exploited sustainably.

2. METHODS AND MATERIALS

2.1 The Study Area

The study area lies within latitude 7^0 30’ and 7^0 35’N and longitude 4^0 30´ and 4^0 34’E (see Figure 1). Ilesa urban area is made up of two local government areas, namely Ilesa West and Ilesa East. Both Council areas are bounded in the North, West and South by Obokun, Atakunmosa and Oriade Local Government areas respectively (see Figure 2). The town covers a total area of about 73.6 square kilometers. It is about 32 Kilometres Northeast of Ile-Ife and about 30 kilometres Southwest of Osogbo, the Osun State Capital. The population of Ilesa has been put at 210,141 in 2006 (NPC 2006). The climate is humid tropical type with a mean annual temperature of about 280C and a mean annual rainfall of over 1600 mm. the underlying geology is mainly fine-grained biotite gneiss and schists although quartzite and quartz-schist rocks are common especially on slopes and ridges. The soils are mainly the well-drained Egbeda series known as alfisols which has been classified as one of the most fertile soils in the Nigeria cocoa belt (Smyth and Montgomery, 1962). The whole area is drained by tributaries of Osun, Sasa and Oora, rivers which flow south ward and southwest ward directions. The natural vegetation is the Tropical Rain Forest which could only be found in patches all over the district but mainly on hills.

2.2 Methodology

Figure 3 shows the flow chart adopted for the study.

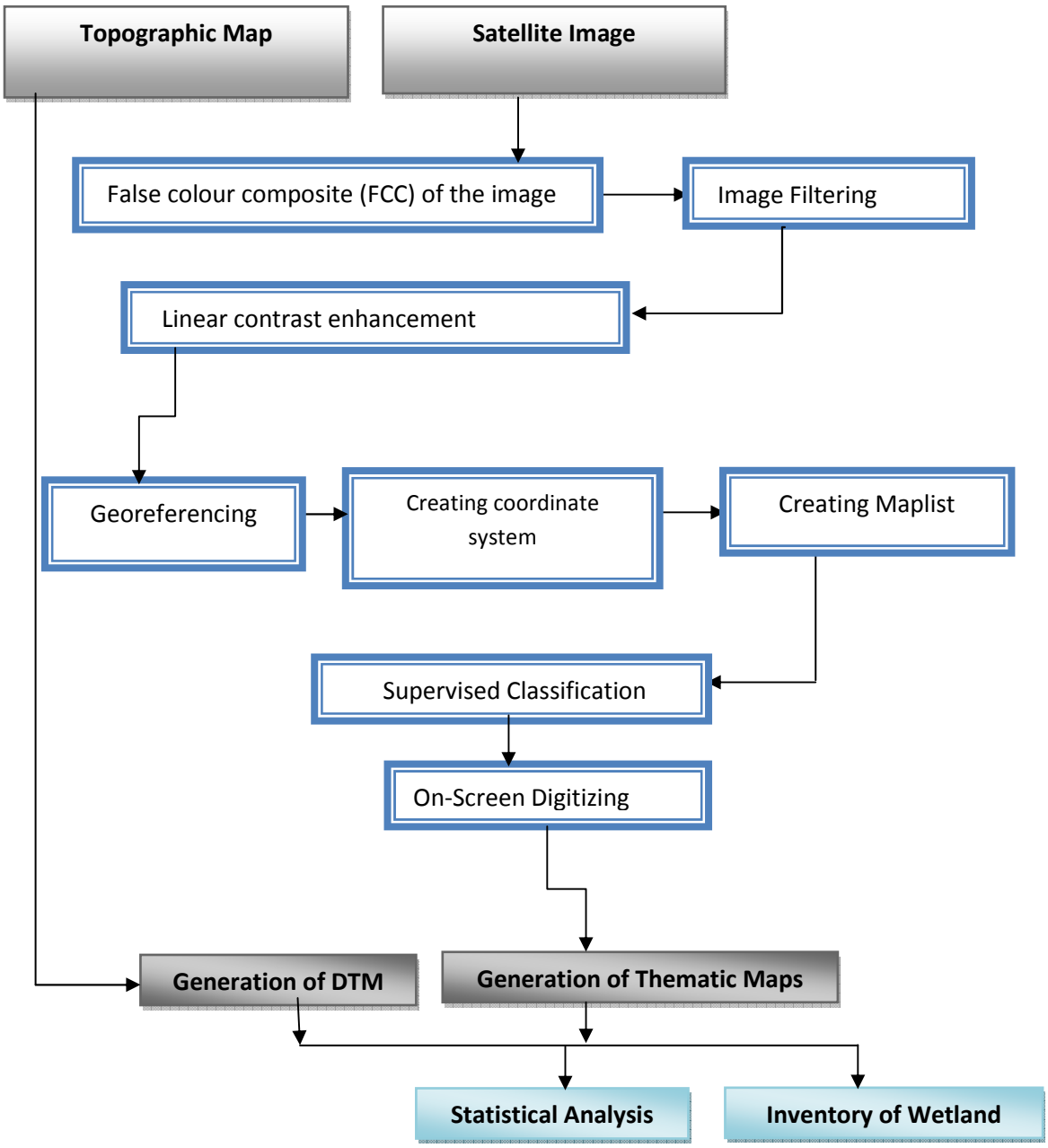

Figure 3: The Flow chart

Primary and secondary data were employed for this study. The primary data was collected on the physical attributes of five key land use types for this study. The sample sites were determined from the remotely sensed imageries that was used for the study. The geographical

locations of the sample sites were also tracked with Global Positioning System (GPS). The secondary data sources are Landsat-TM 1986 and 1991 and Landsat ETM+ 2002 covering the area. Topographical map of Ilesa SE and SW was used to generate DTM of the area. The primary dataset was summarized for eventual integration with the spatial datasets. The processing and the analysis of secondary data include image enhancement, geometric correction, variable combination of spectral bands for land use mapping and a creation of a database for handling the various data types. These operations were performed using ILWIS software version 3.4, ArcView 3.2 and AutoCARD Map R2 to bring out the classes of land use types currently dominant in the area. The resulting land use characteristics are compared to assess the changes that have taken place in the wetland environment in quantitative and qualitative terms. To obtain a better result, points were identified, selected and marked. The geographic location of the map was determined with the adjoining points having the same coordinates. These coordinates were transformed from geographical coordinates to Universal Transverse Mercator (UTM) using GEOCALC software. The GEOCALC has the capabilities of transforming coordinates from one coordinates system to another. In the course of this project, a latlong geographic point on the map was changed to UTM.

3. RESULT AND DISCUSSION

3.1 The Landuse / Land cover Classification Scheme

Table 1 shows the hierarchical classification of landuse / landcover in the study area. The classification level is made up of two levels – primary and secondary. This was prepared specifically for use with remotely sensed data of the study area.

Table 1: The land use/land covers Classification Scheme of the study area

Code	Level I (Primary category)	Code	Level II (Secondary category)
1	Settlement	11	Built-up Areas
		12	Partially Developed Areas
2	Wetlands	21	Swampy, muddy
		22	Streams, rivers
3	Dense vegetation/Riparian	31	Heavy Forest
		32	Raffia Palm Forest
		33	Bamboo forest
4	Agricultural land	41	Fallow land
		42	Cultivated plot
5	Baresoil/land	51	Hill
		52	Mountains

The classification scheme clearly shows the degree of details used for this study, as well as the clarity in defining each landuse/land cover category in the study area. From Table 1 the following landuse / landcover features were adopted:

Settlement: These are areas covered with buildings and other artificial structures and intensive human developmental in-print. In this category we have built-up areas and partially developed areas. The built-up areas are the areas under intensive use with most of the land

covered with structures that are essentially residential. On the other hand, the partially developed areas are areas of less intensive usage and are mostly located around the outskirt of the study area where there are developmental processes in progress.

Wetlands: These include the areas cover mainly with water: lagoon, rivers, creeks and ponds. The ponds are water-bodies in depression, but mostly connected to other water-bodies through seasonal streams. Wetlands include the following as identified in the study area, swampy, muddy, rivers and streams, which are forested and non-forested in nature. Forested wetlands covered area that is water logged but covered with aquatic plants mostly mangrove and raffia palms. Areas mostly covered with water but with ferns, shrubs and short mangroves are referred to as non-forested area and this area can also be referred to as marshy area.

Dense Vegetation and Riparian Forest: These areas are regions covered with trees of different species, with little or no human activities. These regions include: heavy forest, light forest with raffia palm and bamboo forest. These areas are associated with wetlands but some distance away from the water course. The heavy forest areas generally covered with trees, which are typical of rain forest. Regarding the raffia palm forest they are mainly found in undisturbed area of the study area.

Agricultural land: These areas are used for growing agricultural crops and are apparently cultivated during the growing season and also during the dry season for those areas that are mainly in the waterlogged areas. Some of the area is also covered with shrubs, thickets and grasses which show sign of abandonment.

Bare soil/land: these are exposed land as a result of human activities, ridges, hilly and mountainous area within the study area.

Table 2: Areal extent of land use types in the study area in 1986

Land use types	Areal extent (ha)	% of total	Cumulative
Bare soil/land	1401	6.49	6.49
Dense/Riparian vegetation	8791	40.72	47.21
Agricultural activities	7047	32.64	79.85
Settlement	4093	18.96	98.81
Wetlands	258	1.19	100.00
Total	21590	100.00	100.00

3.2 Sizes of Land Use Types between 1986 and 2002

Tables 2, 3 and 4 show the computed land areas for each of the main land use types in the three periods considered in the study area. Figures 1, 2 and 3 show the outcome of image processing of the landuse/ landcover of the area. Figure 4 displays these land use types in various forms. Table 2 shows that in 1986 the area has been experiencing some encroachment on the wetlands compared with what is obtainable on the topographic map of 1966 which clearly shows that the whole area is dissected by rivers. Table 2 shows that in 1986, 6.49% of the total area mapped was under bare soil /land, 40.72% of the study area was under

dense/riparian forest, 32.64% under agricultural activities while 18.96% and 1.19% are under settlement and wetlands respectively.

Table 3 shows that by 1991 the proportion of wetlands, dense/riparian forest had gone down to 0.69% and 27.40% respectively while the proportion of the bare soil/land, agricultural activities and settlement has gone up tremendously, i.e. 9.12%, 41.76% and 21.03% respectively. This may be due to increase in population and consequently, developmental processes in the study area. From this analysis one can infer that human activities of various forms have really been on the increase in the study area which has led to radical transformation of the natural resources in the study area and urban sprawling when one compared the fieldwork result with topographic map and the satellite imageries employed for this study.

Table 3: Areal extent of land use types in the study are in 1991

Land use types	Areal extent (ha)	% of total	Cumulative
Bare soil/land	1969	9.12	9.12
Dense/Riparian vegetation	5915	27.40	36.52
Agricultural activities	9017	41.76	78.28
Settlement	4541	21.03	99.31
Wetlands	148	0.69	100.00
Total	21590	100.00	100.00

Table 4 is the outcome of Landsat ETM+ which enhances the clarity of the features better than the first two data sets, as a result of this singular factor variation in value crept in to the outcome of the analysis generated.

Table 4: Areal extent of land use types in the study are in 2002

Land use types	Areal extent (ha)	% of total	Cumulative
Bare soil/land	2902	10.09	10.09
Dense/Riparian vegetation	1328	4.62	14.71
Agricultural activities	14435	50.18	64.89
Settlement	10012	34.80	99.69
Wetlands	89	0.31	100.00
Total	28766	100.00	100.00

3.2 Pattern of Land Use Changes

The details of land use changes in the study area can be grouped into two. These are:

i. Land use types whose area extent had increased;
ii. Land use types whose area extent had decreased.

The first group includes those land use types whose areal extent has increased between 1986 and 1991 and between 1991 and 2002. The land use types whose areal extent has increased between 1986 and 1991 include the bare soil/ land from 1401 hectares in 1986 to 1969 hectares in 1991; agricultural activities from 7041 hectares in 1986 to 9017 hectares in 1991; and settlement from 4093 in 1986 to 4541 hectares in 1991. Similarly, the same set of features increased simultaneously between 1991 and 2002. For instance, bare soil/land increased from 1969 hectares in 1991 to 3302 hectares in 2002; agricultural land from 9017 hectares in 1991 to 10735 hectares in 2002; and settlement from 4541 hectares in 1991 to 12712 hectares in 2002. In sum total these land use types have grown tremendously in areal extent in the study area.

The second landuse changes in the study area are those whose extent of coverage has decreased. By 1986 Dense / riparian which is one of the dominant features of wetland environment had decline from 8791 hectares to 5919 hectares in 1991 and to 1928 hectares in 2002. This trend is consistent with what has been described for natural resources in Nigeria (Ola-Adams, 1981; Orimoogunje, 2005). As a result of agricultural activities going on around the wetland environment in the study area many of the valuable trees has been destroyed (see Plate 1).

3.4. Wetlands Inventory

Table 5 shows the list of wetlands identified in the study area and what they are used for. It was identified during the study that there are a number of activities that took place that are still taking place in the wetlands of the study area. Landuse activities such as settlement and infrastructural development, sewage and solid waste disposal and cultivation have been and continue to be undertaken in the wetlands in the study area as indicated by plate mosaic of wetlands inventory capture in the study area.

Table 5: Inventory of Wetlands

SN	Name	Location		General Characteristics	Present Use/Cover
		Latitude (N)	Longitude (E)		
1.	Iloko Road	07^0 51' 10.5''	$004^0$47'42.6''	Partly fallow with arable crops	Cassava, maize and plantation
2.	River Asoro	07^0 37' 17.5''	$004^0$47'09.9''	Drained area for yam cultivation, cocoyam, sugar cane, maize	Twins Brother Aluminum products, Saw mill etc
3.	Asoro 2nd point	07^0 37' 23.7''	004^0 47'06.5''	Drained area for yam cultivation, cocoyam, sugar cane, maize	Banana, sugar cane, sedges, etc
4.	River Eruru	07^0 37' 08.8''	$004^0$42'46.6''	Dominated by banana and raffia palm	Cleared and used as car wash centre
5.	River Ayao	07^0 37' 09.9''	$004^0$44'03.4''	Not cultivated but used as dumping ground and abattoir	Car wash centre, river is far approach
6.	River Oora	07^0 37' 14.7''	$004^0$44'10.4''	No cultivation: full of grasses	In its natural status
7.	R. Ajegbadun	07^0 36' 20.1''	$004^0$44'26.4''	Fishery and farming activities	Encroachment by buildings
8.	R. Ayao 2pts	07^0 36' 03.2''	$004^0$44'15.7''	Cultivation of coconut, breadfruit; part as dumping centre	Encroachment by building e.g. churches
9.	Kappa area	07^0 37' 59.2''	$004^0$44'58.4''	Cultivation of banana, maize	Encroachment by building, churches
10.	Illo area	07^0 38' 18.5''	$004^0$45'17.0''	Cultivation of maize, banana	Ornamental garden and horticulture
11.	OSSCE Ilesa dam	07^0 35' 57.7''	$004^0$42'44.3''	Maize plantation, cassava, yam	Dam and water supply
12.	Omi oke Aanu	07^0 35' 59.9''	$004^0$43'52.6''	Churches and cultivation of crops	Encroachment by buildings
13.	Bolorunduro	07^0 35' 59.7''	$004^0$43'59.3''	Fishery, sugar cane, maize	Encroachment by buildings
14.	Ijofi	07^0 37' 13.2''	$004^0$44'19.7''	Car wash and banana plantation	Horticultural garden
15.	Oke-ooye	07^0 37' 01.1''	$004^0$44'40.7''	Car wash and sugar cane field	Encroachment by buildings
16.	Aayo stream	07^0 36' 54.0''	$004^0$44'38.6''	Churches and tree crops	Encroachment by buildings
17.	Stadium	07^0 36' 57.6''	$004^0$44'56.3''	Swampy and waterlogged	Grasses, sedges and reeds
18.	Obokun	07^0 37' 12.1''	$004^0$45'29.1''	Churches, banana, dumping sites	Buildings are encroaching
19.	Omi asoro	07^0 37' 17.0''	$004^0$47'08.8''	Maize field and yam farm	Car wash
20.	Oloruntedo	07^0 38' 23.1''	$004^0$44'58.6''	Banana plantation, and churches	car wash
21.	Oke-omiiru	07^0 38' 41.5''	$004^0$44' 31.4''	Banana plantation and car wash site	
22.	Anglican gram sch	07^0 39' 03.8''	$004^0$43'55.8''	Fishery and car wash	Banana plantation
23.	Omi-oko	07^0 38' 18.3''	004^0 44' 24''	Banana plantation and water supply	Encroachment by building
24.	Kayanfanda	$07^0$37' 34.4''	$004^0$43'39.9''	Swampy and waterlogged	Reeds, grasses and sedges

Source: Authors fieldwork, 2008

The larger portion of the wetlands in Ilesa and its environs is used for settlement and infrastructural development whereas in the urban periphery the larger portion of the wetland is used for agricultural purpose. Cultivation is practice in both wetlands in urban and urban periphery of Ilesa. The settlement and infrastructural development and solid and sewage disposal in wetlands in Ilesa is end up leading to the total destruction of wetlands in the study area. It is clearly shown that there is a potential danger for the wetlands in Ilesa to become extinct in the near future as a result of high pressure. As reported in FAO (2000), about 25% of the world's wetlands have already been lost, largely due to conversion to agriculture or diversion of water for agriculture and aquaculture.

Extra efforts are therefore needed to conserve these wetland resources including those in urban periphery of Ilesa as their existence are highly threatened by the growing demand of land for agriculture and infrastructural development. Conflicts of interest between agriculture and infrastructural development are inevitable given the analysis from the satellite imageries of the study area. Tables 2, 3 and 4 shows the agricultural activities, settlements and bar

soil/land depending on the respective wetlands area in the region. The pressure that exerts stress on the wetland resources in the area include shortage of lands and poverty which forces people to practise agriculture on the wetlands where they are assured of getting good returns.

3.5 Threats to Wetlands in Ilesa

Urbanization and agricultural activities put pressure on wetland resources in the area. Urbanization, over cultivation and encroachment of the wetlands resources due to high population and the suitability of the areas for production of arable crops has increased stress to the wetland resources in the study area. For instance, the population of Ilesa has increased tremendously. As a result of this increasing population, the areas that were regarded to be wetlands (see Figures 3, 4 and 5) have been converted to agricultural purposes and settlement.

Siltation and improper handling of solid wastes are other activities causing stress to wetland resources. Over cultivation and farming that do not take care of soil conservation in the respective hilly and mountainous areas has resulted into flooding during the rainfall. The floods bring silts from the head streams which cause siltation to the wetlands downstream threatens the existence of the wetland resources in the study area. Solid waste (see Plate 1) has also been regarded as one of the factor causing stress to the wetland resources in the area. This has been associated with the blockage of water source in stream and rivers that dissected Ilesa to some wetlands in the area. A typical example in the area is River Ayao and Oora.

3.6 Stakeholder Analysis

From Table 5 the identification of the actual stakeholders and assessment of their interests and the way in which these interests affect the wetland management in the area was documented in form of general characteristics and present use and cover. The stakeholder includes the peasant farmers, butchers, saw miller, the religious group, horticulturist, those engaged in car washing, Department of Agricultural Science, Osun State College of Education, wine tapper and sandigger.

3.7 Impacts of Wetland Uses

The uses of wetland for cultivation, settlement and infrastructural development and solid and sewage disposal have got ecological and socio-economic consequences on the functioning of the wetlands in the study area. These include the following:

3.7.1 Infilling in Wetlands:

The use of wetlands for agricultural activities has led to the problem of infilling into the wetlands which has also led to the reduction of water in wetlands. This is mostly taking place in the wetlands in Asoro, Kappa and Iloko road. The people were originally cultivating the crops far away from the wetlands. They were increasing their cultivation each and every year in the direction of the wetlands. It should be established that, the cultivation of crops (e.g. maize, yam, cassava, etc) in the wetlands will affect the soil greatly because these crops do

not bind or cover the soil like the natural wetland vegetation. As a result the wetlands will be less effective at regulating stream flow and purifying water because the drainage channels speed up the movement of water through the wetlands.

3.7.2 Alien Invasion in Wetlands

The use of wetlands for cultivation has also disturbed the species composition in the area. The disturbance of the area has attracted rooted plants that are non native, that is, the alien plant species such as *Psidium gujava* (Apple Guava), *Ricinus communis* (castor- oil), *Chromolaena odoratum* (Seam weed) etc. These alien plant species have now invaded the wetlands and are now out-competing the wetlands species and as a result the ecology of the area has changed. The presence of alien species is also leading to the reduction of water in the wetlands.

3.7.3 Loss of Biodiversity

The conversion of wetlands to settlement and infrastructural development has led to the destruction of most of wetlands plant species such as reeds, sedges and grasses. In the absence of these plant species, the wetlands are failing to play their important functions such as trapping of sediments, removal of waste materials and purification of water. The habitat required by wetland-dependent species is frequently lost. This is also leading to the total destruction of the wetlands and this has impacts on the ecology of the area because it is making the area to change from wetlands to a settlement area.

3.7.4 Pollution of Wetlands

Solid and sewage disposal into the wetlands is taking place in the wetlands in Ilesa (see Plate 1). Sewage disposal includes used water from domestic activities such as laundries, car wash, lavatories whereas solid waste includes suspended matter especially bones from abattoir, floating matter such as tins, plastics and scraps of old motor vehicles. As a result of this, the waters natural purification process in the wetland will cease as more and more solid and sewage is disposed in to the wetlands.

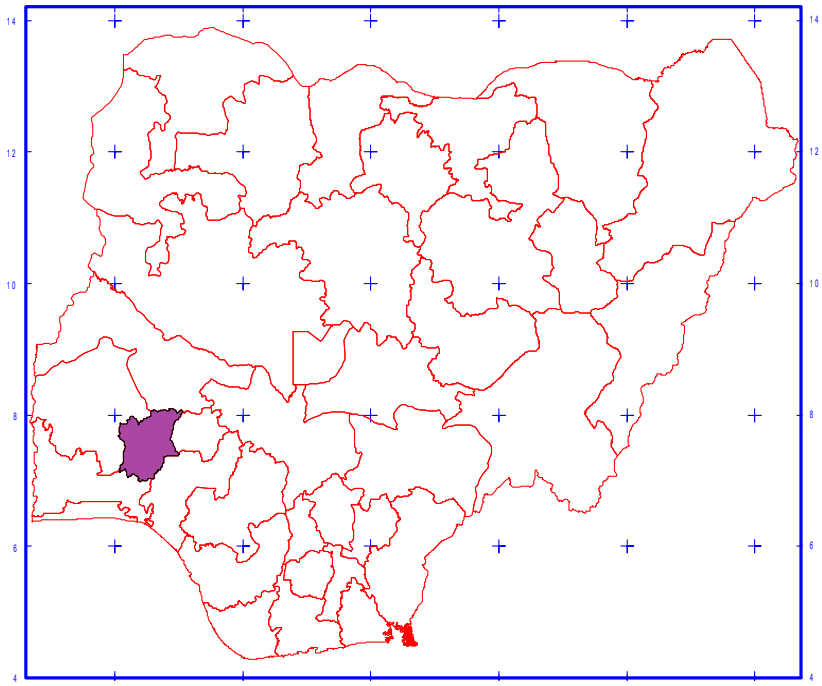

Figure 1: Map of Nigeria showing Osun State

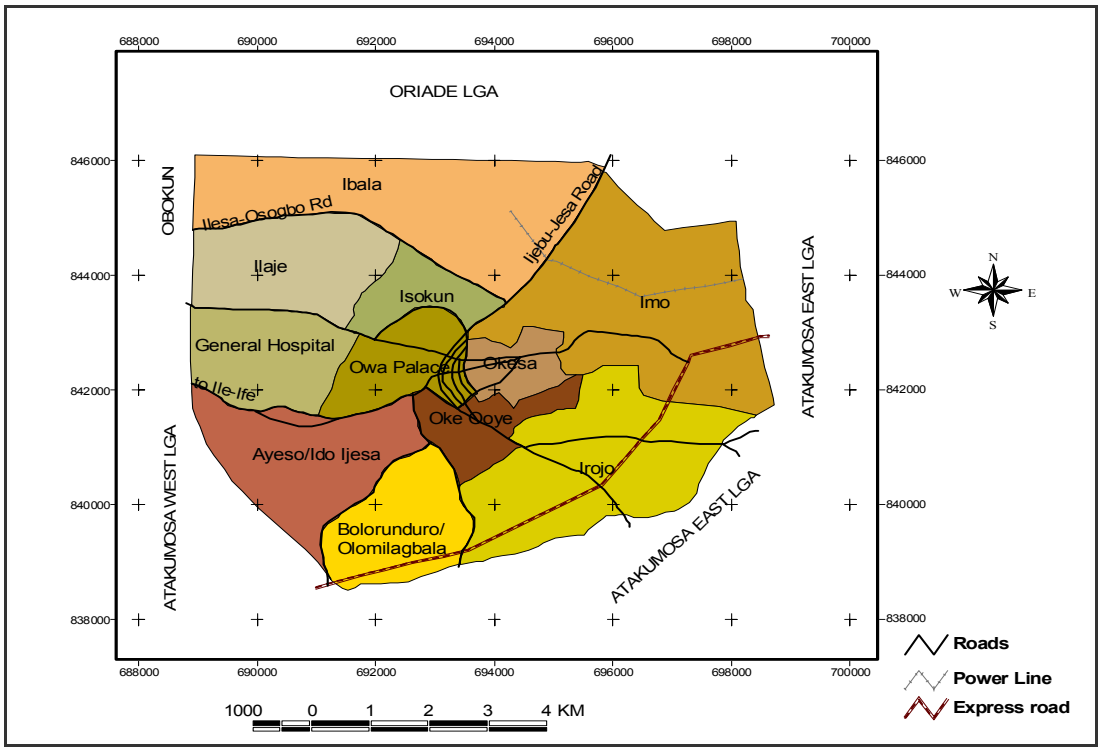

Figure 2: Ilesa Urban area

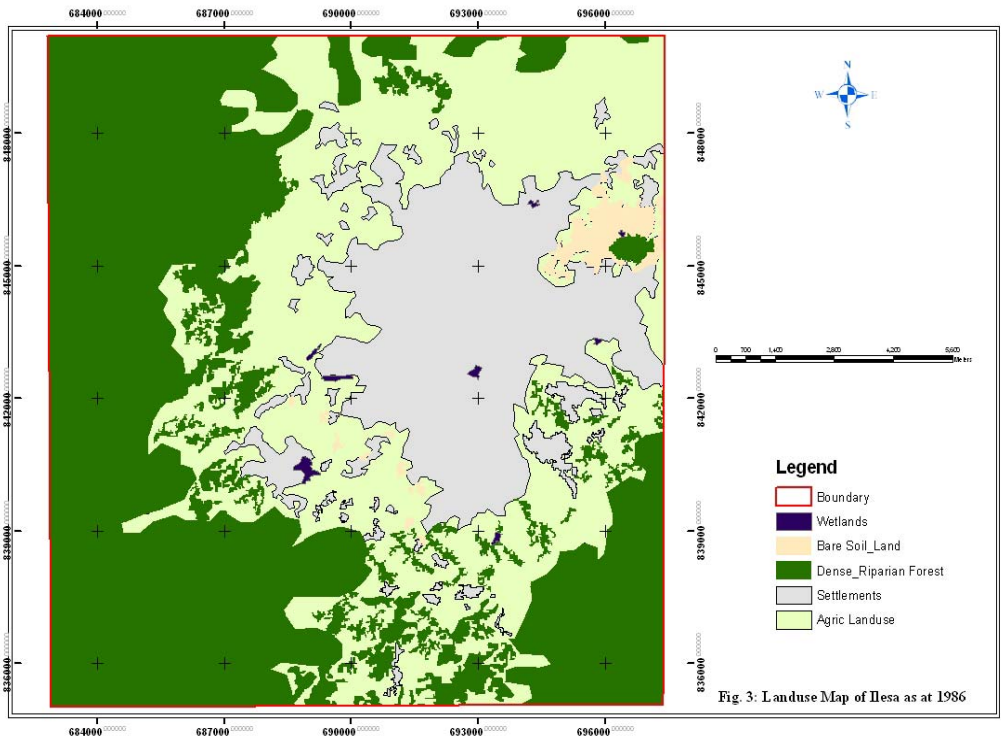

Fig. 3: Landuse Map of Ilesa as at 1986

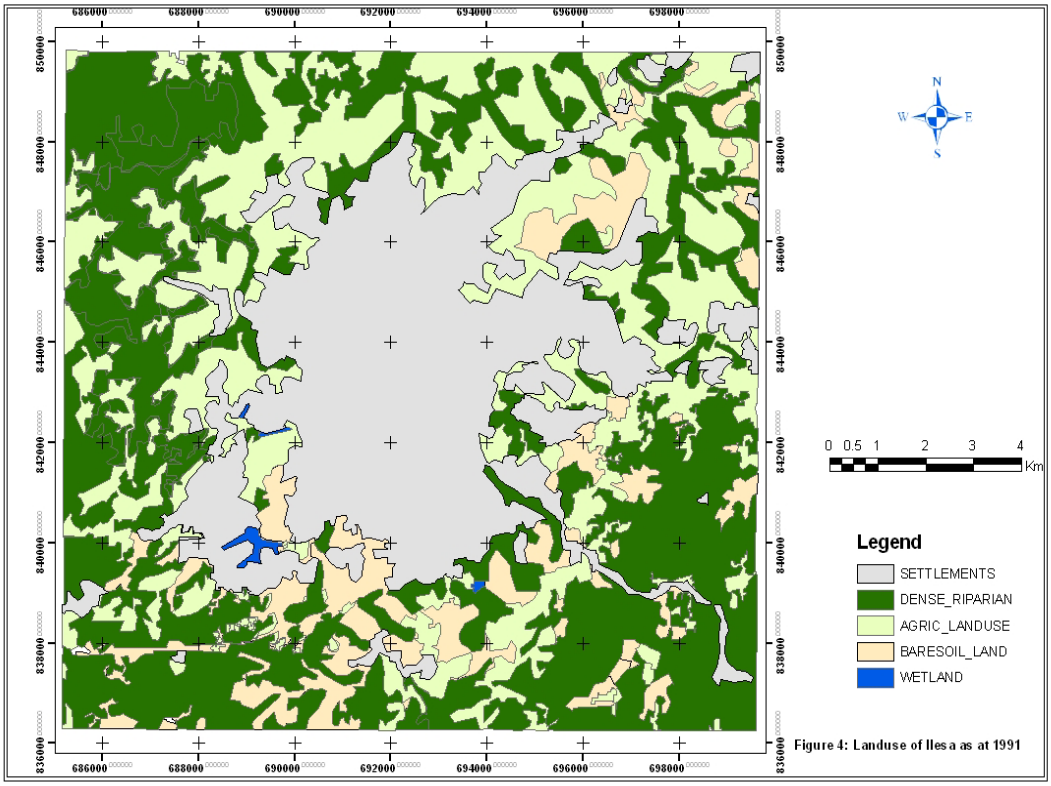

Figure 4: Landuse of Ilesa as at 1991

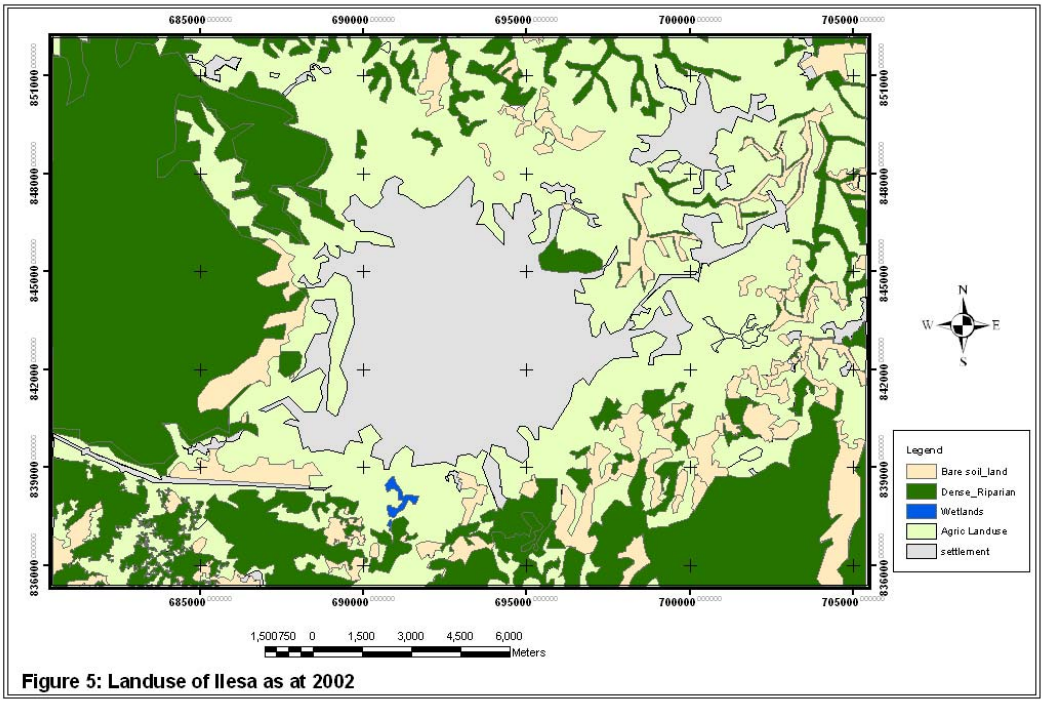

Figure 5: Landuse of Ilesa as at 2002

Wetlands being transformed to dumpsite

Wetlands partially given to banana plantain and sedges, grasses and other water loving vegetation species

PLATE 1: Wetlands Transformation in the Study Area

4 CONCLUSION

The study has indicated that the land use activities that took place and are still taking place in the wetlands in Ilesa and its environs have got negative effects on the functioning of the wetlands. There is abuse of wetlands because they are used in an unsustainable manner; while settlement and agricultural activities have contributed to wetlands transformation in the study area. The areas so designated as settlement have continuously been on the increase. It also shows that the use of wetlands for cultivation has disturbed the specie composition in the study area.

The subject of wetland management is a relatively new area for development in Nigeria. The present study aim at creating the necessary awareness of the subject, and to draw the interest of government and the community involved. The matter is rather urgent because wetland resources are especially threatened throughout Nigeria by overexploitation. There is a need for research and the development of management strategies for sustainable utilization of these valuable resources, and their protection as a genetic pool. It is therefore recommended that the following strategies be adopted as first steps towards developing this sector.

i. The landuse system in the study area should be based on environmental concern.
ii. Education and intensification awareness programmes concerning wetlands should be implemented in the study area. While the management and conservation of wetlands for their long-term sustainable use should be a priority.

iii. Proper funding of a wetland resources sub-sector with the formation of a National Committee for the management of these resources. The Committee shall be responsible for the implementation of the objectives.

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BIOGRAPHICAL NOTES

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