WETLAND USES/DYNAMICS FOR AGRICULTURAL PURPOSES AND ITS HEALTH IMPLICATIONS IN LOWER OGUN RIVER BASIN, LAGOS, NIGERIA

By

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CHAPTER ONE

INTRODUCTION

1.0: Background to Study

Wetlands, according to Carter (1981) are 'land transitional between terrestrial and aquatic systems where the water level is usually at or near the surface or the land is covered by shallow water.' Willard and Rezneat (1982) also defined wetlands as those areas, which are capable of supporting water related vegetation. Wetlands can be identified by the presence of those plants (hydrophytes) that are adapted to life in the soils that form under flooded or saturated conditions, that is, hydric soils (NAS, 1995; Mitsch and Gosselink, 1993). The U.S. Fish and Wildlife Service defines wetlands as lands that are transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water, and that have one or more of the following attributes: (1) At least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year (Cowardin et al., 1979).

Each wetland is however composed of a number of physical, biological and chemical components such as soils, water, plants and animal species, and nutrients. This wetland ecosystem structure (that is, the tangible items) yields benefits, which are of direct use value to humans. Many tropical wetlands are being directly exploited to support human livelihoods. Processes among and within these wetland components allow the wetland to perform certain functions such as flood control, shoreline stabilization, water purification, and general products such as wildlife, fisheries and forest resources. In addition, there are ecosystem scale attributes such as biological diversity and cultural uniqueness/heritage, that have value either because they induces certain uses or because they are valued themselves.

According to Turner (1990), wetland ecosystems account for about six per cent of the global land area and are considered by many authorities to be among the most threatened of all environmental resources. Both the physical extent of wetlands and their quality (in terms of species diversity, etc.) have declined greatly over the past years (Turner, 1990). Most of the physical losses have been due to the conversion of wetlands to other landuses, for example residential and agricultural. However, the benefits derived from such conversion must be sustainable, environmentally friendly and tailored towards food security in the case of agricultural purposes.

Demand for land, as a resource for agriculture and other developmental purposes does lead to change in landuse/landcover. Decisions on observable landuse/landcover change may lead to either great benefit or great losses, sometimes in economic terms, sometimes in less tangible but significant environmental change. The negative impacts of uncontrolled resource utilization on destabilizing ecosystem and the changing landuse patterns makes communities vulnerable to lots of environmental and economical problems, and creating burdens on ecological resources of the world.

The high population densities linked with urban growth, expanding food needs in the developing world especially in the urban areas present major threat to natural resources and biological diversity. The uncontrolled utilization of land in developing countries has led to a considerable loss of prime agricultural land and the disruption or total destruction of fragile wetlands.

However, due to the urgent need to meet the food demand of the rapidly growing urban population, the high rate of unemployment in most urban cities, and the high poverty level, urban agriculture is presently taking over natural wetlands in and around urban cities. Mougeot (2000) defined urban agriculture as the varieties of agricultural activities that take place within the urban sphere of influence. These include all agricultural activities within urban and peri-urban areas, which influence the urban ecology in both positive and negative ways, affecting the socio-economic and environmental well being of the urban people (Arm, 1994; UNDP, 1996). Urban agriculture has the potential capability to enhance self-reliance, representing an important avenue to regain cultural and farming knowledge. It also allows the marginalized especially the poor ones and women to strengthen their household ties and food security, providing employment and source of income for them (Rees, 1997; Nabulo, 2002; Kilelu, 2003). While urban agricultural production promotes health by improving nutrition and providing herbal medicine, uncoordinated and improper use of wetlands for urban agricultural activities can promote diseases diffusion. For instance, planting in wetlands can enhance all year round production but improper management promotes vector of malaria and filariasis (Anosike, 2003).

1.1: Statement of Problem

Landuse science addresses multiple aspects of the complex interactions between humans and the land surface: why does landuse change occur? where does it occur? and what are the consequences for human health, soil productivity, and other ecosystem services? Substantial progress has been made on understanding the complex socio-economic and biophysical factors underlying landuse change (the ‘why’?) and observing and projecting landcover change (the ‘where’?). Less attention within the science of landuse has been directed towards the consequences of landuse changes (the ‘so what’?).

Landuse change has many consequences ranging from changes in disease vectors to downstream flooding to far-away climate feedbacks through atmospheric ‘teleconnection’. However, research on the ecosystem consequences of landuse change is dispersed among many disciplines. Without a comprehensive view of the multiple ecosystem responses, it is difficult to consider these factors in landuse decisions. The contributions from many disciplines ranging from hydrology to public health to ecology to social science are needed and this is what ecosystem approaches offered. The ecosystem approach is a trans-disciplinary approach that allows for merging of contributions from many disciplines with the aim of having a sustainable development of world’s resources in place.

The wetlands around the estuaries of Ogun River and its environs in Ikorodu/Kosofe areas of Lagos State remain unprotected. Thus, the Lower Ogun River Basin Wetlands are presently experiencing a lot of physical changes. Due to the increasing population pressure, increasing and urgent demand for food, high cost of land and the almost unavailability and unaffordable cost of land in Lagos Metropolis, urban agricultural activities and other developmental processes are competing for land, especially wetlands around Ikorodu and Kosofe areas of Lagos State. However, this wetland uses for agricultural purposes and other uses are with consequences on food security, human health, nutritional well-being and agro-ecosystem condition.

In addition, in most developing countries, information on wetlands is very few and insufficient. According to Turner (1990), there is a general lack of available information in the literature concerning tropical wetlands and their valuation. Information on the wetlands around the Lower Ogun River Basin in Ikorodu area of Lagos State with interface with the Lagos Metropolis is generally lacking. Inadequate resource information and the low priority accorded it in the planning process is one of the greatest weaknesses in the efforts of developing countries to develop (Adeniyi, 1985).

Asangwe (1992) estimated that about 60 per cent of Lagos metropolis was originally natural wetlands. However, if wetlands are altered without first taking into consideration their full value, the negative consequences can be felt immediately by local people, the economy of a region or nation may be affected adversely if the alterations are many or large. According to LUCC Newsletter (2004), initial forest (wetlands) clearing for any purposes, for example, results in carbon emissions from biomass removal, habitat loss, and changes in disease vectors. Consequences from landuse intensification in later stages of a landuse transition involve nutrient runoff from synthetic fertilizers, human health consequences associated with urban health islands, and nitrous oxide emissions to the atmosphere. In the Lower Ogun River Basin Wetlands, there has being changes in the functional role being played by the changed wetland due to influx of population and the rapid urbanization, plus their various socio-economic activities and the needs to provide food for the people at low cost. Presently, more and more wetlands are being taken over for urban agricultural purpose.

Thus, the is need to examine the health implications of such conversion using the ecosystem approach, which allows for contributions from transdisciplinary approach with the goal of viewing the benefits, in terms of food security and diet diversity; the agro-ecosystem conditions, and the negatives health implications. The strong and highly complex interaction and interrelation of socio-economic and cultural determinants present a challenge for developing a holistic comprehension of environmental degradation and its impact on human health and well-being. Hence, the ecosystem approach promotes positive action on the environment that improves community well-being with the sole goal of having a sustainable development policy and action in place.

1.2: Significance of Study

Turner (1997) stated that most of the world's environmental issues and global changes are attributed to landuse and landcover changes. Landuse/landcover change/dynamic is a significant agent of change, which influences and is affected by climatic change, loss of biodiversity and the sustainability of human-environment interaction (Turner et al., 1990). According to Lambin et al. (1998) landuse/cover change takes place under the influence of a number of driving forces such as population, technology, political and socio-economic changes, and all at a regional level of spatial desegregation. However, according to LUCC (2001), our understanding of the pattern and drivers of recent changes in landuse/landcover has changed in a major way but there is still room for improvement of our knowledge of the complexity of landcover changes, landuse dynamics and integrated landuse models. Thus, there is need for understanding of landuse dynamics, that is, how people make landuse decisions and the implications of landcover changes.

Hence, this study tackled the quantification of landuse/landcover (especially wetlands), causes, landuse dynamics and the health implications through direct observations using remote sensing, questionnaire administration, disease vector studies, nutritional supply studies and GIS models within an ecosystem approach. The integration of remote sensing, nutritional studies, disease vector studies and socio-economic household survey data within an information system will makes possible a holistic ecosystem approach to agro-ecosystem condition.

1.3: Research Questions

The research questions guiding this proposed work are:

- Are wetlands being converted for agricultural purposes within the study area?
- If yes, at what rate are wetlands being change for agricultural purposes?
- What are the agricultural products being produce from the converted wetlands?
- What are the nutritional values of the agricultural products?
- What are the roles of women in the agricultural activities?
- What has been the effect of the wetlands conversion to agricultural purposes on the diet of the local people, especially women and children?
- What are the health implications of the conversion?

1.4: Aim and Objectives

The aim of this research is to evaluate the spatio-temporal wetland changes for agricultural purposes and examine the health implications of such changes in Lower Ogun River Basin using the ecosystem approach.

In order to achieve this, the following objectives are to be achieved:

1. To map and generate the inventory of wetlands within the study area during the period of investigation.
2. To evaluate the spatio-temporal wetland changes for agricultural purposes within the study area over a specific period.
3. To identify the agricultural products being generated from the converted wetlands and their nutritional values.
4. To examine the effects on food security, agro-ecosystem condition, poverty alleviation, the roles of gender and the socio-economic situation of the farmers and the local people in general.
5. To examine the health implications on the people using ecosystem approach.

1.5: Study Area

The study area covers a region, which according to Oyebande et al. (2003) is refer to as the Lower Ogun River Basin Wetlands and it is a major wetland region in Nigeria located in Ikorodu/Kosofe area of Lagos State. The following Local Government Areas (LGAs) falls within or partly within the study area: Kosofe, Somolu and Ikorodu Local Government Areas (LGAs) of Lagos State, and it also extents into Ogun State around the OPIC Estate.

1.5.1: Location

The study area is located around Longitude 3º22´E and 3º39´E, as well as Latitude 6º31´N and 6º39´N. Ikeja bound the region to the west, the eastern end of Ikorodu LGA to the east, and Akoka/Ilaje-Bariga in Somolu LGA and the Lagos Lagoon to the southeast. It also shares a boundary with Ogun State in the north (see Map 1 and Map 2). The areal extent of the study area is about 361.02Km.sq.

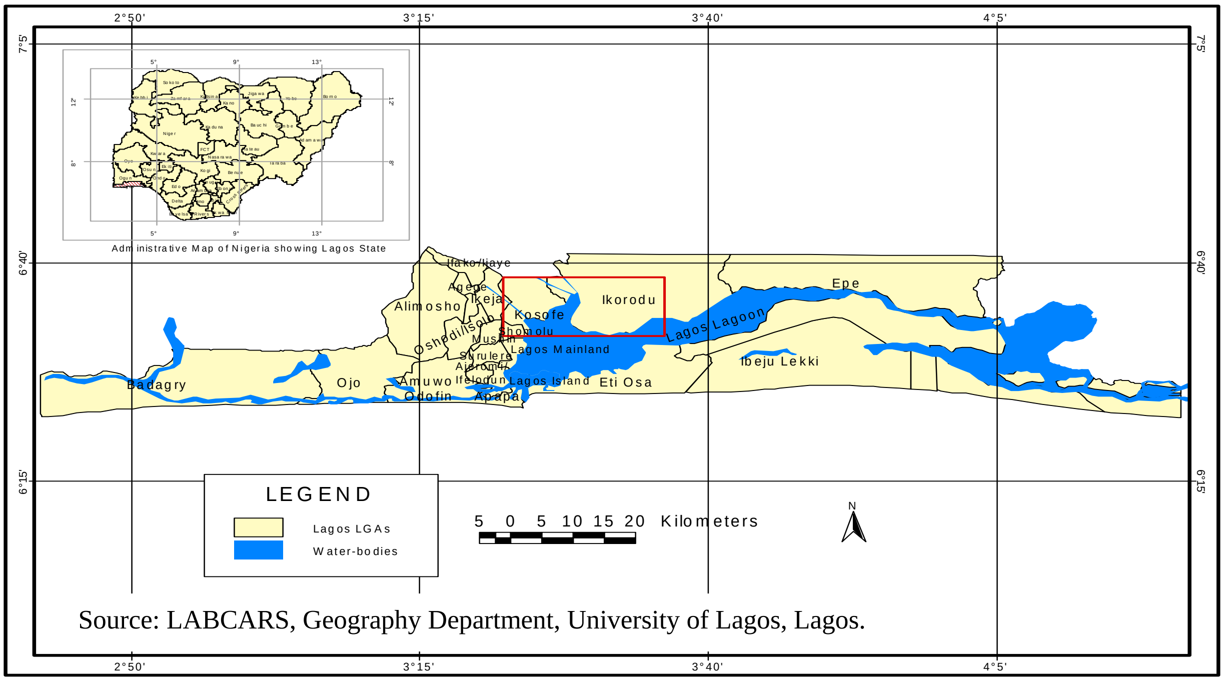
1.5.2: Physical Setting

The topography of the area is generally low-lying undulating flat landform, but with some very rugged areas having scarp slopes and gorges. The altitude varies from sea level to about 15metres above sea level in some parts of Ogudu, Shaginshan and Magodo. The major water bodies in the area include River Ogun and the Lagos Lagoon in the southeastern part of the area. Other important water bodies, which traversed the area, include the Majidun and Agboyi Rivers. The area is covered with clay-sandy soil along the coastal axis in the south and clay-loamy soil at the interior part. Apart from the area still covered by forest, most of the clay-loamy soil of the interior have been seriously leached and presently look more like laterite soil. The soils are well drained with the exception of those found in the wetland areas. The vegetation of the region is that of coastal swamp and marsh forest, part of which had given way to the construction of houses, markets and other infrastructures.

The climate of the area is influenced by two air masses, namely: Tropical maritime and the Tropical continental air masses. The tropical maritime air mass is warm, wet and originates from the Atlantic Ocean. The tropical continental air mass is warm, dry, dusty and originates from the Sahara desert. Hence, the climate of the area is similar to that of the other coastal region of the tropical West Africa with tropical sub-equatorial climate. The temperature is high throughout the year with an annual mean maximum temperature of 33.27ºC, while annual mean minimum temperature is 20.27ºC and the annual mean temperature is 26.77ºC. The study area experience two separate seasons, namely: the wet season, which runs from April to October, with August being the little dry season period. The main dry season is from November to March. The area records an average annual rainfall of about 1830mm, with maxima in June and September. Most rainfall experienced are of conventional origin; however, various disturbances contribute to the rainfall especially between February and May. The mean daily relative humidity of the area is 81.65%.

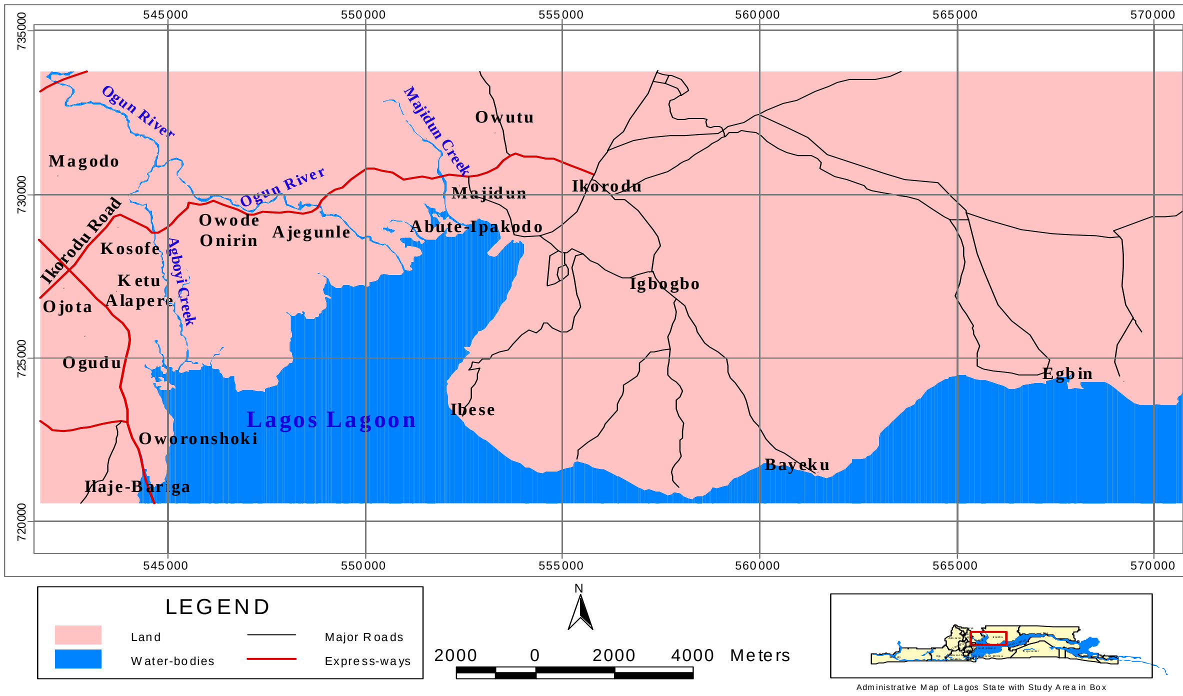
1.5.3: Human Setting

According to 1991 census figure, the population of the area was put at 325,522 for Ikorodu Local Government Area (LGA), 181,914 for Kosofe and Somolu LGAs. The indigenous dwellers of the area are mainly the Ijebus (a Yoruba sub-group). However, people from other parts of the country, as well as foreigners also inhabit the area. The major settlements within the study area include Ikorodu, Ebute-Ipakodo, Owutu, Ijede, Egbin, Ajegunle, Owode-Onirin, Magodo, Ketu, Kosofe, Mile 12, Ketu-Alapere, Ogudu, Osolo, Majidun and Oworonshoki, as well as other minor settlements.



Source: LABCARS, Geography Department, University of Lagos, Lagos.

Map 1: Administrative Map of Lagos State showing Study Area in Box



Map. 2: Map of the Study Area showing Major Settlements

Farming, hunting and fishing have been the chief occupations of the local people for many decades. However, commerce and industry are other major human activities within the area. In Ikorodu area of the study area, most of the human activities are in cottage industries in area of mat making, tie and dye, weaving of basket and chair, fish smoking and food processing. There is presence of some manufacturing industries such as Ragolis Water Limited Ikorodu; Paterson and Zochonis (PZ) Industries PLC, Ikorodu and Dangote Spaghettis Industry in Ebute-Ipakodo. Around Kosofe area of the study area, there is presence of the Metal and spare parts market in Owode-Onirin, the Planet Plastic industries in Mile 12, sawmill (plank) industries, as well as the popular food market at Mile 12. Fishing activities are being carried out mainly in the following areas located within the study area: Ebute-Ipakodo, Majidun, Ajegunle, Owutu, Ketu-Alapere, Ogudu and Oworonsoki. In addition, there is sand mining activity around Majidun, Ajegunle and Oworonsoki, while firewood gathering is mostly restricted to Majidun area.

The study area consists of various types of housing classes, which mostly indicates the income classes. The high and medium income earners occupy areas such as Ogudu GRA, Oworonsoki GRA, Magodo Estate and part of Ebute-Ipakodo area. On the other hand, the low-income earners live mostly in areas such as Ajegunle, Oworonsoki, Kosofe, Ebute-Ipakodo, Owutu and Ikorodu. There is presence of shanty structures (made with mud and planks) around these low-income earner areas.

CHAPTER TWO

CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

2.0: Conceptual Framework

2.0.1: System (Ecosystem) Approach in Geographical Studies

In the words of Tivy and O'Hare (1988), the system approach provides the geographer with a means of organizing and analyzing – i.e. of thinking about – the extremely complex set of relationships and interactions that exist between the components of the earth's surface and, more particularly perhaps, between humans and their environment. According to Harvey (1969) it is possible to identify elements of systems thinking in the works of geographers such as Ritter, Vidal de la Blache, Brunhes, Sauer, and so on. The history of systems thinking in geography is very much bound up with functional approach, with the organismic analogy, with the concept of regions as complex interrelated wholes, and with the ecological approach to geography (Harvey, 1969). According to Tivy and O'Hare (1988) the main advantages of the systems approach in geography are: (a) that it provides a conceptual framework or model by which the component parts of the earth's, and the links between them, can more easily be studied; (b) that the mutual interaction of components throughout a particular system can be more easily illustrated and analyzed; (c) that humans can be studied as integral components of any system, be it physical or human; and (d) that interactions can be studied at any scale.

An ecological system or ecosystem is a set of interacting, interdependent living (organic or biotic) and non-living (inorganic or abiotic) components or sub-systems. According to Tivy and O'Hare (1988), it is a neat, concise term originally coined to convey the idea of a group of organisms and the place or habitat (i.e. home) they occupy, and the way the two are linked together to form a working or functioning unit. All ecosystem display certain common processes and features which result from the fact that they are, within given limits, self-regulating systems. An ecosystem can regulate itself in two ways – as a result either of the interactions between one system and another, or of the interactions within a system. According to Tivy and O'Hare (1988), humans are now the most powerful agents of change in the ecosystem. Their impact can be accidental or deliberate, direct or indirect. In some instances their activities have altered the volume, composition and structure of the organic components and, consequently, the nature of the physical habitat. In others, they have so modified the physical environment as to bring about changes in organic matter. Any change in the composition and structure of one will inevitably have repercussions on that of the other. Human impact on ecosystem components is greatest in those which are deliberately managed in order to maximize the output of a particular product. In this respect, the effect is most marked in crop production. What have become know as *agro-ecosystems* are the most highly developed and widespread of all man-made ecosystems. In creating agro-ecosystem, humans have also provided habitats for other organic components. These are the weeds and pests of cultivation. Both weeds and pests can only really be defined as organisms existing where they are not wanted. However, as agricultural production grows, so also the demands for heavier water-borne load of insecticides, herbicides and nitrates (from fertilizers). Consequently, pollution spreads in streams, wetlands, rivers, lakes, seashores and groundwater.

2.0.2: Ecosystem Approach to Human Health (Ecohealth)

This research work applied system analysis in studying wetland components and the role of man in the use and modification of wetlands for agricultural purposes and identify varies health implications of such use and modification. Since human health can not be considered in isolation, it depends highly on the quality of the environment in which people live; the Ecohealth (ecosystem approach to human health) approach offers a functional platform for reviewing environmentally related health implications. Ecohealth approach is an innovative response to health problems resulting from transformation or high-risk management of either the environment or human health. According to Lebel (2003) 'this approach to human health places human beings at the centre: the aim is to achieve lasting improvements in human health by maintaining or improving the environment.' The objective of Ecohealth approach is not to preserve the environment, but it considered people's social and economic aspirations in a dynamic world created by human needs with the goal of having sustainable development in place. It promotes positive action on the environment that improves people's well being and health. Hence, the eco-health approach recognizes that there are inextricable links between humans and their biophysical, social, and economic environments that are reflected in an individual's health (Lebel, 2003). Unlike the traditional (biomedical) approach (which is sectoral) to human health, the eco-health approach take into account the connections between diseases and socio-economic factors, and the connections between disease and the environment. The challenge of Ecohealth is meeting peoples need without modifying or jeopardizing the ecosystem in the long term and ideally even improving it. According to Bonet (2003) Ecohealth recognizes that there are inextricable links between human activities and their biophysical, social and economic environment that reflected in an individual's health and this is illustrated below in Figure 2.1 unlike the traditional approach which focuses on just one of these factors to the detriment of others there-by compromising ecosystem sustainability.

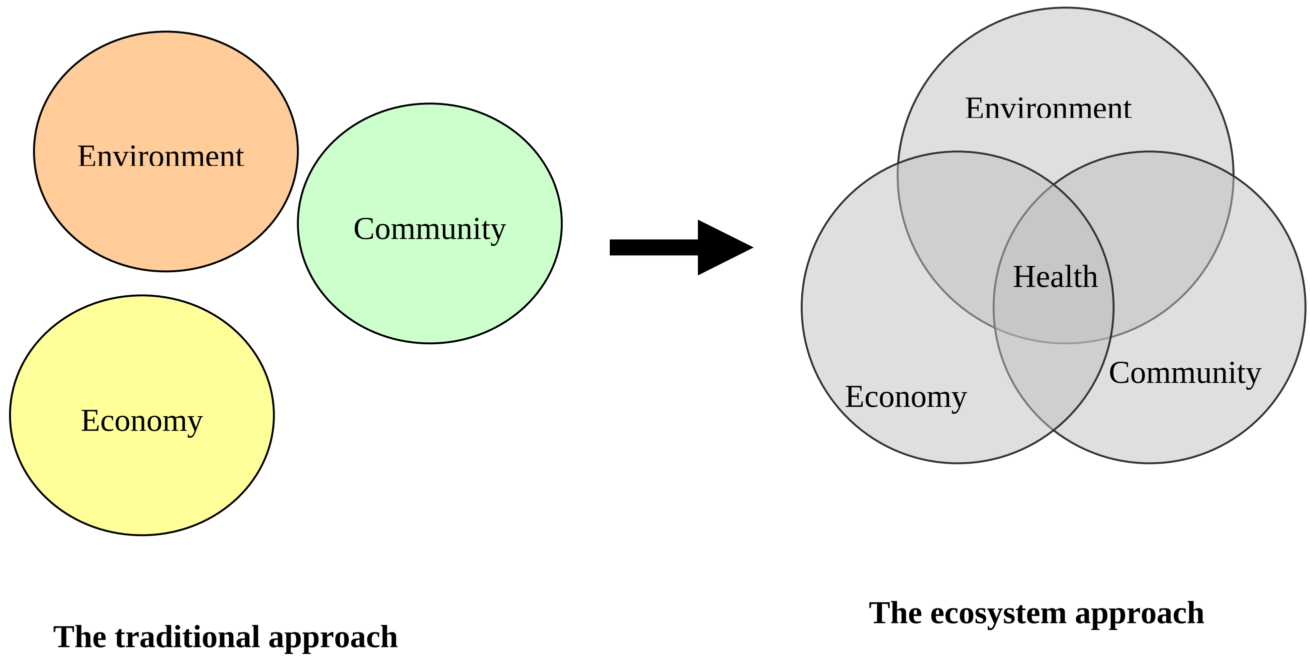


Figure 2.1: The ecosystem approach gives equal importance to environmental management, economic factors, and community aspirations. Traditional methods focus more on the latter two, to the detriment of the environment. *(Source: Lebel, 2003 – adapted from Hancock 1990)*

The Ecohealth approach is based on three methodological pillars and theses are: **transdisciplinarity, participation, and (gender) equity**.

The transdisciplinary approach of ecohealth enables combinations of contributions from different disciplines, while preserving the richness and strength of their respective areas of knowledge. However, the integration of knowledge take place while the problem is being defined to avoids carrying out parallel studies, whose results are pooled together only at the end of the studies. Transdisciplinary framework requires that management of human activity and the environment enhances a better result if different disciplines are drawn together to study the human environment relationships.

The participatory approach targets community representatives, that is the local people themselves, and they are involves directly in the research process. The opinion and perceptions are considered throughout the research process (people's oriented approach). The approach sees community participation as an important component that gives equal weight to both local and scientific knowledge, where-in feasible solutions are identified by exchanging ideas, concerns and needs of the community people. Community members are seen as protagonists and agents of change and that needs to be carried along in any developmental project. Community people or representatives must be integrated in all aspect of the research process in addition to processing particular knowledge of problem at hand, as it is contemporarily believe that community members have a role and stake in its solution.

The gender equity aspect of eco-health approach sheds light on the way in which male-female relations affect everyone's health (Lebel, 2003). Gender dimensions of human covers cultural characteristics that define the social behaviour of men and women and the relationship between them. Understanding the quality and quantitative differences between the communities' social groups helps to reinforce development action programmes.

This work applied the ecosystem approach offered by eco-health, where-in socio-economic, ecological issues, cultural (gender) issues and other environmental issues would be considered in relation to human health well-being.

2.0.3: Landscape Concept

According to Dearden (1985), landscape should be recognized as a resource and is therefore a variable to be considered in land use decisions. The term 'landscape' clearly focuses upon the visual properties or characteristics of the environment, these include natural and man-made elements, and physical and biological resources, which could be identified visually (Daniel and Vining, 1983). Hence, the landscape is the spatial manifestation of the relations between human kind and their environment. This definition stresses the interactions between human agency, including the social, cultural, economic, technological and political aspects, as well as the natural processes with the environment. These interactions are seen to take place over both space and time. Mitchell (1991) stated that the landscape represents an interface between social and environmental processes. A structured method of landscape assessment, linking description, classification, analysis and evaluation, will provide an integrated framework within which decisions on land use management and advice can be debated (Cooper and Murray, 1992).

From a geographer's perspective, the most useful landscape study will involve to some extent the use of cartographic techniques. According to Mitchell (1991), Saucer in 1941 noted that the ideal formal geographic description of landscape is the map. In addition, Quattrochi and Pelletier (1991) stated that the inventory and mapping of landcover phenomena are crucial to understanding why landscapes appear as they do and are requisite for understanding how they came to exist. According to Bishop and Hulse (1994), there is an increasing interest in the use of mapped data and geographic information systems (GISs) to assess visual landscape variables using reproducible methods over a wide area. This research is aimed at generating better understanding of observed wetlands landscape, using geographic method.

On the other hand, there are two major complementary frameworks within which landscape resource assessment methods can be evaluated, namely: landscape ecology and regional political ecology. The landscape ecology approach emphasizes the physical aspects of the resource bases and investigations are concentrated upon determining the role of people in changing the face of the earth through resource use (Mitchell, 1991). The term, according to Troll (1971) is the study of the physico-biological relationships that govern the different spatial units of a region. As presented by Forman and Godron (1986), landscape ecology focused upon three characteristics of the landscape, namely: (i) structure, (ii) function and (iii) change.

Although, landscape ecology does allow for consideration of human impact upon the environment, this is not a key element in the approach. However, to understand human induced landscape changes through various development of land resource, it is essential to address the social, cultural, political and economic contexts within which these changes occur, in addition to the landscape changes themselves. One approach that explicitly considered these factors is that of regional political ecology, as introduced by Blaikie and Brookfield (1987). This research methodology is based upon the landscape ecology concept, but with contributions from regional political ecology. However, to understand the health implications of human interaction with the environment as represented by the landscape, the ecohealth concept formed the main approach to this study with contribution from landscape ecology and other relevant concepts.

In addition, the descriptive techniques of the (United States Geology Survey) USGS landuse and landcover classification system, which is essentially a descriptive approach in landscape evaluation was used with local modification. The USGS landuse and landcover classification system was developed to assess land resources using remotely sensed data, with hierarchically structured levels of landuse and landcover classes (Anderson et al., 1976).

2.1: Literature Review

2.1.1: Wetlands

Oyebande et al. (2003), quoted the Ramsar Convention definition of wetlands as ‘areas of marsh, fen, peatland or water whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6 meters.’ The recurrent or prolonged presence of water (hydrology) at or near the soil surface is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface (Turner, 1990). Wetlands can be identified by the presence of those plants (hydrophytes) that are adapted to life in the soils that form under flooded or saturated conditions, that is, hydric soils (NAS, 1995; Mitsch and Gosselink, 1993). The U.S. Fish and Wildlife Service defines wetlands as: lands that are transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water, and that have one or more of the following attributes: (1) At least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year (Cowardin et al., 1979).

In 1979, a comprehensive classification system of wetlands and deepwater habitats was developed for the U.S. Fish and Wildlife Service (Cowardin et al., 1979). Under this system, wetlands are of two basic types: coastal (also known as tidal or estuarine wetlands) and inland (also known as non-tidal, freshwater, or palustrine wetlands). Oyebande et al. (2003) also grouped wetland ecosystems into three broad categories, namely: freshwater, man-made and saltwater wetland ecosystems.

Coastal wetlands are found along the Atlantic, Pacific, Alaskan, and Gulf coasts and include estuaries (Cowardin et al., 1979). The salt water and tides combine to create an environment in which most plants, except salt-tolerant species (halophytes) cannot survive. Mangrove swamps, dominated by halophytic shrubs or trees, are common in warm climates, while tidal freshwater wetlands form in upstream coastal wetlands where the influence of salt water ends. Inland wetlands include floodplains along rivers and streams (e.g., bottomlands and other riparian wetlands); isolated depressions surrounded by dry land (e.g., prairie potholes); areas where the groundwater intercepts the soil surface (e.g., fens) or where precipitation saturates the soil for a season or longer (e.g., vernal pools and bogs). Grasses and other herbaceous plants or shrubs dominate Marshes and wet meadows; and trees dominate swamps.

2.1.2: Identification of Wetlands

The NAS (1995) report provides a definition for "wetlands" as well as criteria for identification and indicators of wetland conditions. The identification exercise is through on-site or the off-site approaches.

2.1.2.1: On-site Identification

The indicators of the presence of a wetland are hydrophytic vegetation (plant life growing in water, soil, or on a substrate that is periodically deficient in oxygen due to excess water), presence of water, and hydric soils (soils saturated, flooded, or ponded, long enough during the growing season to develop anaerobic conditions in the upper profile) (US ACOE, 1987). Observations of field indicators are used to determine whether the criteria are satisfied since the criteria alone may not be enough to document presence of a wetland. In particular, flooding or saturated soil conditions may occur for only a short time during the year, and generally not when delineators are present. For an ecological determination of the presence of a wetland, all that may be required is the presence of hydrophytic vegetation that require flooded or saturated conditions for survival. Such vegetation is outcompeted by upland species when wetlands are drained. Wetlands require permanent or periodic inundation or soil saturation at the surface for a week or more during the growing season to be a wetland ecologically as well as for jurisdictional purposes.

2.1.2.2: Off-site Identification of Wetlands

Offsite identification of wetlands can be a useful screening tool to determine the possible existence of wetlands. However, on-site verification is necessary to establish the existence, size, shape, and type of wetlands (NAS, 1995). Some resources for offsite identification of wetlands include:

Topographic Maps: These maps portray vegetation cover types, surface features, rivers, lakes, canals, submerged areas, and bogs. The term ‘land subject to inundation’ indicates floodplain areas. In the words of NAS (1995), the topographic Maps allow historical evaluation of a site, which can be useful for restoration purposes. Small wetlands, however, are often not included because of their size and the scale of the maps

Remotely sensed Data: Aerial photos and satellite imageries provides a good source of data compilation on wetlands, which serves as a good means of mapping and generating inventory on existing wetlands (US ACOE, 1987). Aerial photography has been used to map wetlands for at least three decades (Gammon and Carter, 1979 and Johnston, 1991). The Federal Geographic Data Committee in NAS (1995) has published a review of the use of satellite data for mapping and monitoring wetlands, based on the experience of several private and public agencies. In addition, through the use of historical remotely sensed data, the wetland changes can be identified (NAS, 1995).

2.1.3: Wetland Functions and Values

Functions are the physical, chemical, and biological processes occurring in and making up an ecosystem. Processes include the movement of water through the wetland into streams or the ocean; the decay of organic matter; the release of nitrogen, sulfur, and carbon into the atmosphere; the removal of nutrients, sediment and organic matter from water moving into the wetland; and the growth and development of all the organisms that require wetlands for life

Values are "estimate, usually subjective, of worth, merit, quality, or importance" (Richardson, 1994). Wetland "values" may derive from outputs that can be consumed directly, such as food, recreation, or timber; indirect uses which arise from the functions occurring within the ecosystem, such as water quality, and flood control; possible future direct outputs or indirect uses such as biodiversity or conserved habitats; and from the knowledge that such habitats or species exist (known as existence value) (Serageldin, 1993). However, according to Turner (1990) studies attempting to value tropical wetlands are far less numerous, and are typically restricted to direct use valuations.

Turner (1990) stated that the difficulty with determining the value of a wetland is that valuation can be a subjective assessment, particularly the valuation of indirect use, future use, or existence values. However, when decision makers do not understand the basics of ecosystem functions and values, they may make choices that prevent ecosystems from fully functioning. A familiarity with the functions and values of an ecosystem such as a wetland can improve decision making today and protect values that may be held by future generations as well. The following are some of the functions and values of wetlands:

Hydrologic Flux and Storage

Water balance: Wetlands play a critical role in regulating the movement of water within watersheds as well as in the global water cycle (Mitsch and Gosselink, 1993; Richardson, 1994). Wetlands store precipitation and surface water and then slowly release the water into associated surface water resources, ground water, and the atmosphere. Wetlands help maintain the level of the water table and exert control on the hydraulic head (O'Brien, 1988; Winter, 1988). The extent of ground water recharge by a wetland is dependent upon soil, vegetation, site, perimeter to volume ratio, and water table gradient (Weller, 1981; Carter and Novitzki, 1988). Weller (1981) stated that researchers have discovered ground water recharge of up to 20% of wetland volume per season.

Climate control: Climate control is another hydrologic function of wetlands. Many wetlands return over two-thirds of their annual water inputs to the atmosphere through evapotranspiration

(Richardson and McCarthy, 1994). Brinson (1993) observed that wetlands might also act to moderate temperature extremes in adjacent uplands.

Hydrologic flux and life support: Normal hydrologic flux in wetlands allows exchange of nutrients, detritus, and passage of aquatic life between systems (Crance, 1988). Values added to wetlands as a result of the functions of hydrologic flux and storage includes: water quality, water supply, flood control, erosion control, wildlife support, recreation, culture, and commercial benefits.

Biogeochemical Cycling and Storage: Wetlands may be a sink for, or transform, nutrients, organic compounds, metals and components of organic matter. According to Gilliam (1994), wetland processes play a role in the global cycles of carbon, nitrogen, and sulfur by transforming them and releasing them into the atmosphere. The values of wetland functions related to biogeochemical cycling and storage include: water quality and erosion control.

Biological Productivity

Wetlands are among the most productive ecosystems in the world (Mitsch and Gosselink, 1993). Immense varieties of species of microbes, plants, insects, amphibians, reptiles, birds, fish, and other wildlife depend in some way on wetlands. Wetland plants provide breeding and nursery sites, resting areas for migratory species, and refuge from predators (Crance, 1988). According to Crance (1988) decomposed plant matter (detritus) released into the water is important food for many invertebrates and fish both in the wetland and in associated aquatic systems. Wetland plants also reduce erosion as their roots hold the stream-bank, shoreline, or coastline. Values associated with biological productivity of wetlands include the following: water quality, flood control, erosion control, community structure and wildlife support, recreation, aesthetics, and commercial benefits.

Decomposition: Decomposed matter (detritus) forms the base of the aquatic and terrestrial food web (Richardson, 1995). However, according to Johnston (1991) decomposition rates vary across wetland types, particularly as a function of climate, vegetation types, available carbon and nitrogen, and pH. A pH above 5.0 is necessary for bacterial growth and survival. The nutrients and compounds released from decomposing organic matter may be exported from the wetland in soluble or particulate form, incorporated into the soil, or eventually transformed and released to the atmosphere.

Community structure and wildlife support: The inundated or saturated conditions occurring in wetlands limit plant species composition to those that can tolerate such conditions. Beaver, muskrat and alligators create or manipulate their own wetland habitat that other organisms, such as fish, amphibians, waterfowl, insects, and mammals can then use or inhabit (Weller, 1981; Mitsch and Gosselink, 1993). Values associated with community structure and wildlife support in wetlands include: fish and wildlife support, recreation, aesthetics, and commercial benefits (Harris, 1988; Brinson 1993).

Water Supply: Wetlands act as reservoirs for the watershed and they release the water they retain (from precipitation, surface water, and ground water) into associated surface water and ground water. Forested wetlands, kettle lakes and prairie potholes have been noted to have significant water storage and groundwater recharge (Weller, 1981; Brown and Sullivan, 1988).

Flood Protection: Wetlands help protect adjacent and downstream properties from potential flood damage. According to Mitsch and Gosselink (1993), the value of flood control by wetlands increases with: (1) wetland area, (2) proximity of the wetland to flood waters, (3) location of the wetland (along a river, lake, or stream), (4) amount of flooding that would occur without the presence of the wetlands, and, (5) lack of other upstream storage areas such as ponds, lakes, and reservoirs. Wetlands within and upstream of urban areas are particularly valuable for flood protection. The impervious surface in urban areas greatly increases the rate and volume of runoff, thereby increasing the risk of flood damage.

Erosion Control: Wetland plants hold the soil in place with their roots, absorb wave energy, and reduce the velocity of stream or river currents. Coastal wetlands buffer shorelines against the wave action produced by hurricanes and tropical storms (Mitsch and Gosselink, 1993).

Fish and Wildlife Habitat: Diverse species of plants, insects, amphibians, reptiles, birds, fish, and mammals depend on wetlands for food, habitat, or temporary shelter. NOAA (1990) stated that coastal and estuarine wetlands provide food and habitat for estuarine and marine fish and shellfish, bird species, and some mammals.

Recreation, Aesthetics, Culture and Science: Wetlands have archeological, historical, cultural, recreational, and scientific values. According to USEPA (1994), the monetary value derived from the observation and photography of wetland-dependent birds by more than 50 million Americans is at least $10 billion per year. In the area of science, scientists value the processes of wetlands individually, particularly the role of wetlands in the global cycles of carbon, nitrogen, and water. Mitsch and Gosselink (1993) noted that many scientists consider the removal of carbon dioxide from the atmosphere into plant matter and its burial (sequestration) as the most valuable function of wetlands.

2.2: Operational Definitions

Operational definitions have substantial implications for resource analysis in the understanding of different variables under investigation. Unless key concepts and terms are operationally defined, it is difficult for the user of a report to know what relevance assembled evidence has for the problem under study. Thus, the following (key-words) operational definitions are given below:

2.2.1: Wetlands: are lands on which water covers the soil or is present either at or near the surface of the soil or within the root zone, all year or for varying periods of time during the year, including the growing season

2.2.2: Wetland Changes: refers to the conversion of wetlands to other landuse/landcover or the change of types of wetland from either forested to non-forested wetland or vice-versa through natural and/or artificial causes. This changes result in the change of wetland values and functions.

2.2.3: Wetlands Encroachment: is the act of expanding human activities through anthropogenic processes of man into original territory of wetlands. It is the act of converting wetlands into other landuse(s) such as residential, industrial and agricultural.

2.2.4: Farm community: is the working together of a group of farmers who share common interest in the same locality or neighborhood.

2.2.5: Farmer: a farmer is any person engaged in farming activities whether directly or indirectly. There are three types of farmers identified in this study, and these are labourers (farm worker), Owners (who do not participate in cultivation but provide resources), and owner / worker (those who own farm, who provide resources and also join in the cultivation activities). In this study therefore, farmers are referred to any person who cultivate directly on the farm site, but exclude (owners) provider of farm resources.

2.2.6: Health: is a state of complete physical, mental and social well-being and not merely the absence of disease

2.2.7: Remote Sensing: is the science of deriving information about an object, area or phenomenon from measurement made at a distance from the object, area or phenomenon under investigation.

2.2.8: Geographic Information System (GIS): is a powerful computer based set of tools for collecting, storing, retrieving at will, transforming and displaying geographical referenced data from the real world for a particular set of purposes. It allows for the integration of spatial and non-spatial data within a system.

2.2.9: Biodiversity: refers to the variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species, and of ecosystems.

CHAPTER THREE

METHODOLOGY

3.0: Introduction

Information is crucial in order to assess wetland changes and use for agricultural purposes in terms of rate, trend, direction and magnitude of change, to monitor the state of the remaining wetlands, the driving forces and health implications of the changes and to ensure their sustainable management. In wetlands, the task of collecting information by ground inventory is extremely difficult, time consuming, and therefore expensive. For this reason, remote sensing is an attractive means of obtaining data for detecting wetland changes and updating management plans. This research involved the integration of remote sensing techniques and socio-economic survey (through questionnaire administration and focus group discussion) within a Geographic Information System (GIS) framework along with contributions from other disciplines using the ecohealth approach. With remote sensing and GIS, the ability of generating digital environmental data has greatly improved, in terms of time, spatial coverage and spatial/spectral details (Omojola, 1999). Remote sensing and GIS have turned-out to be a major driving force in modern resource evaluation and mapping. Wetlands, which are mostly inaccessible and remote areas, can be better monitored with remotely sensed imageries.

3.1: Data Types and Sources: The research made used of both spatial and non-spatial (attribute) data. The spatial data include topographic maps, satellite imagery, Global Positioning System (GPS) {locational readings} and administrative maps. The non-spatial data include responses from questionnaire, field observations, focus group discussions, disease vector studies, clinical records, nutritional studies and other relevant data.

Table 1: Data Characteristics

Data	Type	Date	Source	Scale/Number
Topographic map (Lagos SE sheet)	Spatial	1970	Federal Survey, Lagos	1:50,000
Satellite imagery (SPOT) XS	Spatial	1994	Geography Department, University of Lagos	1:50,000
Satellite imagery (Landsat) TM	Spatial	2000	Geography Department, University of Lagos	1:50,000
Focus Group Discussion (Participatory approach)	Non-spatial	During Field work	Farmers: i. Male, ii. Female	2

Questionnaire	Non-spatial	During Field work	Inhabitants/farmers of the Study Area during field work.	160
Interview and materials on policy	Non-spatial	During Field work	Officers of Lagos State Urban & Regional Planning, Ikeja.	
Literatures	Non-spatial		Library and Internet	
Location of notable special structures in and around wetlands	Spatial	During Field work	Global Positioning System (GPS)	
Population figure	Non-spatial		National Population Commission (NPC)	
Clinical report (Disease presence test)	Non-spatial	During Field work	Parasitological Lab of Lagos University Teaching Hospital (LUTH).	
Disease Vector Studies	Non-spatial	During Field work	Microbiological and Environmental Chemistry Lab of University of Lagos.	

In addition, contributions from sociologist, economist, statistician and urban agricultural expert were used in the course of this research in order to have a transdisciplinary approach.

3.2: Materials: The materials that would be used during the research include the following:

- Hardware – Scanner, Personal Computer, Global Positioning System (GPS) and questionnaire.
- Software – ArcView GIS (version 3.1), Arc-Info software (version 3.5.1) and SPSS (for database creation).

3.3: Procedure: The procedure used in this research includes the following major processes: data collection and compilation, data input and interpretation, and data analysis.

3.3.1: Data Collection and compilation: The aerial photograph of 1985 at scale 1: 25,000 coving the study area was acquired from Federal Survey Lagos, while the SPOT XS imagery of 1994 was sourced from Laboratory for Remote sensing and Cartography (LABCARS) and the Landsat TM imagery of 2000 was acquired from the Department of Geography.

Regarding the socio-economic survey, a structured questionnaire was designed and administrated on the inhabitants and farmers of the study area that falls within agriculturally encroached wetlands. Farming Communities identified as been on encroached wetlands were listed and 4 of such communities were randomly selected as sampling sites. The farming communities selected are: Alapere, Ajegunle, Majidun and Ibese. The questionnaire was administrated randomly at household level in a stratified manner using a random table. In all, the number of questionnaire administered was 120, that is, 30 per community. To the farmers, a total of 40 questionnaires were administered with each farming community having 10 questionnaires. For gender equity, women were given preference where and when available during the questionnaire administration and focus group discussion. Table 3.2 below shows the gender composition during the questionnaire administration.

Table 3.2: Gender Composition of Respondents during Questionnaire Administration

Questionnaires Administered	Communities							
	Ibese		Alapere		Ajegunle		Majidun	
	Male	Female	Male	Female	Male	Female	Male	Female
Inhabitants	20	10	18	12	22	8	16	14
Farmers	6	4	5	5	7	3	5	5
Total	26	14	23	17	29	11	21	19

This task was done during the months of February and July 2006, where-in four research assistants along with the researcher administered the questionnaires. For the focus group discussion, 10 (5 male and 5 female) farmers per farming community were interviewed. Furthermore, 10 farmers per farming community supplied blood and stool for disease parasites presence test, and this gives the point epidemiological status of the farmers. In addition, direct information through field observation was carried out with photographs taking.

3.3.2: Spatial Data Input and Interpretation: This involved the use of archival remotely sensed data and topographic maps to generate multi-temporal, as well as spatial states of wetlands. Firstly, the aerial photograph was scanned to convert them into digital format which was then opened within the Arc-view environment as image data. There-after, the scanned image was geo-rectified using Universal Transverse Mercator (UTM) projection with Clarke 1880 spheroid for proper projection and to make it registered with the satellite images (Spot and Landsat) as planimetrically accurate data source. On the other hand, the satellites images were opened directly within the Arc-view software environment. A hierarchical classification scheme which takes into consideration the characteristics of the multi-source and multi-date remotely sensed data, and the physical and human setting (from field observation) of the study area was then developed. This is a modified USGS (United State Geological Survey) classification scheme with two (primary and secondary) levels, which was prepared specifically for use with remotely sensed data and in hierarchical order. In addition, the classification scheme considered the degree of details required for this study, as well as the clarity in defining each landuse/landcover category. The classification scheme used for this research work is presented below in Table 1.

Table 1: The landuse/landcover classification scheme

Code	Level 1 (Primary category)	Code	Level 11 (Secondary category)
1	Settlement	11	Built-up Areas
		12	Partially Developed Areas
2	Wetlands	21	Forested Wetlands
		22	Non-forested Wetlands
3	Forest	31	Heavy Forest
		32	Light Forest
		33	Palm Forest
4	Cultivation	41	Cultivation
5	Shrub	51	Shrub/Thickets
61	Water-bodies	61	Ponds
		62	Rivers/Creek/Lagoon

Landuse/Landcover Classification Scheme Description

1 – Settlement: These are areas covered with buildings and other artificial structures and intensive human developmental in-print. In this category are: built-up areas and partially developed areas. The built-up Areas are composed of areas under intensive use with most of the land covered with structures and this include residential, industrial, commercial, strip development along highways, and institutional complexes. On the other hand, the partially developed Areas are areas of less intensive usage and are mostly located around the outskirt of towns (where there is developmental processes in progress), farm settlements and villages.

2 – Wetlands: These are and where the water table is near or above the surface long enough to promote the formation of hydric soils or to support the growth of hydrophytes (plants that grow in water or on very wet soils). Wetlands include the following: forested and Non-forested wetlands. 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

3 – Forest: These areas are regions covered with trees of different species, with little or no human activities. These regions include: heavy forest, light forest and palm forest. The heavy forest areas generally covered with trees and are areas with typical rain forest; there are three storeys of trees. The light forest areas are regions of trees but not as dense as what is obtained in the heavy forest and here there is presence of short trees, shrubs and palms. Regarding palm forest, these are areas

dominated with palms with scattered bushes of woody plants.

4 – Cultivation: These are areas use for growing agricultural crops and are apparently cultivated during the growing season.

5 - Shrubs: Areas covered with shrubs, thickets and grasses with little or no trees are referred to as shrubs. These areas are classified as shrubs/thickets for the purpose of this research.

6 – Water-bodies: These include the following 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.

The interpretation task of the remotely sensed data includes the identification, classification, enumeration and delineation of the study area into classes in line with the developed classification scheme. Using the mage interpretation elements such as tone, texture, shape, association, site, size and pattern the images were visually interpreted using the on-screen (automatic) digitization method. The digitization was done at a scale of 1: 5, 000; that is, the images were zoom-in at the digitization scale for uniformity in detail and precision levels. The various features were then digitized into either as line theme (roads and streams), polygon theme (landuse/landcover) and point theme (settlement names). For verification, a ground truthing exercise was conducted, which used effect all necessary correction of the generated coverage. The generated coverage were then exported into Arc-info (version 3.5.1) for editing (using the ArceditW section of Arc-info to edit nodes terminating or joining polygons, which must be perfectly snapped together and every polygon labeled); cleaning (to construct the topology of the coverage and 'CLEAN' command was used); and topology building ('BUILD' command of the ArcW module was used for topology building). The edited and built coverage were then re-introduced into Arc-view environment for designing as maps for the different year under investigation and further analysis.

3.3.3: Data Analysis: The major analyses carried out include the following:

- **Multi-temporal inventory of Wetlands:** The mapping of the study area at different times (1980s, 1994 and 2000) was done within the Arcview software as stated earlier. Analyses, in form of areal extent were derived from the Attribute Table section of the Arc-view software.
- **Spatio-temporal change detection Analysis:** Two change detection methods were used in this study and these are: (1) the area analysis and (2) the point by point (or area specific) analysis. The area analysis involves the analysis which highlights the trend and rate of the landuse/landcover changes over the period under investigation. The percentage change is calculated using the equation:

Percentage Change = (OC / ASC) X 100

Where OC is the observed change; and ASC is the absolute sum of change.

The annual rate of change is calculated using the equation:

$$\textbf{Annual Rate of Change} = \mathbf{OC/\ (Y_2\text{-}Y_1)}$$

Where OC is the observed change; Y_1 is the starting year; and Y_2 is the ending year.

The point by point analysis involves the actual topological overlay of the various classified landuse/landcover maps generated within the Arcview software, to produce change maps (Change Detection Exercise). This was done to generate the nature, location and magnitude of the changes. This process is like the post-classification change detection technique on digital image analysis system; which according to Adeniyi and Omojola (1999) was considered by Weismiller et al. in 1977 as being superior to other change detection techniques on the image analysis system. The change maps were digitally generated using the '*geo-processing extension*' with intercept command and the query tool bar within the Arcview software. However, emphasis was placed on wetlands in the change maps composition being the focus of this research study. In addition, the topological map overlay also led to the generation of a two-dimensional change matrix within the GIS environment.

This two-dimensional matrix shows the nature of the landuse and landcover changes for two given sets of years. Figure 3.1 below shows a change matrix template.

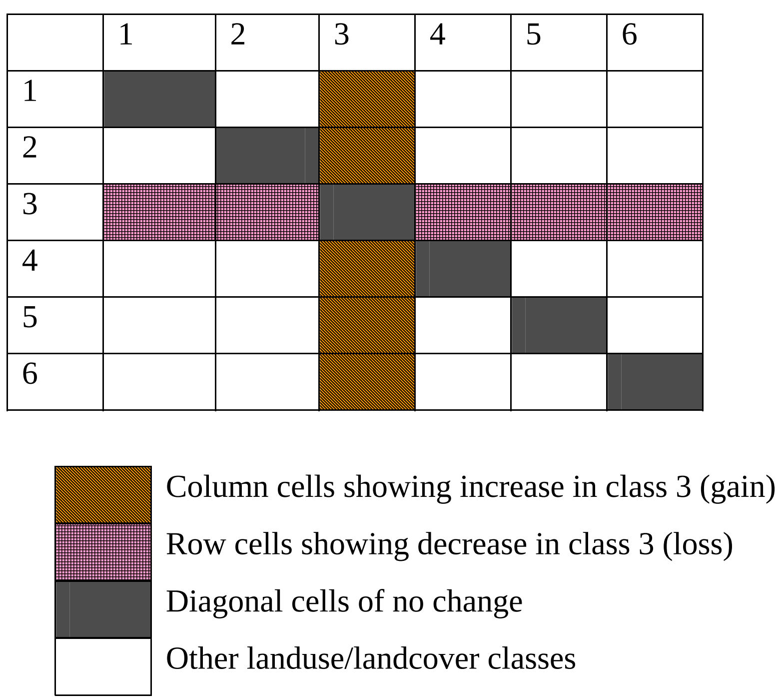


Figure 3.1: A Change Matrice template

- **Socio-economic Analysis:** This was done through the administration of socio-economic questionnaire within the study area. A structured questionnaire was administrated to generate information on the local inhabitants understanding and preferences of wetland environments, uses of wetlands for agricultural purposes and the products derived from them, as well as the health implications of wetlands uses for agricultural purposes on the inhabitants as well as the farmers. In addition, socio-economic profile of the local inhabitants and farmers in terms of level of education, cultural affiliation and income level were generated, as well the roles of women in the use of wetlands for agricultural purposes. Statistical Package for Social Sciences (SPSS) software was used to input and generates the needed analyses. However, this was done after developing a good coding system. Relationship statistics, cross tabulation and measure of tendency were applied where appropriate.

- **Nutritional Values analysis:** The nutritional contain of the agricultural products were studied in this part of the work. This assist in understanding the nutritional state of the people and the diet diversity offered by the conversion of the wetlands for agricultural purposes. The quantity and quality of agricultural products, and the rate and ratio of nutrition available to the population were also examined as part of food security studies.

- **Health Implications analysis:** The health implications (both positive and negative) were identified in this section of the work. The health risk and possible population at risk, the rate and pattern of the health risk, as well as the magnitude of the health situation were examined in this work. The presence of disease vectors and the people at risk based on association, proximity and contact were studied in this section of the research. Prevalence rate and ratio were estimated as the primary epidemiological indicators. Both point and period (spatio-temporal) rates were estimated. The point prevalence gives a snapshot of the burden of the health problems (diseases) at the time of the survey using clinical report of disease(s) presence tests, with information on the sick people in their home and hospital (that is, it consider only the cases at the time of survey and the population at risk at the period of survey through clinical lab tests). The period prevalence rates are particularly useful in testing seasonal diseases, recurrent and the burden of episodic (that is, it would consider all the cases over a period and the average population at risk during the same period).

CHAPTER FOUR

RESULT PRESENTATION AND ANALYSIS – WETLANDS / AGRICULTURAL ACTIVITIES: SPATIO-TEMPORAL

4.0: Introduction

The results presented and analyzed below in this section represent the spatial coverage of landcover/landuse especially wetlands and cultivation over time under investigation and these were generated using the various methods stated in methodology section of this paper and are in line with the aim and objectives of this research work.

4.1: Multi-Temporal Inventory of Landuse/Landcover (1986, 1994 and 2000)

The areal extent of landuse/landcover for the years under investigation are presented in Table 3, while Map 3, 4 and 5 shows the spatial distribution of the static landuse/landcover of the study area in 1986, 1994 and 2000 respectively. The graphical representation of Table 3 is presented in Figure 2.

Table 3: Landuse/Landcover (Areal Extent) for 1986, 1994 and 2000 in the Study Area

Landuse/Landcover Class	1986		1994		2000	
	Area (Sq. Km)	Area (%)	Area (Sq. Km)	Area (%)	Area (Sq. Km)	Area (%)
Built-up Area (BUA)	31.548	8.068	34.473	8.816	81.586	20.865
Partially Developed Areas (PDA)	10.486	2.681	12.202	3.120	0	0
Forested Wetlands (FW)	68.280	17.462	64.689	16.544	57.550	14.718
Non-Forested Wetlands (NFW)	3.970	1.015	3.907	0.999	4.367	1.116
Cultivation (CUL)	107.877	27.589	100.723	25.759	109.239	27.937
Light Forest (LF)	7.842	2.005	20.085	5.136	12.439	3.181
Palm Forest (PF)	62.992	16.110	57.336	14.663	38.148	9.752
Heavy Forest (HF)	10.926	2.794	10.057	2.571	0	0
Shrub and Thickets (ST)	0.179	0.045	0.192	0.049	0.046	0.011
Rivers/Creeks/Lagoon (RCL)	86.502	22.122	86.765	22.190	87.429	22.359
Ponds (PO)	0.407	0.103	0.579	0.148	0.205	0.052
Total	**391.009**	**100**	**391.009**	**100**	**391.009**	**100**

Source: GIS Analysis of Interpreted Remotely Sensed data (2006)

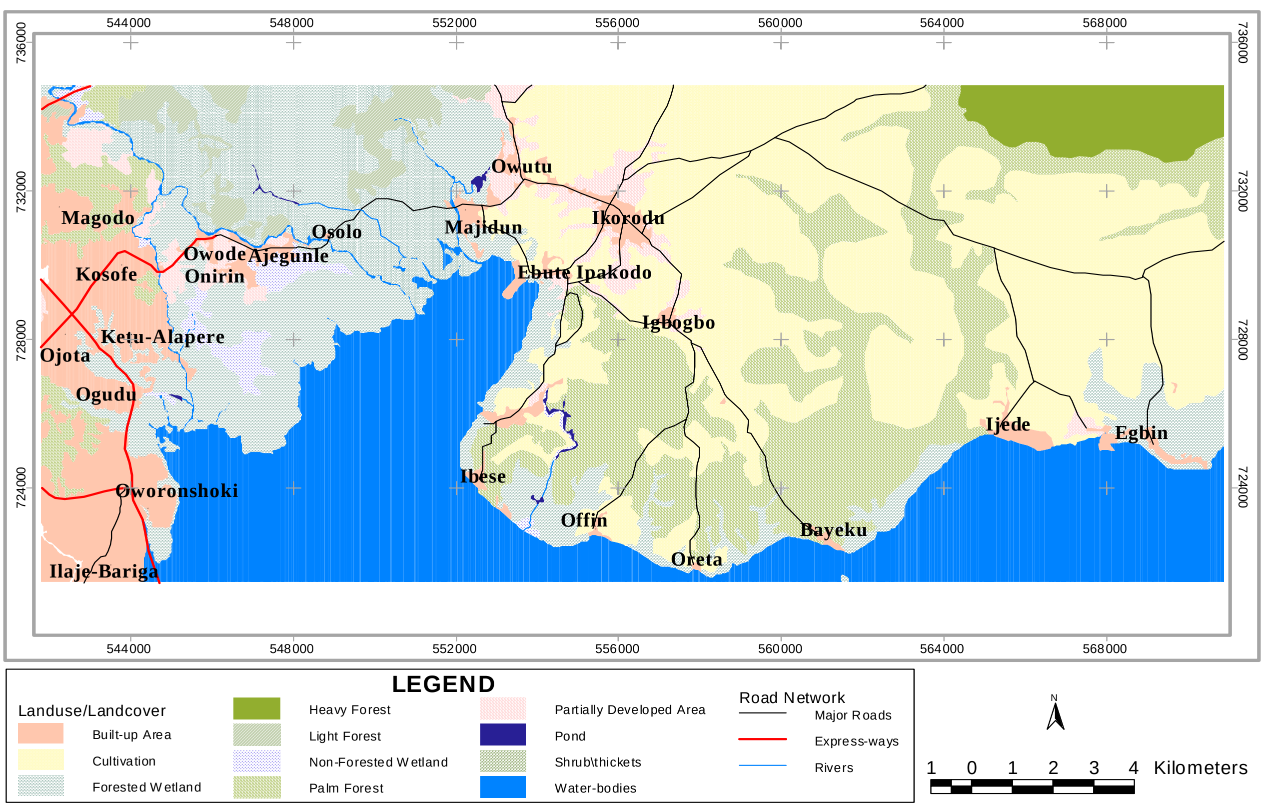
As shown in Table 3, the entire study area covered 391.009 sq. km. During the three periods investigated, built-up area recorded 31.548 sq. km (8.068%), 34.473 sq. km (8.816%) and 81.586 sq. km (20.865%) in 1986, 1994 and 2000 respectively. In 1986 1994 and 2000, river/creeks/lagoon covered 86.502 sq. km (22.122%), 86.765 sq. km (22.571%) and 87.429 sq. km (22.359%)

respectively. On the other hand, partially developed and heavy forest recorded 0% apiece in 2000.

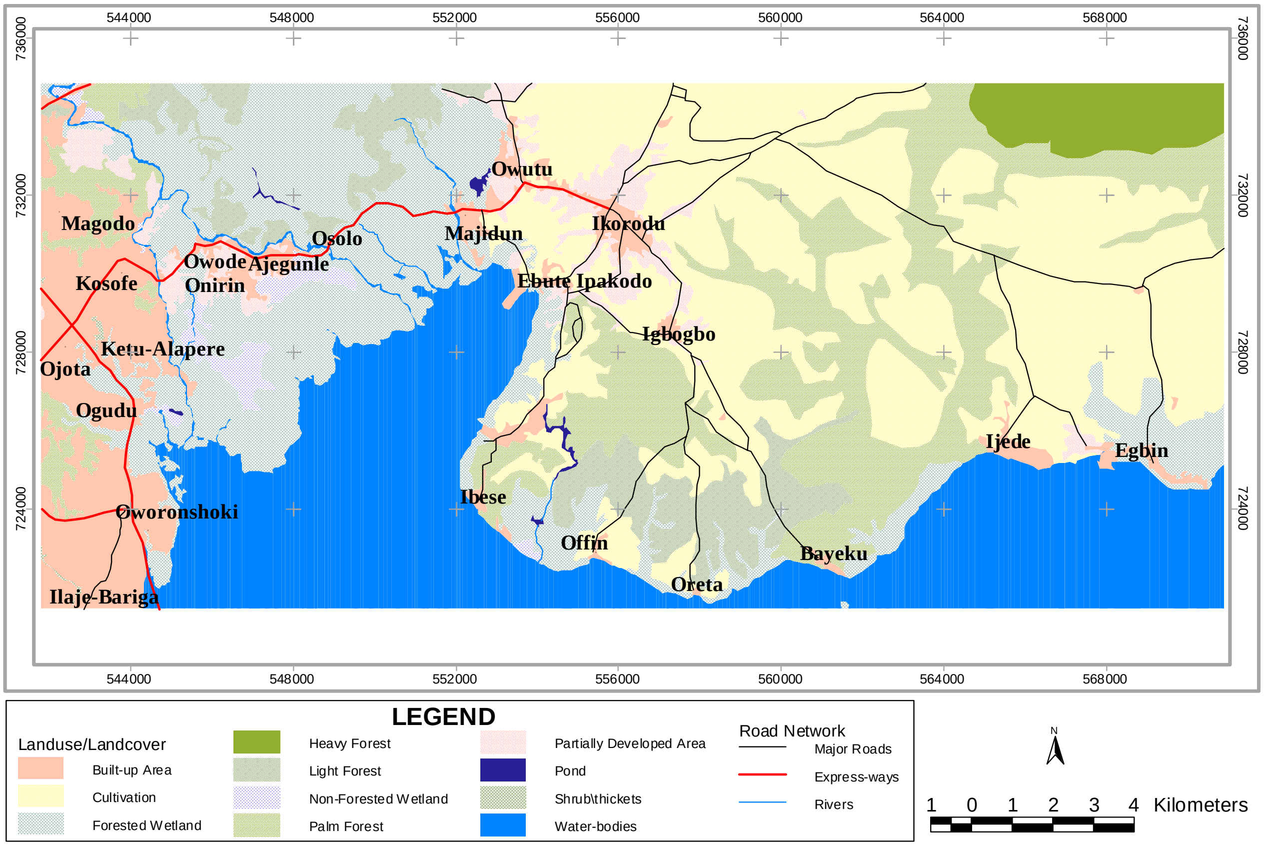
4.1.1: Multi-Temporal Inventory of Wetlands and Cultivation (1986, 1994 and 2000)

In line with the objectives of the study, emphasis is given here to the areal extent of wetlands (Forested and Non-forested) and cultivation over the three periods (1986, 1994 and 2000). As shown in Table 3 above, forested wetlands covered 68.280 sq. km in 1986, representing 17.462% of the total study area; while in 1994, it covered 64.689 sq. km (16.544%) and 57.550 sq. km (14.718%) in 2000. Non-forested wetlands recorded 3.970 sq. km in 1986, which represent 1.015% of the entire study area. In 1994, non-forested wetlands covered 3.907 sq. km (0.999%) and 4.367 sq. km (1.116%) in 2000. On the other hand, cultivation covered the largest area with 107.877 sq. km (27.589%), 100.723 sq. km (25.759%) and 109.239 sq. km (27.937%) in 1986, 1994 and 2000 respectively.

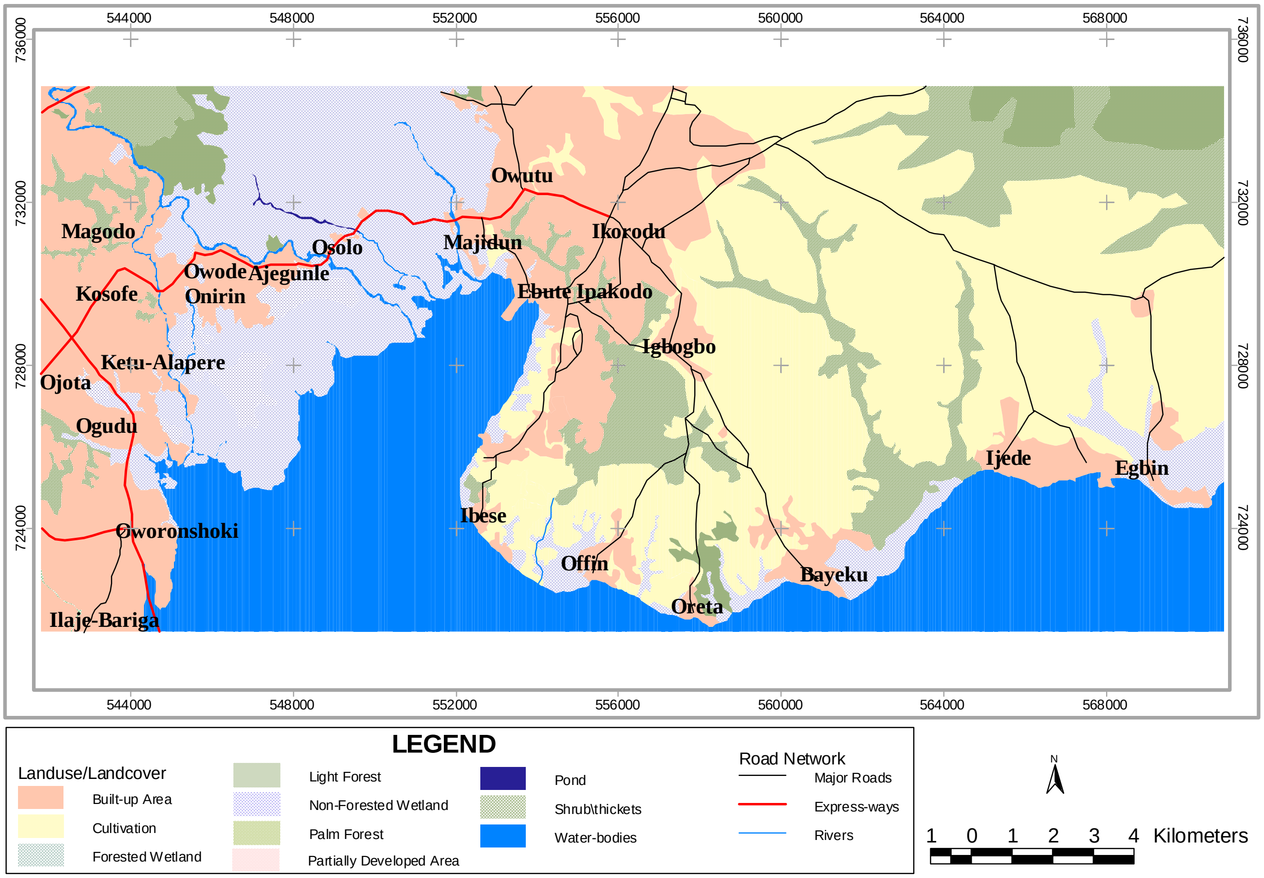
However, when considering wetlands separately, Table 4 below shows the comparison of wetland types in terms of areal extent and percent contributed to wetland landscape during the three periods examined and Figure 3 shows their contributions graphically.



Map 3: Landuse/Landcover Distribution of the Study Area in 1986



Map 4: Landuse/Landcover Distribution of the Study Area in 1994



Map 5: Landuse/Landcover Distribution of the Study Area in 2000

Table 4: Wetland Types Areal Extent for 1986, 1994 and 2000 in the Study Area

Wetland Types	**1986**		**1994**		**2000**	
	Area (Sq. Km)	**Area (%)**	**Area (Sq. Km)**	**Area (%)**	**Area (Sq. Km)**	**Area (%)**
Forested Wetlands	68.280	94.505	64.689	94.304	57.550	92.947
Non-Forested Wetlands	3.970	5.495	3.907	5.696	4.367	7.053
Total	**72.25**	**100**	**68.596**	**100**	**61.917**	**100**

Source: GIS Analysis of Interpreted Remotely Sensed data (2006)

Table 4 shows that in 1986, 1994 and 2000, forested wetlands contributes around 94.505% (68.280 sq. km), 94.304% (64.689 sq. km) and 92.947% (57.550 sq. km) respectively to the total wetland landscape area; while non-forested wetlands recorded 5.495% (3.970 sq. km), 5.696% (3.907 sq. km) and 7.053% (4.367 sq. km) in 1986, 1994 and 2000 respectively. In totality, wetlands covered 72.250 sq. km (representing around 18.477% of the entire study area) in 1986, while in 1994 and 2000, wetlands covered 68.596 sq. km (17.543%) and 61.917 sq. km (15.834%) respectively.

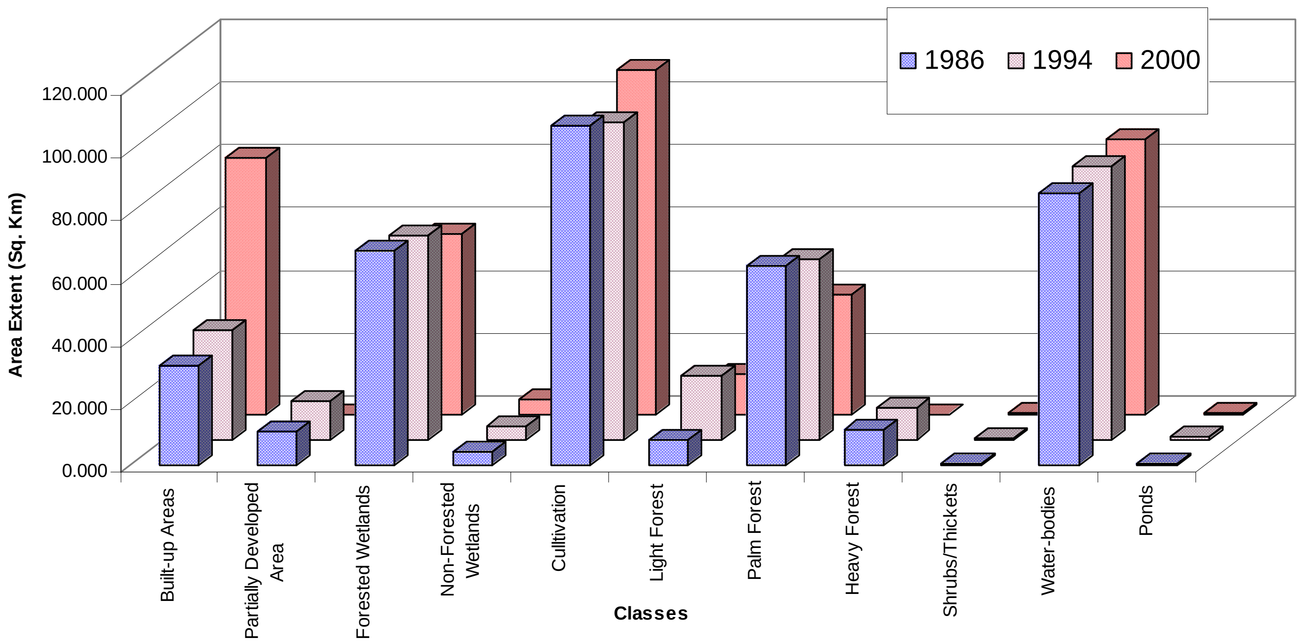


Figure 2: Areal Extent of Static Landuse/Landcover of Study Area during the Three periods

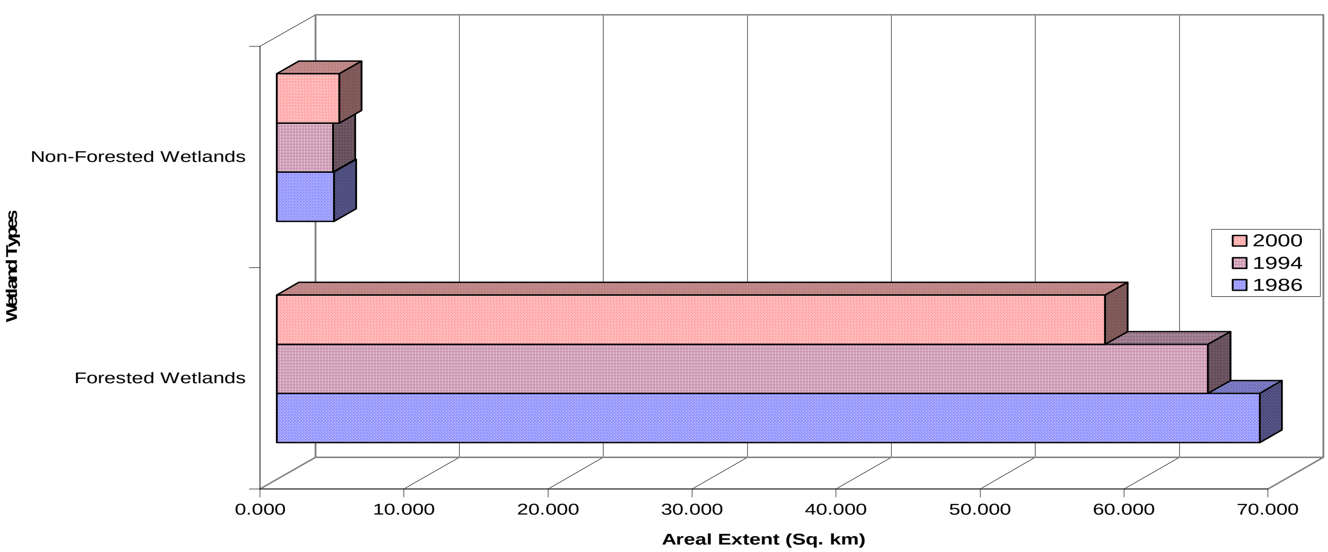


Figure 3: Comparison of Wetland Types distribution for 1986, 1994 and 2000 in the Study Area

4.2: Changes in Landuse/Landcover

The result of landuse/landcover within the study area is presented below with regards to (i) the trend and rate of changes and (ii) the nature of changes. On the other hand, the result of wetland changes for agricultural purpose (represented by cultivation) is presented with regards to (i) the trend and rate of changes; (ii) the natural of changes; and (iii) the locations of the changes.

4.2.1: Changes in Landuse/Landcover: Trend and Rate

The absolute, percentage and annual rates of landuse/landcover within the study area for the periods: 1986-1994, 1994-2000 and 1986-2000 are shown in Table 5 below, and Fig. 4 shows the annual rates of change for 1986-2000.

Table 5: Landuse/Landcover change statistics in the study area between 1986, 1994 and 2000

Landuse/ Landcover	**Landuse/Landcover Change**						**Annual Rates of Change**		
	1986-1994		1994-2000		1986-2000		1986-1994 Area (Sq. km)	1994-2000 Area (Sq. km)	1986-2000 Area (Sq. km)
	Areal (Sq. Km)	% Change	Areal (Sq. Km)	% Change	Areal (Sq. Km)	% Change			
Built-up Area	2.925	8.439	47.113	41.507	50.038	43.646	0.366	7.852	3.574
Partially Developed Areas	1.716	4.950	-12.202	-10.750	-10.486	-9.147	0.214	-2.034	-0.749
Forested Wetlands	**-3.591**	**-10.358**	**-7.139**	**-6.290**	**-10.730**	**-9.359**	**-0.449**	**-1.190**	**-0.766**
Non-Forested Wetlands	**-0.063**	**-0.181**	**0.461**	**0.406**	**0.398**	**0.347**	**-0.008**	**0.077**	**0.028**
Cultivation	**-7.153**	**-20.635**	**8.516**	**7.502**	**1.362**	**1.188**	**-0.894**	**1.419**	**0.097**
Light Forest	12.243	35.318	-7.646	-6.736	4.597	4.010	1.530	-1.274	0.328
Palm Forest	-5.656	-16.316	-19.189	-16.905	-24.845	-21.671	-0.707	-3.198	-1.775
Heavy Forest	-0.869	-2.508	-10.057	-8.860	-10.926	-9.531	-0.109	-1.676	-0.780
Shrub/Thickets	0.013	0.036	-0.146	-0.129	-0.133	-0.116	0.002	-0.024	-0.010
Water-bodies	0.263	0.758	0.664	0.585	0.927	0.808	0.033	0.111	0.066
Ponds	0.173	0.498	-0.374	-0.330	-0.202	-0.176	0.022	-0.062	-0.014

Source: GIS Analysis of Change Detection through Topological Overlay (Area Analysis) (2006)

Note: The positive sign means gain and the negative sign indicates loss in areal extent.

As shown in Table 5 above, built-up area recorded 8.439%, 41.507% and 43.646% percentages of change during the periods 1986-1994, 1994-2000 and 1986-2000 respectively; while the annual rates of change for the same periods are 0.366 sq. km, 7.852 sq. km and 3.574 sq. km respectively. This shows that built-up area increased during 1986-1994 at the rate of 0.366 sq. km per year, while during 1994-2000 the rate was 7.852 sq. km per year and 3.574 sq. km per year during the period 1996-2000. Partially developed areas recorded 4.950%, -10.750% and -9.147% percentages of change during the periods 1986-1994, 1994-2000 and 1986-2000 respectively; with 0.214 sq. km, -2.034 sq. km and -0.749 sq. km as the annual rates of change during the same periods respectively. Light forest, palm forest and heavy forest recorded 1.530 sq. km, -0.707 sq. km and -0.109 sq. km respectively as annual rates of change for the period 1986-1994. For 1994-2000, light forest, palm forest and heavy forest recorded -1.274 sq. km, -3.198 sq. km and -1.676 sq. km respectively as annual rates of change; while for the period 1986-2000, the rates of change are 0.328 sq. km, -1.775 sq. km and -0.780 sq. km for light forest, palm forest and heavy forest respectively. The percentages of change for light forest, palm forest and heavy forest are 35.318%, -16.316% and -2.508% respectively for 1986-1994; -6.736%, -16.905% and -8.860% respectively for 1994-2000; and 4.010%, -21.671% and -9.531% respectively for 1986-2000. On the other hand, the annual rates of change for shrub/thickets, rivers/creeks/lagoon and ponds during 1986-2000 are -0.010 sq. km, 0.066 sq. km and -0.014 sq. km respectively. The percentages of change for shrub/thickets, water-bodies and ponds for the period 1986-2000 are -0.116%, 0.808% and -0.176% respectively.

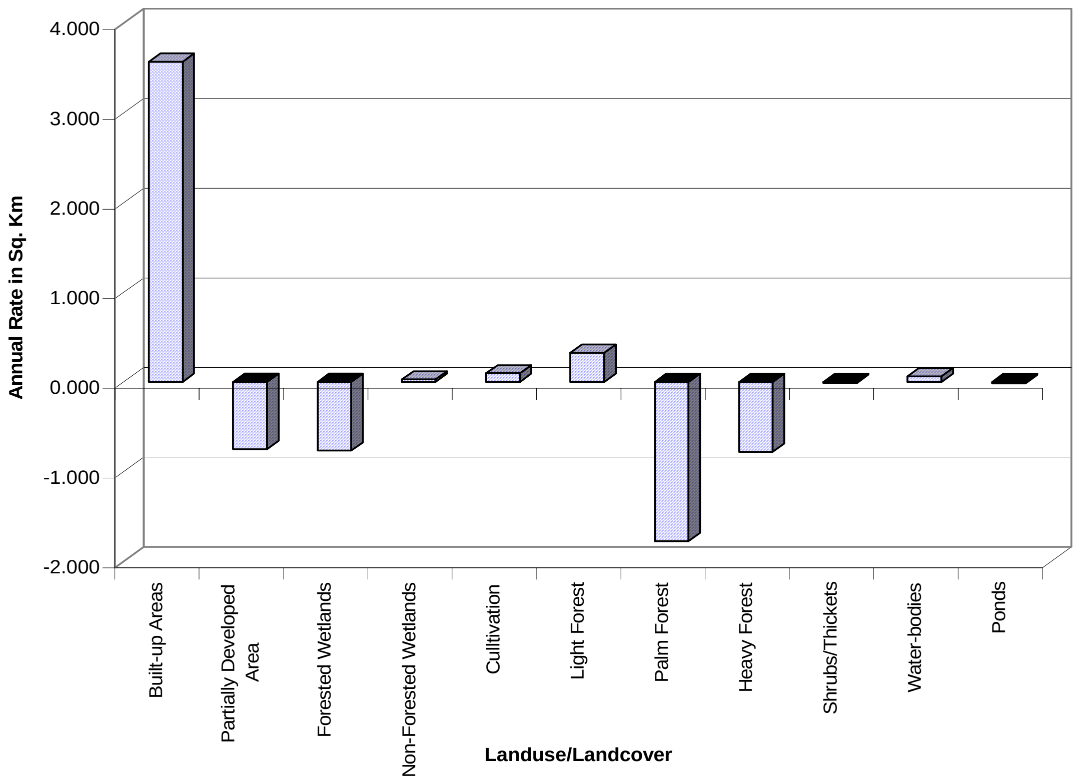


Fig. 4: Annual Rate of Change (1986-2000)

4.2.1.1: Changes in Cultivation and Wetlands: Trend and Rate

Table 5 above shows that the percentages of change for cultivation are -20.635% for 1986-1994, 7.502% for 1994-2000 and 1.188% for the period 1986-2000. On the other hand, the annual rates of change are -0.894 sq. km, 1.419 sq. km and 0.097 sq. km for the period 1986-1994, 1994-2000 and 1986-2000 respectively for cultivation.

Regarding wetlands, the forested wetlands recorded -10.358%, -6.290% and -9.359% as percentages of change during 1986-1994, 1994-2000 and 1986-2000 respectively. This shows that forested wetlands recorded only loss in terms of areal extent during the period under investigation. The annual rates of change for forested wetlands during 1986-1994 1994-2000 and 1986-2000 are -0.449 sq. km, -1.190 sq. km and -0.766 sq. km respectively.

Non-forested wetlands recorded -0.181%, 0.406% and 0.347% during the period 1986-1994, 1994-2000 and 1986-2000 respectively as percentages of change. This indicated that non-forested wetlands recorded loss in areal extent only during the period 1986-1994, while it recorded gain during 1994-2000 and an absolute gain in areal extent during the entire period under investigation (1986-2000). On the other hand, the annual rates of change for non-forested wetlands are -0.008 sq. km, 0.077 sq. km and 0.028 sq. km during the period 1986-1994, 1994-2000 and 1986-2000 respectively.

4.2.2: Changes in Landuse/Landcover: Nature

The nature of Landuse/Landcover change refers to the identification of 'what landuse/landcover is changing and from what to what?' Nature of landuse/landcover changes information helps in highlighting the spatial or locational stability of the landuse/landcover over time, also it reveal changes that are desirable or undesirable and the response of the resource base to management decisions (Adeniyi and Omojola, 1999). The nature of changes has been examined in this study in terms of (i) landuse/landcover stability (areas of landuse/landcover with no change; (ii) areas of landuse/landcover classes gained by other classes; and (iii) the areas of landuse/landcover classes lost to other classes. Losses to a class indicate an encroachment on that particular class at time t1 by other class(es) at time t2. In the same way, gain to a class is an emergence of that particular class on other class(es) at a later time; while no change areas indicate the spatially consistent or unchanged part of a particular landuse/landcover.

The statistics on nature of changes for the study area during the periods 1986-1994, 1994-2000 and 1986-2000 are presented on the change matrix tables (Table 6, 7 and 8) below.

Table 6: Landuse/Landcover change Matrix of the Study Area for 1986 and 1994

Landuse/Landcover (LULC)												
LULC	1994											Total (1986)
1986	BUA	PDA	FW	NFW	CU	LF	PF	HF	ST	RCL	PO	
BUA	29.91	0.01	0.00	0.00	0.13	0.00	0.36	0.00	0.20	0.93	0.00	31.55
PDA	1.02	7.91	0.00	0.00	0.33	0.07	0.94	0.00	0.00	0.14	0.07	10.49
FW	**1.12**	**0.84**	**61.60**	**0.86**	**1.06**	**0.53**	**1.01**	**0.00**	**0.00**	**1.15**	**0.11**	**68.28**
NFW	**0.42**	**0.83**	**0.45**	**1.89**	**0.13**	**0.00**	**0.06**	**0.00**	**0.00**	**0.01**	**0.18**	**3.97**
CU	**1.17**	**1.62**	**0.07**	**0.00**	**98.04**	**3.76**	**2.65**	**0.00**	**0.00**	**0.57**	**0.00**	**107.88**
LF	0.19	0.56	0.28	0.00	0.22	6.48	0.10	0.00	0.00	0.01	0.00	7.84
PF	0.13	0.12	1.01	0.25	0.71	7.99	51.23	0.00	0.00	1.00	0.54	62.99
HF	0.00	0.00	0.00	0.00	0.00	0.00	0.86	10.07	0.00	0.00	0.00	10.93
ST	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.18

RCL	0.32	0.21	**1.25**	**0.81**	**0.11**	0.85	0.01	0.00	0.00	86.50	0.00	90.06
PO	0.00	0.09	**0.03**	**0.10**	0.00	0.39	0.12	0.00	0.00	0.00	-0.33	0.41
Total (1994)	34.47	12.19	**64.69**	**3.91**	100.73	20.08	57.34	10.07	0.19	90.32	0.57	391.57

Source: GIS Analysis of Change Detection through Topological Overlay (Point by point Analysis) (2006

** The slight difference in the total is due to rounding errors.*

As shown in Table 6 above, in terms of stability, 29.91 sq. km, 7.91 sq. km, 6.48 sq. km, 51.23 sq. km, 10.07 sq. km and 86.50 sq. km were recorded as unchanged areas between 1986 and 1994 for built-up area, partially developed areas, light forest, palm forest, heavy forest and rivers/creeks/lagoon respectively. On the other hand, shrub/thickets, and ponds recorded negative figure of -0.01 sq. km and -0.33 sq. km respectively, which shows that they were completely unstable during the period (1986-1994). During this period, the LU/LC of this study area can be claimed to be stable as 353.29 sq. km (i.e. 90.32%) remained unchanged.

In terms of area gained, built-up area, partially developed areas, light forest, palm forest, shrub/thickets, rivers/creeks/lagoon and ponds recorded 4.56 sq. km (i.e. 9.55% of the total area gained, which is 47.75 sq. km), 4.28 sq. km (8.96%), 20.08 sq. km (42.05%), 6.11 sq. km (12.79%), 0.2 sq. km (0.42%), 3.81 sq. km (7.97%) and 0.9 sq. km (1.88%) respectively. Heavy forest however recorded 0%, meaning no gain in areal extent during the period.

Regarding loss, built-up area recorded 1.64 sq. km (representing 3.97% of the total area loss, which is 41.29 sq. km), while partially developed area recorded 2.58 sq. km (6.25%); light forest, palm forest, heavy forest and shrub/thickets recorded, 1.36 sq. km (3.29%), 11.76 sq. km (28.48%), 0.86 sq. km and 0.19 sq. km (0.46%) respectively; also rivers/creeks/lagoon and ponds recorded 3.56 sq. km (8.62%) and 0.74 sq. km (1.79%) respectively as loss during the period 1986-1994.

Table 7 below shows the statistics on nature of changes for the study area during the period 1994-2000.

Table 7: Landuse/Landcover change Matrix of the Study Area for 1994 and 2000

Landuse/Landcover (LULC)												
LULC	2000											Total (1994)
1994	BUA	PDA	**FW**	**NFW**	**CU**	LF	PF	HF	ST	RCL	PO	
BUA	26.32	0.00	**0.01**	**0.01**	**1.63**	0.00	3.14	0.00	0.02	3.35	0.00	34.47
PDA	9.30	0.00	**0.03**	**0.23**	**1.35**	0.00	0.94	0.00	0.00	0.35	0.00	12.20
FW	**10.31**	**0.00**	49.19	**0.41**	**1.87**	**0.43**	**1.22**	**0.00**	**0.00**	**1.07**	**0.19**	**64.69**
NFW	**2.12**	**0.00**	**1.31**	0.27	**0.07**	**0.00**	**0.11**	**0.00**	**0.00**	**0.03**	**0.00**	**3.91**
CU	**22.96**	**0.00**	**3.01**	**0.00**	71.94	**1.29**	**1.05**	**0.00**	**0.00**	**0.47**	**0.00**	**100.72**
LF	3.99	0.00	**0.98**	**0.00**	**10.05**	0.85	2.58	0.00	0.00	1.62	0.02	20.08
PF	3.39	0.00	**1.06**	**0.00**	**18.13**	2.93	25.81	0.00	0.00	6.02	0.00	57.34
HF	0.00	0.00	**0.00**	**0.00**	**0.00**	6.77	3.29	0.00	0.00	0.00	0.00	10.06
ST	0.17	0.00	**0.00**	**0.00**	**0.00**	0.00	0.00	0.00	0.02	0.00	0.00	0.19
RCL	2.81	0.00	**1.95**	**3.21**	**4.11**	0.16	0.01	0.00	0.00	74.51	0.00	86.77
PO	0.22	0.00	**0.02**	**0.24**	**0.09**	0.00	0.00	0.00	0.00	0.00	0.02	0.58
Total (2000)	81.59	0.00	**57.55**	**4.37**	**109.24**	12.43	38.14	0.00	0.04	87.43	0.22	391.01

Source: GIS Analysis of Change Detection through Topological Overlay (Point by point Analysis) (2006

In terms of stability, Table 7 above shows that 26.32 sq. km, 0.85 sq. km, 25.81 sq. km and 74.51 sq. km were recorded as unchanged areas between 1994 and 2000 for built-up area, light forest, palm forest, rivers/creeks/lagoon and ponds respectively. On the other hand, The LU/LC of this study area during this period (1994-2000), was relatively stable as 199.43 sq. km (i.e. 51.00%) remained unchanged.

Built-up area, light forest, palm forest, shrub/thickets, rivers/creeks/lagoon and ponds gained 55.27 sq. km (i.e. 38.90% of the total area gained, which is 142.08 sq. km), 11.58 sq. km (8.15%), 12.33 sq. km (8.68%), 0.02 sq. km (0.01%), 12.92 sq. km (9.09%) and 0.2 sq. km (0.14%) respectively. Partially developed areas and heavy forest recorded 0%, meaning no gain in areal extent during the period.

Regarding loss, built-up area recorded 8.15 sq. km (representing 5.81% of the total area loss, which is 140.08 sq. km), while partially developed area recorded 12.2 sq. km (8.71%); light forest, palm forest, heavy forest, shrub/thickets, rivers/creeks/lagoon and ponds recorded, 19.23 sq. km (13.73%), 31.53 sq. km (22.51%), 10.06 sq. km (7.18%), 0.17 sq. km (0.12%), 12.26 sq. km (8.75%)

and 0.56 sq. km (0.39%) respectively as loss during the period 1994-2000.

Table 8: Landuse/Landcover change Matrix of the Study Area for 1986 and 2000

Landuse/Landcover (LULC)												
LULC	2000											Total (1986)
1986	BUA	PDA	**FW**	**NFW**	**CU**	LF	PF	HF	ST	RCL	PO	
BUA	21.76	0.01	**0.01**	**0.01**	**1.76**	0.00	3.50	0.00	0.22	4.28	0.00	31.55
PDA	10.32	-4.29	**0.03**	**0.23**	**1.68**	0.07	1.88	0.00	0.00	0.49	0.07	10.49
FW	**11.43**	**0.84**	46.10	**1.27**	**2.93**	**0.96**	**2.23**	**0.00**	**0.00**	**2.22**	**0.30**	**68.28**
NFW	**2.54**	**0.83**	**1.76**	**-1.75**	**0.20**	**0.00**	**0.17**	**0.00**	**0.00**	**0.04**	**0.18**	**3.97**
CU	**24.13**	**1.62**	**3.08**	**0.00**	69.26	**5.05**	**3.70**	**0.00**	**0.00**	**1.04**	**0.00**	**107.88**
LF	4.18	0.56	**1.26**	**0.00**	**10.27**	-12.75	2.68	0.00	0.00	1.63	0.02	7.84
PF	3.52	0.12	**2.07**	**0.25**	**18.84**	10.92	19.70	0.00	0.00	7.02	0.54	62.99
HF	0.00	0.00	**0.00**	**0.00**	**0.00**	6.77	4.15	0.01	0.00	0.00	0.00	10.93
ST	0.35	0.00	**0.00**	**0.00**	**0.00**	0.00	0.00	0.00	-0.18	0.01	0.00	0.18
RCL	3.13	0.21	**3.20**	**4.02**	**4.22**	1.01	0.02	0.00	0.00	70.69	0.00	86.50
PO	0.22	0.09	**0.05**	**0.34**	**0.09**	0.39	0.12	0.00	0.00	0.00	-0.89	0.41
Total (2000)	81.58	-0.01	**57.56**	**4.37**	**109.25**	12.42	38.15	0.01	0.04	87.43	0.21	391.01

Source: GIS Analysis of Change Detection through Topological Overlay (Point by point Analysis) (2006

Regarding stability, Table 8 above shows that 21.76 sq. km, 69.26 sq. km, 19.70 sq. km, 0.01 sq. km and 70.69 sq. km were recorded as stable (or unchanged) areas between 1986 and 2000 for built-up area, cultivation, palm forest, heavy forest and rivers/creeks/lagoon respectively. On the other hand, partially developed area, non-forested wetlands, shrub/thickets and ponds recorded negative figure of -4.29 sq. km, -1.75 sq. km, -12.75 sq. km, -0.18 sq. km and -0.89 sq. km respectively, which shows that they were completely unstable during the period (1986-2000). During this period, the LU/LC of this study area can be claimed to be slightly stable as 207.66 sq. km (i.e. 52.94%) remained unchanged.

In terms of area gained, built-up area, cultivation, palm forest and rivers/creeks/lagoon recorded 59.82 sq. km (i.e. 41.13% of the total area gained, which is 149.08 sq. km), 39.99 sq. km (26.82%), 18.45 sq. km (12.38%) and 16.74 sq. km (11.23%) respectively.

Regarding loss, built-up area recorded 9.79 sq. km (representing 5.34% of the total area loss, which is 183.36 sq. km), while partially developed area recorded 14.78 sq. km (8.06%); cultivation, light forest, palm forest, heavy forest and shrub/thickets recorded 38.62 sq. km (21.06%), 20.59 sq. km (11.23%), 43.29 sq. km (23.60%), 10.92 sq. km (5.96%) and 0.36 sq. km (0.19%) respectively; also rivers/creeks/lagoon and ponds recorded 15.81 sq. km (8.24%) and 103 sq. km (0.71%) respectively as loss during the period 1986-2000.

4.2.2.1: Changes in Wetlands and Cultivation: Nature

During the period 1986-1994, table 6 above shows that forested wetlands and non-forested wetlands recorded 61.60 sq. km and 1.89 sq. km respectively as stable areas, which mean that 63.49 sq. km of wetlands within the study area remains unchanged during the period; while cultivation recorded 98.04 sq. km as stable area. On the other hand, forested wetlands and non-forested wetlands recorded 3.09 sq. km (that is, 6.47% of the total area gained by all the landuse/landcover within the study area in 1986-1994) and 2.02 sq. km (4.23%) respectively as area gained. However in totality, wetlands gained 5.11 sq. km, with forested wetlands recording 60.47% of this area gained by wetlands; while non-forested recorded 39.53%. Regarding area gained by cultivation, table 6 shows that 2.69 sq. km (5.63%) was recorded. In terms of loss, forested wetlands recorded 6.68 sq. km (representing 16.18% of the landuse/landcover loss within the study area during the period 1986-1994) and non-forested wetlands recorded 2.08 sq. km (5.04%). Hence, wetlands within the study area during 1986-1994 recorded 8.76 sq. km as loss, with forested wetlands recording 76.26% and non-forested wetlands recorded 23.74%. On the other hand, cultivation recorded 9.84 sq. km (23.83%).

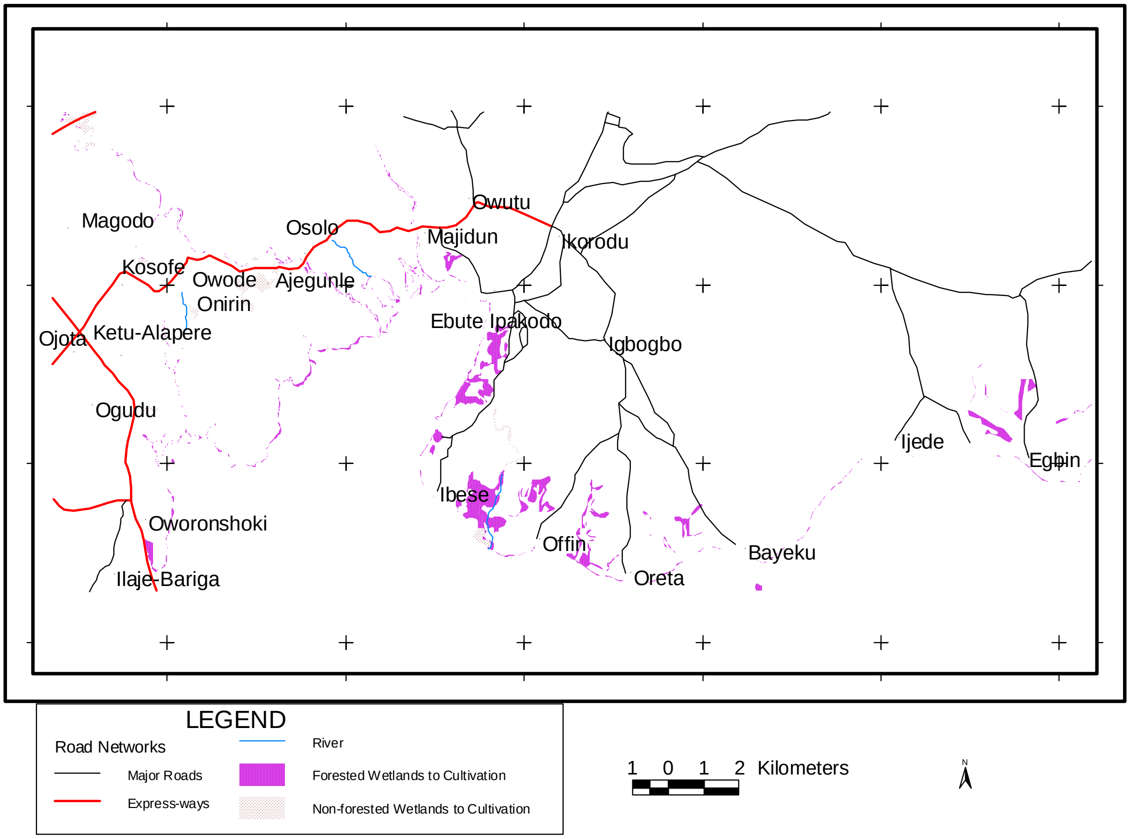
As shown in table 7 above, during the period 1994-2000, forested wetlands and non-forested wetlands recorded 49.19 sq. km and 0.27 sq. km respectively as stable areas. Thus, 49.46 sq. km of wetlands remains unchanged during the period 1994-2000; while cultivation recorded 71.94 sq. km Regarding gain, forested wetlands and non-forested wetlands recorded 8.36 sq. km (representing 5.88% of the study area total gained area during the period 1994-2000) and 4.1 sq. km (2.89%) respectively. Wetlands in totality recorded 12.46 sq. km (representing 8.77% of the total area gained by LU/LC within the study area during 1994-2000); with forested wetlands and non-forested wetlands contributing 67.09% and 32.91% respectively. The area gained by cultivation during this period was 37.3 sq. km (26.25%). In terms of loss, forested wetlands and non-forested wetlands recorded 15.50 sq. km (11.07% of the total area loss by LU/LC during the period 1994-2000) and 3.64 sq. km (2.59%) respectively. The total area recorded as loss by wetlands during the period 1994-2000 is 19.14 sq. km; with forested wetlands and non-forested wetlands accounting for 80.98%

and 19.02% respectively. Cultivation recorded 28.78 sq. km (20.55%) as loss between 1994 and 2000.

Forested wetlands recorded 46.10 sq. km as stable area during the period 1986-2000 as shown in table 8 above, while non-forested recorded -1.75 showing that it changed completely during the period; and cultivation recorded 69.26 sq. km as stable area during the period 1986 to 2000. On the other hand, 11.46 sq. km (representing 7.68% of the total area gained by LU/LC during 1986-2000) and 2.62 sq. km (1.76%) were recorded as gain during the period 1986-2000. In totality, wetlands recorded 13.65 sq. km as gain area during 1986-2000; with forested wetlands and non-forested wetlands contributing 81.03% and 18.97% respectively to the total area gained by wetlands. Cultivation recorded 39.99 sq. km (26.82%). Regarding loss, forested wetlands recorded 22.18 sq. km (representing 12.09% of the total area loss during 1986-2000), while non-forested wetlands recorded 5.72 sq. km (3.12%). Wetlands recorded 27.90 sq. km as area loss to other landuse/landcover during the period 1986-2000; while forested wetlands accounts for 79.5 % and non-forested accounts for 20.5%. The total loss recorded by cultivation during the period 1986 to 2000 was 38.62 sq. km (21.06%).

4.2.3: Changes in Wetlands and Cultivation: Location

As shown in Table 8 above, cultivation gain 2.93 sq. km and 0.20 sq. km from forested and non-forested wetlands respectively during the period 1986 to 2000; in addition, field observation indicated that the trend is on the increase. Thus, this section shows the map of the location (area) where cultivation has recorded gain from wetlands (see map 6 below).



Map 6: Wetlands changed to Cultivation (Agricultural Uses)

CHAPTER FIVE

RESULT PRESENTATION AND ANALYSIS – SOCIO-ECONOMIC ASPECTS OF AGRICULTURAL ACTIVITIES ON WETLANDS

5.0: Introduction

Result derived from the various procedures applied in this research in the areas of socio-economic, products derived, roles of gender, nutritional values of the products, and the health implications of cultivating wetlands for food crops production are presented in this section.

5.1: Socio-economic Results

(1) Gender composition of Farmers

The gender composition of farmers recorded in the five farming communities where wetlands are being use for agricultural purposes is presented below in Figure 5. The results shows that in Ibese and Ajegunle men dominated with 6 (60%) in Ibese and 7 (70%) in Ajegunle; while in Alapere and Majidun they have equal ratio of men and women as farmers.

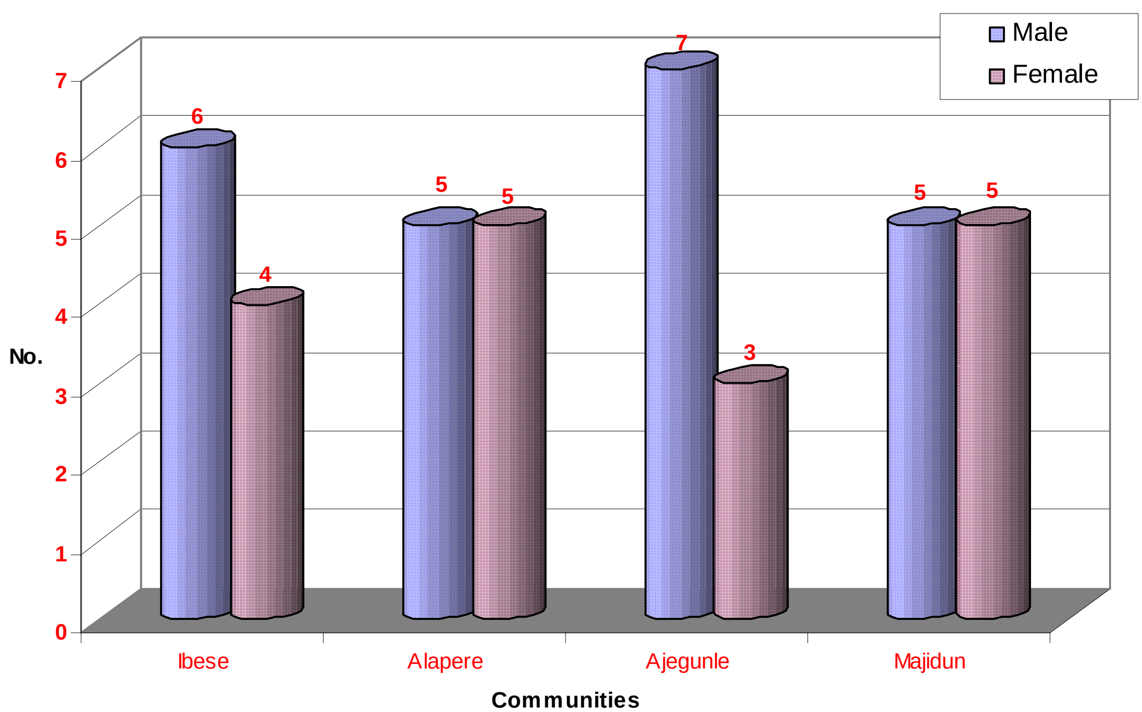


Figure 5: Gender Composition of Respondents (Farmers)

(2) Age of Farmers

The age distribution of farmers is presented below in Table 9 and graphically illustrated in Figure 6.

Table 9: Age Distribution of Farmers working on wetlands

Age groups	Ibese	Alapere	Ajegunle	Majidun
Less than 25	0	1	0	1
25 – 35	2	3	3	4
36 – 45	5	4	4	4
Above 45	3	2	3	1
Total	10	10	10	10

Source: Field work (2006)

As shown above, most of the farmers in Ibese (5), Alapere (4) and Ajegunle (4) falls within the age group 36 to 45 years of age; while the age group – less than 25 years of age also recorded the lowest in all the 3 communities. In Majidun, 25 – 35 and 36 – 45 years of age recorded 4 apiece and less than 25 and above 45 years of age also recorded 1 apiece.

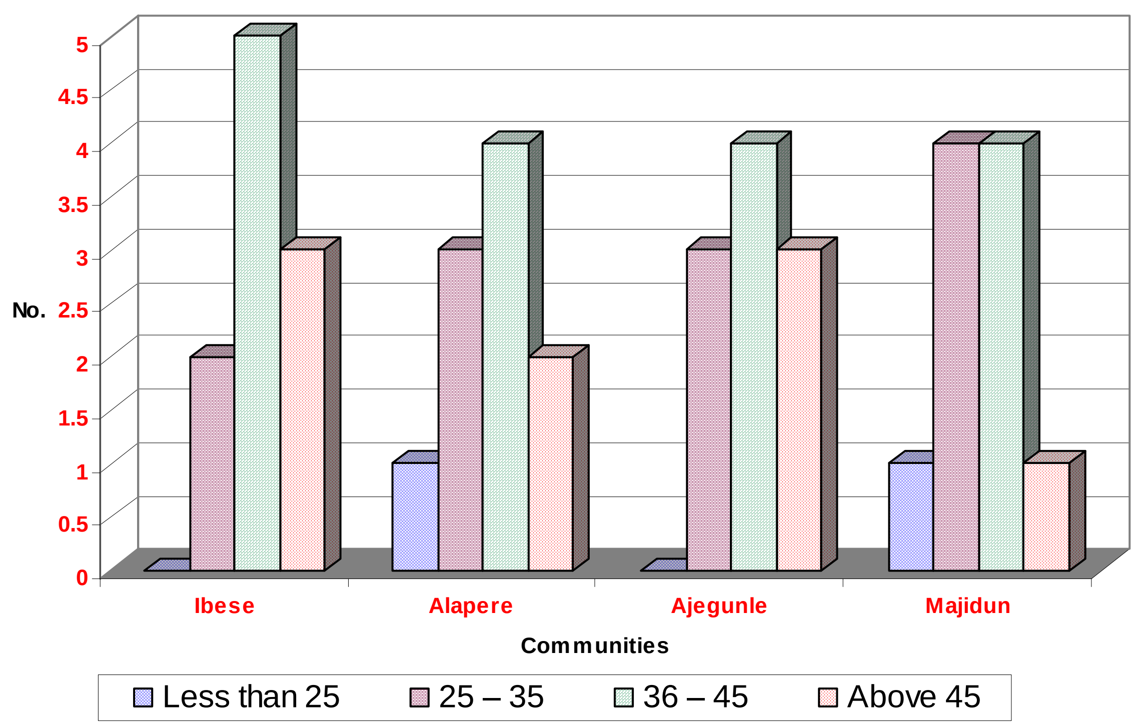


Figure 6: Age Distribution of Farmers cultivating wetlands

(3) Ethnic Background of Farmers

Figure 7 below shows the ethnicities of the farmers in the 4 communities. The farmers of Hausa ethnic background dominates in Ibese (5) and Alapere (6); while the Yoruba farmers are the major farmers in Majidun (5) and in Ajegunle the Hausa (5) and the Yoruba (5) farmers are equal.

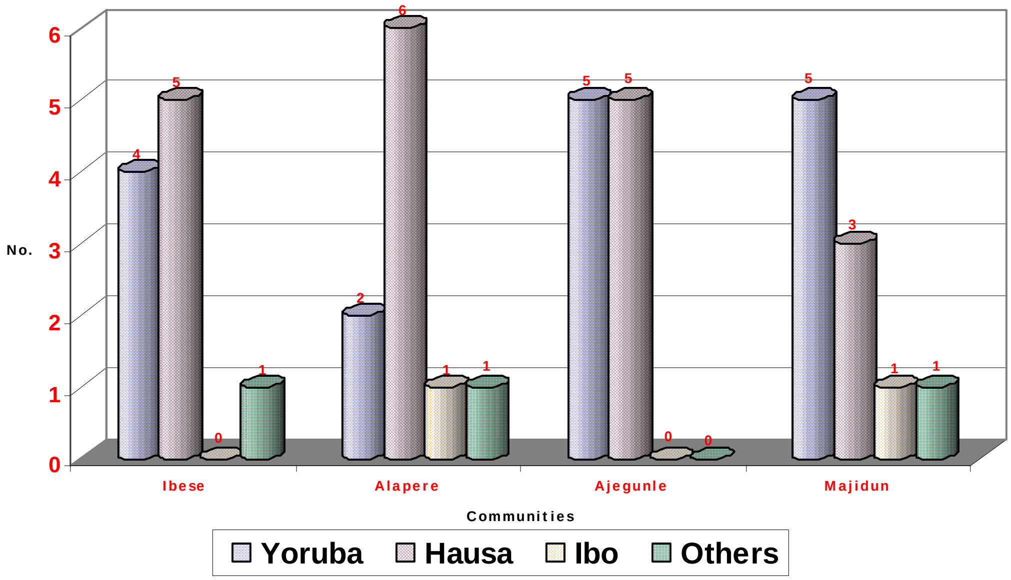


Figure 7: Ethnic Background of Farmers

(4) Occupations

(i) Main (Primary) Occupations: The main sources of income in terms of primary or main occupations were examined and the result is presented below in Table 10 and graphically illustrated in Figure 8.

Table 10: Main (Primary) Occupations of Farmers

Occupations	Ibese	Alapere	Ajegunle	Majidun	Total
Farming	2	5	2	5	14
Civil service	1	0	1	0	2
Craft-work	3	1	2	2	8
Self employed	1	0	1	1	3
Private Organization	0	1	1	0	2
Trading	2	2	1	0	5
House-wife	1	2	1	2	6
Total	10	10	10	10	40

Source: Field work (2006)

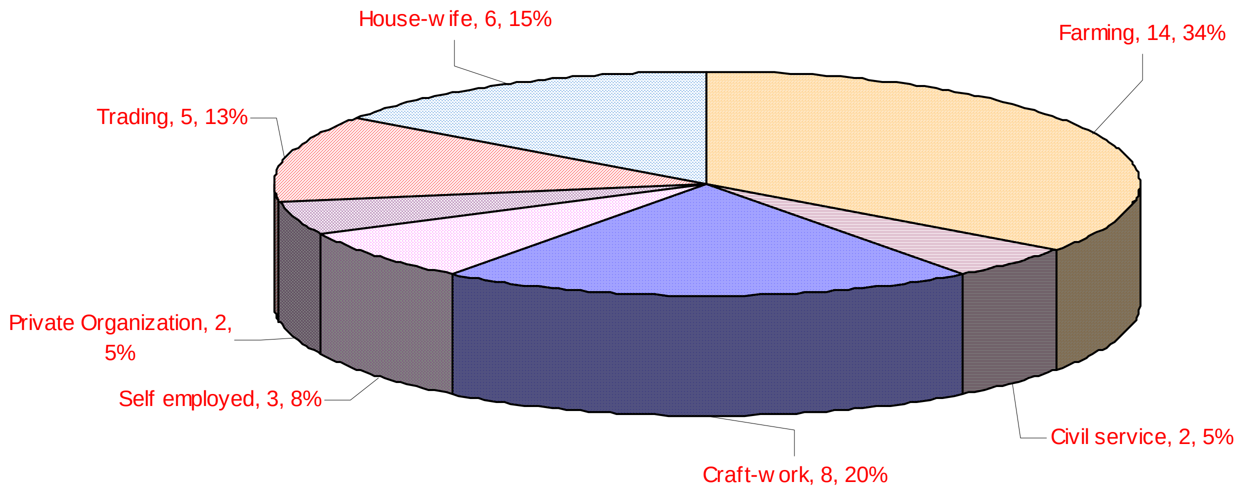


Figure 8: Main (Primary) Occupations of Farmers

As shown above, 34% of the farmers are into farming as their main occupation and source of income, while 20% are into craftwork as their main occupation, 15% are full time housewife, 13% are into trading, 8% are self employed and only 5% apiece are into private organization and civil service.

(ii) Secondary Occupations

The result shows that 66% of the farmers are into crop cultivation on wetlands on part-time base just to supplement their main sources of income; while 9 (65%) of those farmers that into farming on wetlands as their main occupation have no other occupation, 2 (14%) are into trading and 3 (21%) are into security work (which they do at night).

(5) Income

The average monthly income of the farmers is presented below in Table 11 and graphically depicted in Figure 9.

Table 11: Average Monthly Income of Farmers in Local Currency - Naira

Income Class (in Naira)	Ibese	Alapere	Ajegunle	Majidun	Total
Less than 10,000	4	5	4	3	16
10,000 – 20,000	3	3	3	5	14
21,000 – 30,000	2	2	1	2	7
31,000 – 40,000	1	0	1	0	2
Above 40,000	0	0	1	0	1
Total	10	10	10	10	40

Source: Field work (2006)

Note: N120 = $1

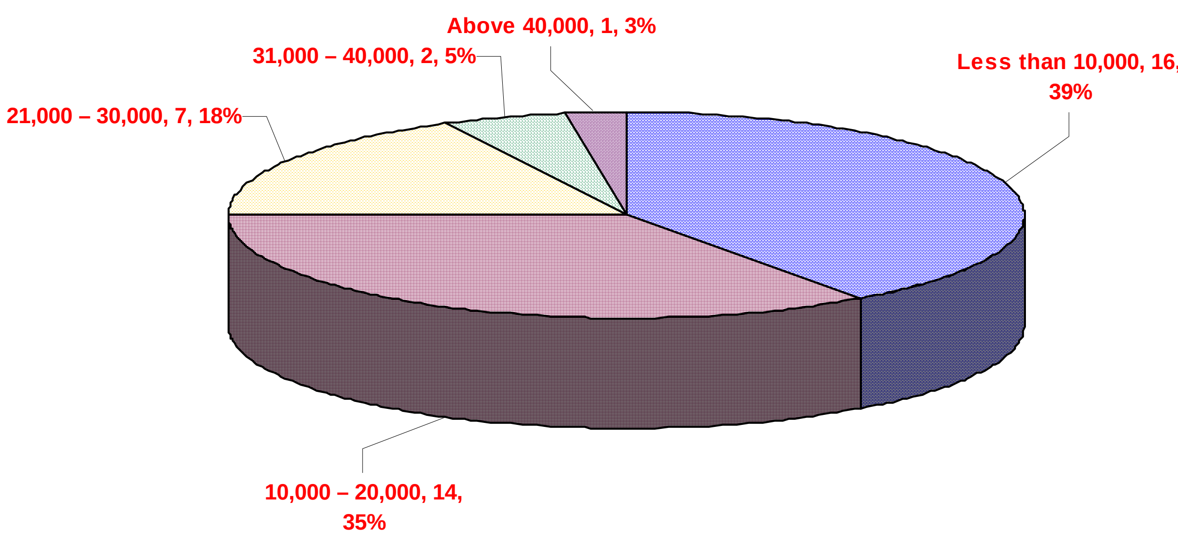


Figure 9: Average Monthly Income of Farmers (in Naira)

Table 11 above shows that 16 (39%) of the farmers earns less than N10,000 per month, 14 (35%) earn between N10,000 and N20,000 per month; while 7 (18%), 2 (5%) and 1 (3%) generates between N21,000 – N30,000, N31,000 – N40,000 and above N40,000 respectively.

(6) Educational Qualification

The research shows that 9 (22.5%) of the farmers have no formal education, 12 (30%) have primary school education, 5 (12.5%) have some secondary school education; while 14 (35%) have secondary school education.

5.2: Agricultural Activities

(1) Reasons for Farming

The reasons given for being involved in farming in and around wetlands varies and this is presented below in Table 12 and illustrated graphically in Figure 10.

Table 12: Reasons for Farming in and around wetlands

Reasons	Ibese	Alapere	Ajegunle	Majidun	Total
Recreation	1	1	0	1	3
Main Occupation	2	5	2	5	14
To supplement income	4	3	3	2	12
To supplement food supply to family	3	1	5	2	11
Total	10	10	10	10	40

Source: Field work (2006)

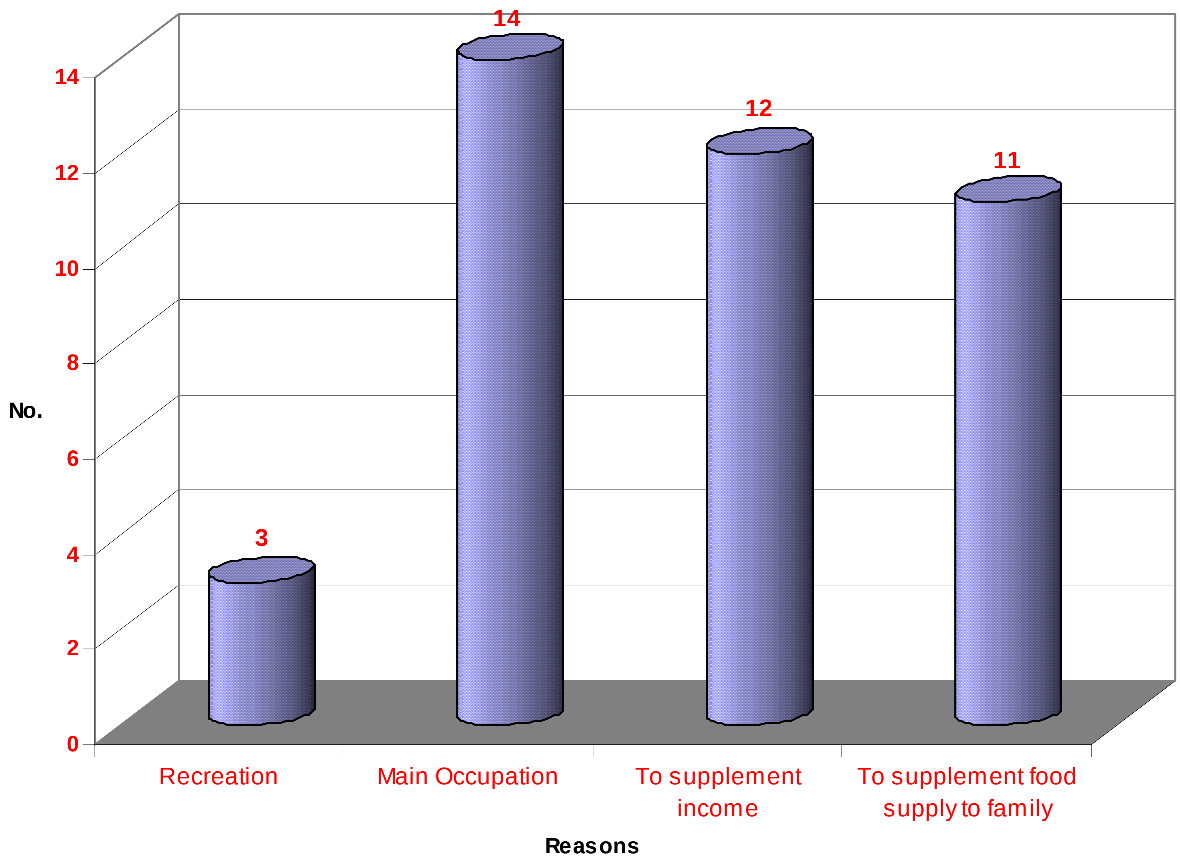


Figure 10: Reasons for Farming

As shown above, in the study area the highest reason given for being involved in farming in and around wetlands was as the main source of income (primary occupation) - 14 (34%) and this is followed by to supplement income – 12 (30%), to supplement food supply to the family recorded 11 (27.5%), and recreation recorded the lowest with only 3 (7.5%). During the focus group discussion, one of the farmers in Majidun remarked that: "***farming on this land you call wetland is very difficult and most of us are into it because we need money for our daily needs. As you know unemployment is very high in Nigeria now."*** Thus, most of the reasons given are more of economic gains.

(2) Seasons of Cultivation

Cultivation activities are done during the two seasons of dry and wet seasons by all the farmers interviewed. However, cultivation in and around wetlands are mostly done in an intensive way with water from the wetlands providing the needed water for the crops. Table 12 below shows the average numbers of wetlands under cultivation during the two seasons.

Table 12: Average Numbers of wetland Plot cultivated by a Farmer due the two seasons

	Ibese		Alapere		Ajegunle		Majidun	
Number of Plots	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season
Less than 1	4	7	2	5	2	4	4	4
1	5	3	4	4	3	5	5	6
2- 3	1	0	3	1	5	1	1	0
Above 3	0	0	1	0	0	0	0	0
Total	10	10	10	10	10	10	10	10

Source: Field work (2006)

As shown above, in Ibese 4 of the farmers indicated that they usually cultivate less that a plot of wetland due the dry season, while in wet season 7 indicated cultivating less than 1 plot. 5 farmers indicated using 1 plot of wetland during the dry season, 3 during the wet season; while 1 farmer indicated using 2 – 3 plots of wetland during the dry season. In Alapere, 2 farmers indicated using less than 1 plot of wetland during dry season, 5 indicated using less than 1 plot during wet season. 4 farmers apiece indicated using 1 plot of wetland during both wet and dry seasons respectively; while 3 farmers remarked that they uses 2 – 3 plots of wetland during dry season and only 1 during wet season. Only 1 farmer indicated using above 3 plots of wetlands during the dry season in Alapere. In Ajegunle, 5 farmers indicated using 2 -3 plots of wetlands during dry season, 1 plot recorded 3 farmers, and less than 1 plot recorded 2 farmers during dry season in Ajegunle; while during the wet season, 5 farmers indicated using 1 plot, 4 uses less than 1 plot and 1 uses 2 – 3 plots. During the dry season in Majidun, 5 farmers indicated using 1 plot of wetland, 4 uses less than 1 plot, and 1 uses 2 – 3 plots of wetlands. In Majidun during the wet season 6 farmers indicated using 1 plot of wetland, while 4 uses less than 1 plot. In general, the average number of plots of wetlands cultivated by most of the farmers during the dry season is 1 and less than 1 during the wet season.

(3) Type of cropping system

All the farmers indicated mixed cropping agricultural system where-in they plant a numbers of crops on the same plot together. They all however indicated using rudiment farmer tools such as cutlass, hoe, watering can and other handy tools. None of the farmers uses mechanized farming tools. In addition, 6 (15%) indicated that their farming products are only for subsistent and family use; while 46 (85%) indicated selling their products to generate income needed by them and their family members.

(4) Roles of Women in the farming activities

Women are involved in all stages of farming in the study area except in clearing of a vegetated wetlands for farming (the female farmers indicated that they usually engaged the service of labor to clear a vegetated wetlands). However, most of the selling is being done by the women farmers and wives of the male farmers at the local markets near or on the farms.

In terms of farm ownership, Table 13 below shows the numbers of women farmers interviewed that owns their farms and those working on farms that belong to their husbands.

Table 13: Farm Ownership Status of Women Farmers

	Ibese		Alapere		Ajegunle		Majidun		Total	
Status	F	%	F	%	F	%	F	%	F	%
Owner	3	75	4	80	3	100	3	60	13	76.5
Assisting Partner	1	25	1	20	0	0	2	40	4	23.5
Total	4	100	5	100	3	100	5	100	17	100

Source: Field work (2006)

Table 13 above shows that 13 (76.5%) of the 17 women farmers interviewed owns their farms, while only 4 (23.5%) are only on the farm to assist their partners (husbands).

(5) Types of crops produced

Most of the farmers – 31 (77.5) indicated producing main vegetables; while 9 (22.5%) indicated producing vegetables along with grain – maize during the two seasons, while cassava is produced only once in a year where-in harvest is done mostly during the dry season. The vegetables produced include both exotic and local varies, and the following are the vegetables listed as being produced in the study area: **Exotic -** *Lettuce, Radish, India spinage, Spring onions, Garden egg, Aloe Vera, Green pepper and Parsley*; **Local -** *Ewedu C Oliferus, Okra, Tomatoes, Bitter leaf, Water leaf, Fluted pumpkin, Amaranth spp and Eweroko (Ugu leaf).*

Table 14 below shows the types of vegetables produced by the farmers and illustrated graphically in Figure 11 below.

Table 14: Types of Vegetables Produced by Farmers

Types of Vegetable	Ibese		Alapere		Ajegunle		Majidun		Total	
	F	%	F	%	F	%	F	%	F	%
Exotic	1	10	4	40	3	30	2	20	10	25
Local	7	60	3	30	2	20	2	20	14	35
Exotic & Local	2	30	3	30	5	50	6	60	16	40
Total	10	100	10	100	10	100	10	100	40	100

Source: Field work (2006)

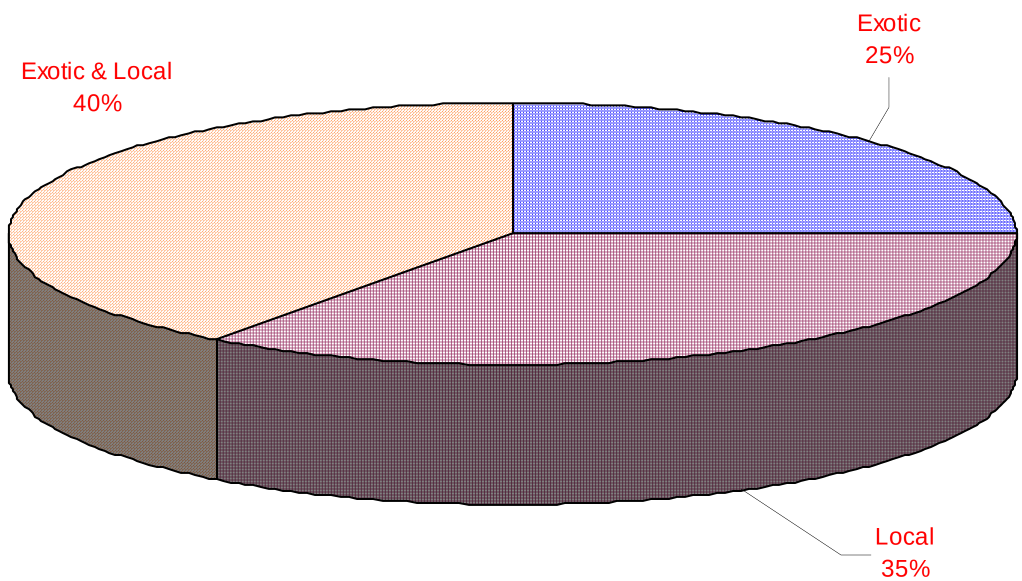


Figure 11: Types of Vegetable Produced by Farmers

As shown above, 40% of the farmers indicated producing both exotic and local vegetables; 35% produces only local vegetables and 25% produces only exotic vegetables.

However, the respond from the local inhabitants shows that all these listed are edible except Aloe Vera that they stated is mainly for medicinal use.

(6) The average yields of the farmer

The average quantity of yield per plot under cultivation was estimated by the farmers using empty bag of 50kg fertilizer. Table 15 shows the estimated units of the bags produced annually by a farmer per plot of cultivated wetlands and this is illustrated graphically in Figure 12.

Table 15: Estimated average quantity of Vegetables Produced by Farmers per plot (using empty 50kg fertilizer bag as unit of measurement)

No. of Bags	Ibese		Alapere		Ajegunle		Majidun		Total	
	F	%	F	%	F	%	F	%	F	%
Less than 20	0	0	1	10	3	30	1	10	5	12.5
20 - 40	4	40	5	50	5	50	6	60	20	50
41 - 60	4	40	3	30	2	20	3	30	12	30
Above 60	2	20	1	10	0	0	0	0	3	7.5
Total	10	100	10	100	10	100	10	100	40	100

Source: Field work (2006)

As shown above, 20 (50%) of the farmers indicated generating 20 – 40 bags of empty 50kg fertilizer bags annually from 1 plot of converted wetlands; while 12 (30%) indicated producing 41 – 60 bags, 5 (12.5%) indicated less than 20 bags, and only 3 (7.5%) indicated above 60 bags of vegetable from 1 plot of converted wetlands.

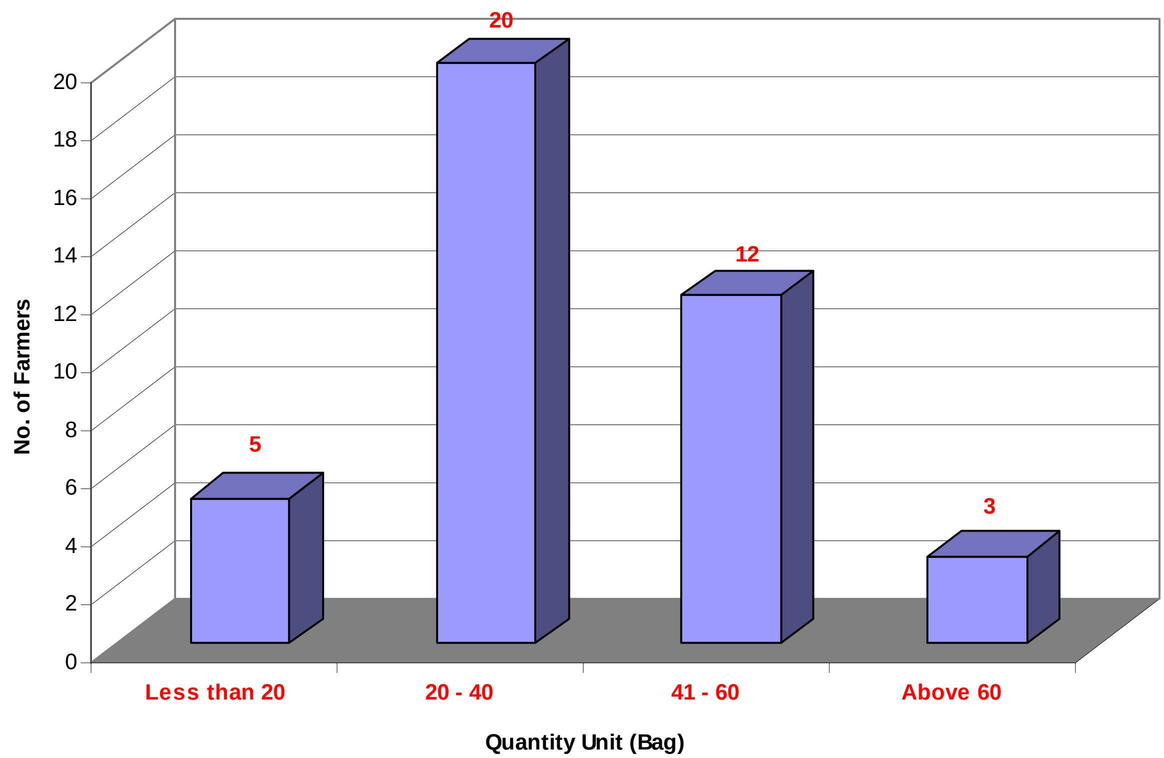


Figure 12: Quantities of Yield Produced annually per plot

(7) Income generated

The average annual income per plot generated from the farms by the farmers was estimated and presented below in Table 16 and graphically illustrated in Figure 13.

Table 15: Estimated average annual income generated by Farmers per plot (in Naira)

Income	Ibese		Alapere		Ajegunle		Majidun		Total	
	F	%	F	%	F	%	F	%	F	%
Less than N50,00	1	10	0	0	1	10	0	0	2	5
N50,000 – N100,000	3	30	2	20	2	20	3	30	10	25
N100,001 – N200,000	4	40	5	50	6	60	5	50	20	50
N200,001- N300,000	2	20	2	20	1	10	1	10	6	15
Above N300,000	0	0	1	10	0	0	1	10	2	5
Total	10	100	10	100	10	100	10	100	40	100

Source: Field work (2006)

Note: N120 = 1$

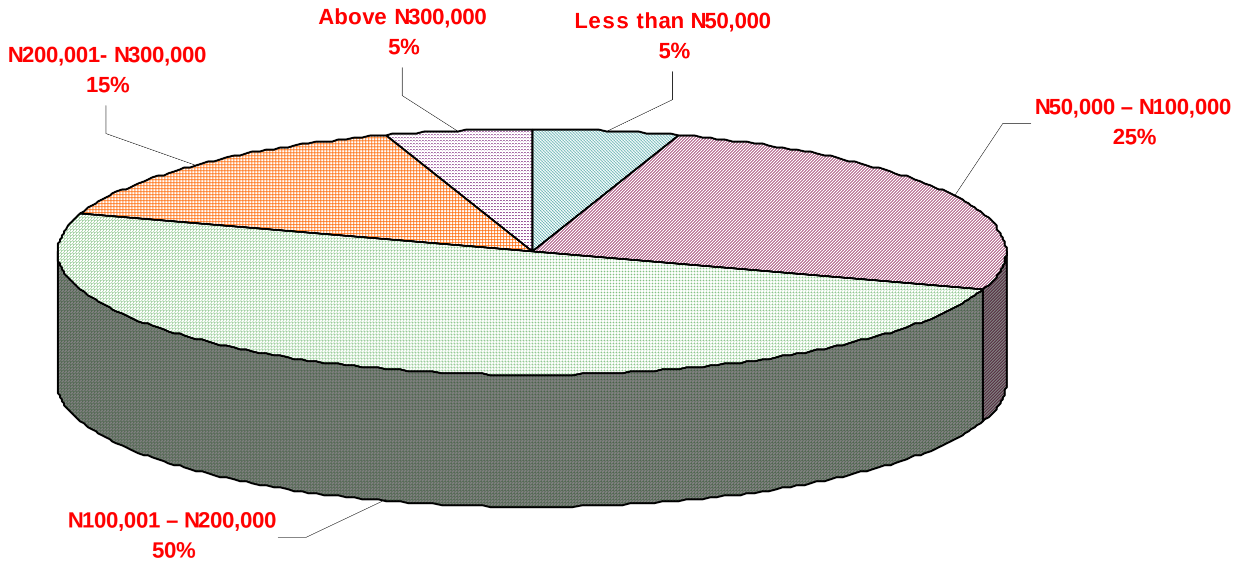


Figure 13: Income Generated by Farmers per plot of converted Wetlands

Table 15 shows that 20 (50%) of the farmers indicated generating N100,001 – N200,000 annually from a plot, 10 (25%) earns N50,000 – N100,000; while 2 (5%) apiece indicated less than N50,000 and above N300,000 respectively, and 6 (15%) indicated N200,001 – N300,000.

(8) Benefits derived from farming on the wetlands

(i) By the general public: The research indicated that most (71 [59.2%]) of the inhabitants believed that farming on wetlands has provide them access to fresh and affordable vegetable that is readily available. While 22 (18.3%) indicated that it has led to decrease in presence of mosquitoes in their areas, and 27 (22.5%) stated that it has provides employment opportunities to the unemployed people thus improving their economic status in the communities. Generally, this shows that most inhabitants viewed cultivation of wetlands from food security point of view; followed by those that examined it from economic point, that is, as a means of alleviating poverty in their communities; while the rest considered the benefits from the health gain point of view.

(ii) By the Farmers: Most of the farmers (32 [80%)) indicated that the main benefit they derived from farming on wetlands was that their economic situations has been enhanced, as a kind of poverty alleviation; others (8 [20%]) ranked provision of stable and fresh vegetables for their family in-take as the main benefit they derived. In other words, economic gains in terms of poverty alleviation ranked first followed by food security, which health gain was not mentioned by the farmers.

5.3: Nutritional Values of products

The nutritional content and values analysis was conducted by a food scientist in the department of food technology University of Agriculture, Abeokuta, Nigeria. Samples of the main agricultural products from the study area were given for laboratory analysis and these were mainly vegetables and maize. The result is presented below in Table 16.

Table 16: Nutritional Contents and values of Agricultural Products from the converted wetlands

S/N	Agricultural Products	Major Nutritional Contents and Values (in 50 grams)
1	Lettuce	Vitamin A (6400 IU), Vitamin A (370 mcg_RAE), Vitamin C (18 mg), Vitamin K (173.6 mcg), Carotene (4443 mcg), Calcium (36 mg), Iron (0.86 mg), Water (95.07 g), Protein (1.36 g), Carbohydrate (2.79 g), Potassium (194 mg), Sodium (28 mg), Phosphorus (29 mg).
2	India spinage	Vitamin A (6200 IU), Vitamin A (297 mcg_RAE), Carotene (3200 mcg), Vitamin K (82.7 mcg), Vitamin C (25.2 mg), Water (101 g), Carbohydrate (1.65 g), Potassium (176 mg), Phosphorus (31 mg), Calcium (44 mg), Sodium (12 mg), (Iron (1.8 mg).
3	Spring onions	Potassium (260 mg), Phosphorus (33 mg), Calcium (61 mg), Vitamin A (4000 IU), Vitamin A (200 mcg_RAE), Carotene (2400 mcg), Vitamin K (22.7 mcg), Vitamin C (45.6 mg), Lutein (916 mcg), Water (91.8 g), Carbohydrate (5.65 g), Sodium (4 mg), (Iron (1.92 mg).
4	Garden egg	Vitamin A (4300 IU), Vitamin A (220 mcg_RAE), Vitamin C (16 mg), Vitamin K (100.12 mcg), Carotene (2750 mcg), Calcium (22 mg), Iron (2.11 mg), Water (79.02 g), Protein (2.03 g), Carbohydrate (1.91 g), Potassium (145 mg), Sodium (21 mg), Phosphorus (19 mg).
5	Tomatoes	Protein (1.16 g), Vitamin A (75 mcg_RAE), Vitamin A (1490

		IU), Magnesium (7 mg), Potassium (200 mg), Calcium (3 mg), Sodium (40 mg), Water (84.75 g), Carbohydrate (2.27 g), Phytosterols (4 mg)
6	Eweroko (Ugu leaf)	Protein (5.22 g), Vitamin A (95 mcg_RAE), Vitamin A (1300 IU), Magnesium (2 mg), Potassium (110 mg), Calcium (4 mg), Sodium (21 mg), Iron (1.53 mg), Water (79.54 g).
7	Maize	Potassium (125.6 mg), Phosphorus (143.8 mg), Calcium (22.3 mg), Magnesium (10.6 mg), Iron (3.67 mg), Sodium (18.4 mg), Copper (0.9 mg), Zinc (2.3 mg), Protein (9.7 mg), Carbohydrate (69.35 g)

Source: Nutritional Analysis (2006)

As shown in Table 16 above, the analyzed vegetables mostly contain vitamins (A, C and K), along with some other nutrients notable among which include potassium, calcium, water and iron. Maize, on the other hand contains more of carbohydrate.

CHAPTER SIX

RESULT PRESENTATION AND ANALYSIS – HEALTH IMPLICATIONS OF AGRICULTURAL ACTIVITIES ON WETLANDS

6.0: Introduction

This section highlights the health situation (period and point health conditions) of the farmers, the identified health problems of the communities, the frequency of disease attacks, the changes in vectors as a result of farming on wetlands, and the general health implications of agricultural activities on wetlands (on the inhabitants of the study area and the farmers).

6.1: Health Implications of converting wetlands for cultivation (Agricultural purposes)

(1) Health Situation of the Communities

(i) The Communities period diseases prevalence: The major diseases of the study area were examined from the questionnaire administered on the inhabitants and the farmers. Table 17 below shows the major diseases mentioned by the respondents as common diseases of the communities and graphically illustrated in Figure 14.

Table 17: The major diseases of the communities

Diseases	Ibese		Alapere		Ajegunle		Majidun		Total	
	F	%	F	%	F	%	F	%	F	%
Malaria	21	10	18	0	17	10	20	0	76	63.3
Intestinal diseases	2	30	3	20	4	20	3	30	12	10
Typhoid fever	4	40	6	50	6	60	5	50	21	17.5
Malnutrition	2	20	1	20	0	10	1	10	4	3.3
Skin diseases	1	0	2	10	3	0	1	10	7	5.9
Total	30	100	30	100	30	100	30	100	120	100

Source: Field work (2006)

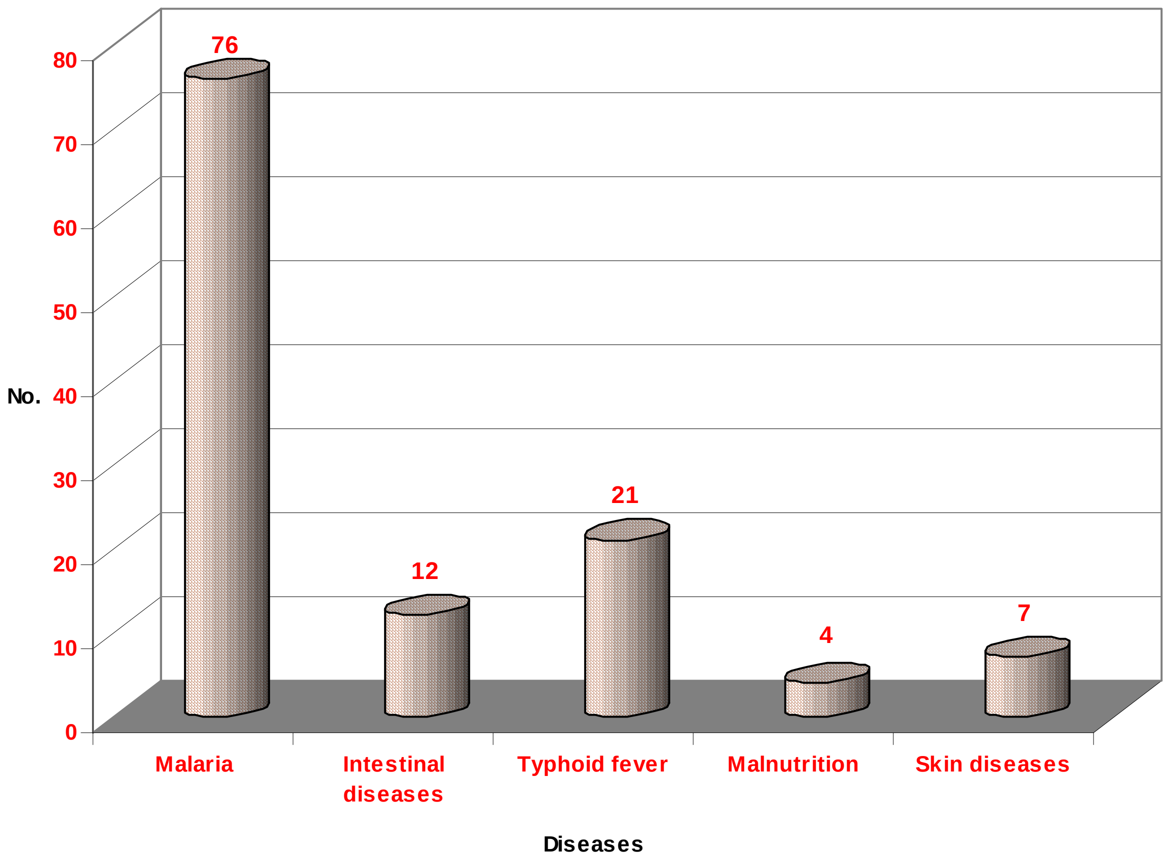


Figure 14: The major diseases of the study area

As depicted above, malaria was indicated as the major disease of the study area b 76 (63.3%), followed by typhoid fever that recorded 21 (17.5%), intestinal diseases was indicated by 12 (10%), while skin diseases and malnutrition were indicated by 7 (5.9%) and 4 (3.3%) of the respondents respectively.

When asked about the disease(s) the respondents have had in the last three months, their respond is presented below in Table 18 and illustrated graphically in Figure 15.

Table 18: The diseases had by the respondents' in the last three months

Diseases	Ibese		Alapere		Ajegunle		Majidun		Total	
	F	%	F	%	F	%	F	%	F	%
Malaria	26	86.7	21	70	18	60	17	56.7	82	68.3
Intestinal diseases	1	3.3	4	13.3	2	6.7	1	3.3	8	6.7
Typhoid fever	1	3.3	1	0.8	1	3.3	3	10	6	5
Malnutrition	0	0	0	0	0	0	0	0	0	0

Skin diseases	0	0	1	0.8	0	0	2	6.7	3	2.5
None	2	6.7	3	2.5	9	30	7	23.3	21	17.5
Total	30	100	30	100	30	100	30	100	120	100

Source: Field work (2006)

Table 18 above depicted that most of the respondents – 82 (63.3%) indicated malaria as the disease they have had in the last three months, this is followed by those that indicated none – 21 (17.5%), while typhoid fever and skin diseases recorded 8 (6.7%) and 6 (5%) respectively; and malnutrition was indicated by none.

For the farmers, the diseases indicated by them as diseases they have had in the last three months is presented below in Table 19 and graphically depicted in Figure 16.

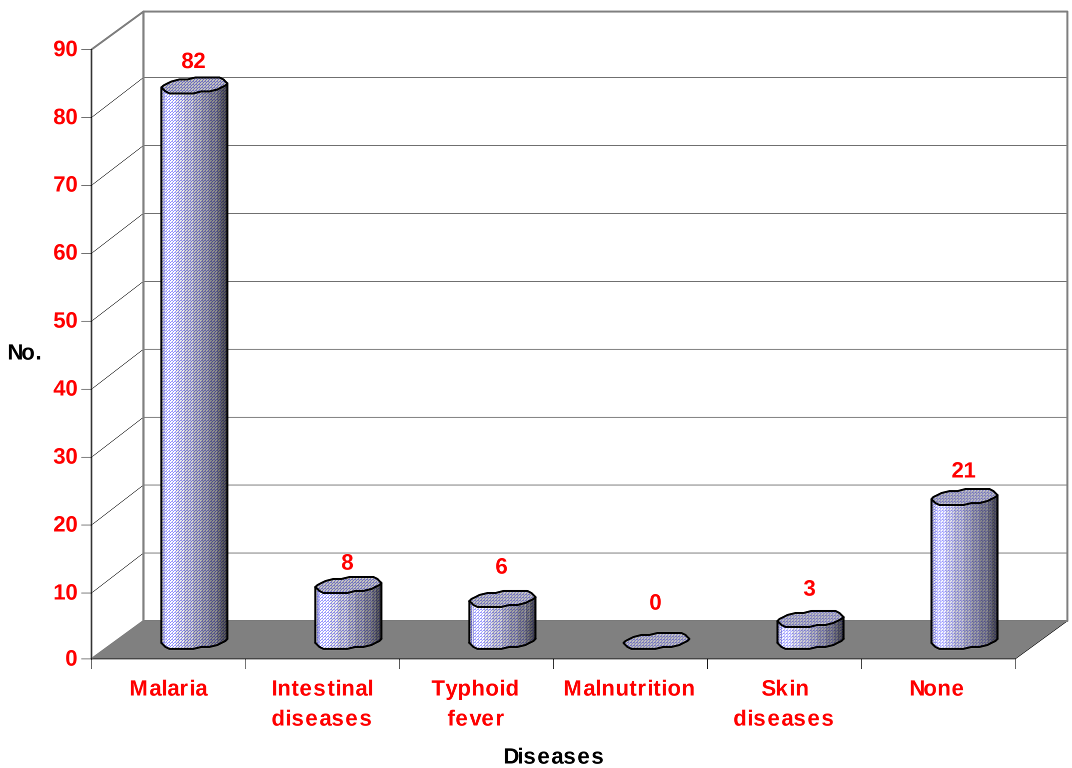


Figure 15: The Major diseases of the respondents in the last three months

Table 19: The diseases had by the Farmers' in the last three months

Diseases	Ibese		Alapere		Ajegunle		Majidun		Total	
	F	%	F	%	F	%	F	%	F	%
Malaria	7	70	5	50	6	60	7	70	25	62.5
Intestinal diseases	1	10	3	30	1	10	2	20	7	17.5
Typhoid fever	1	10	0	0	1	10	0	0	2	5
Malnutrition	0	0	0	0	0	0	0	0	0	0
Skin diseases	1	10	1	10	1	10	0	0	3	7.5
None	0	0	1	10	1	10	1	10	3	7.5
Total	10	100	10	100	10	100	10	100	40	100

Source: Field work (2006)

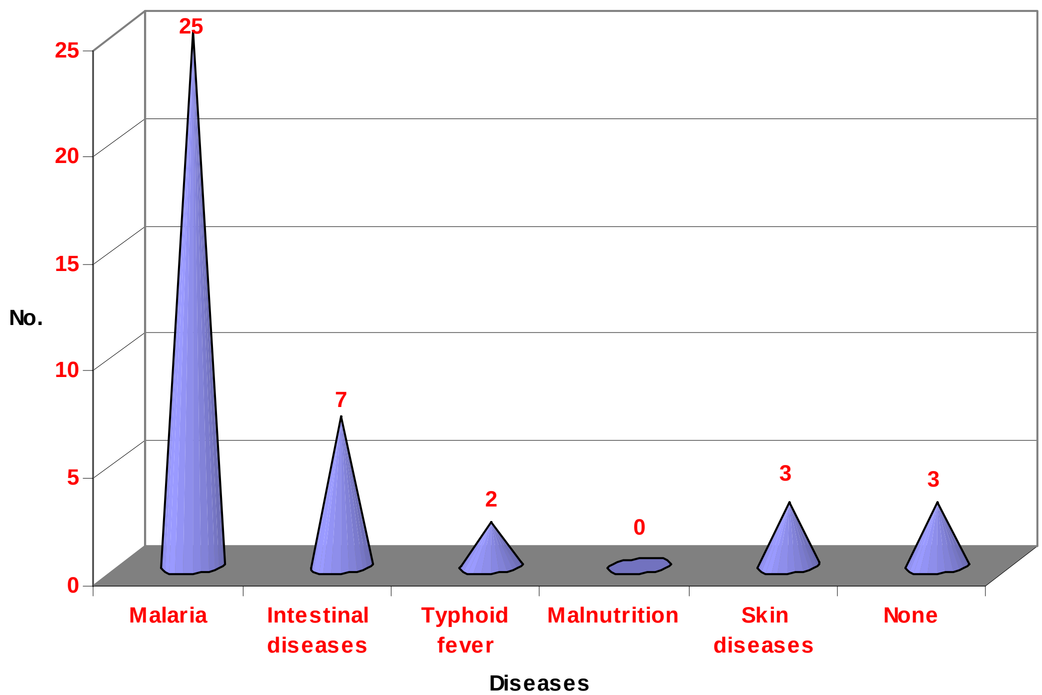


Figure 16: Major diseases had in the last three months by Farmers

As shown in Table 19, a large numbers of the farmers have had malaria in the last three months – 25 (62.5%); while 7 (17.5%) had intestinal diseases, 2 (5%) had typhoid fever and 3 apiece indicated skin diseases and none respectively. From the results it can be noted that malaria is the major disease that the inhabitants and farmers of the study area are facing in their communities.

The frequency of having disease attack or showing symptoms of disease was examined among the farmers and the result in presented below in Table 20 and in Figure 17.

Table 20: The frequency of diseases attack by the Farmers' in the last three months

Frequency of disease attack	Ibese		Alapere		Ajegunle		Majidun		Total	
	F	%	F	%	F	%	F	%	F	%
Once a month	3	30	1	10	2	20	2	20	8	20
Twice in a month	2	20	1	10	2	20	1	10	6	15
Once in the last 3 months	4	40	4	40	4	40	4	40	16	40
Twice in the last 3 months	1	10	3	30	1	10	2	20	7	17.5
None in the last 3 months	0	0	1	10	1	10	1	10	3	7.5
Total	10	100	10	100	10	100	10	100	40	100

Source: Field work (2006)

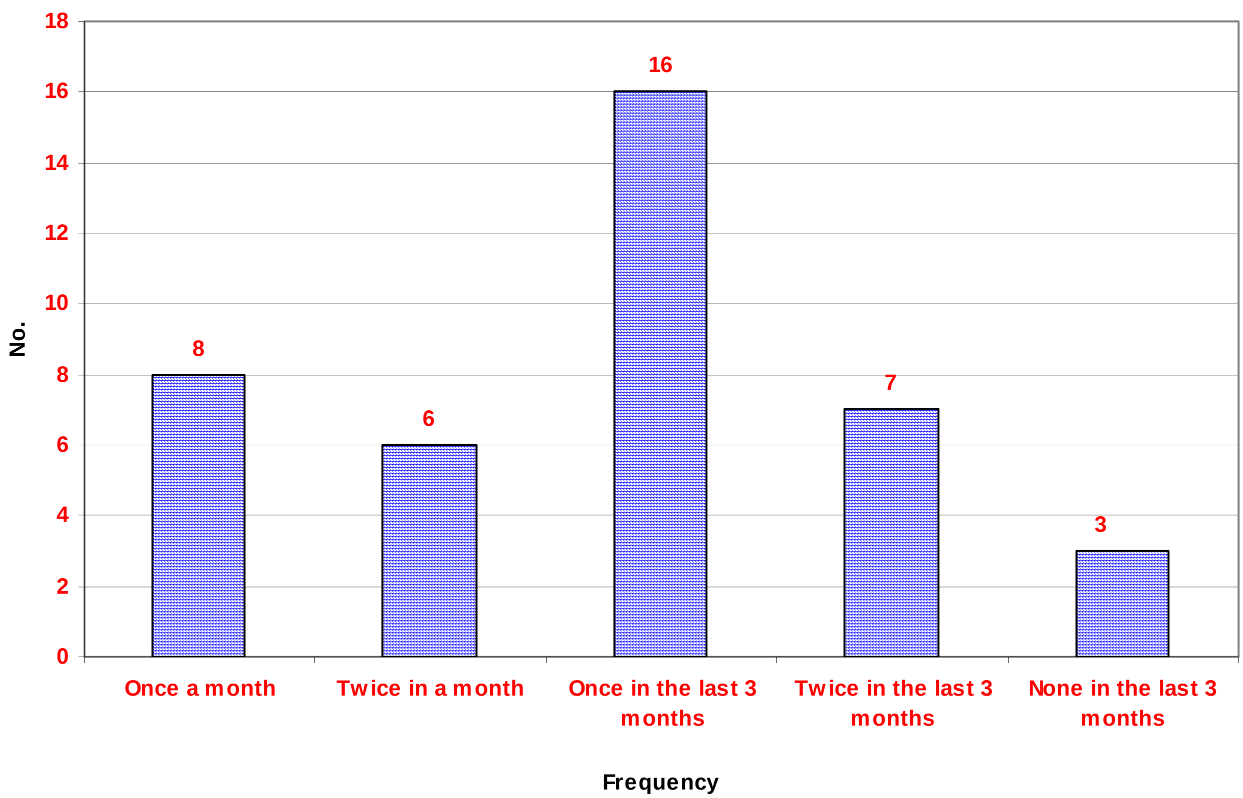


Figure 17: Frequency of Disease Attack(s) in three months by Farmers

Table 20 above shows that most of the farmers - 16 (40%) indicated have a disease attack only one in the last three months, 8 (20%) indicated once a month in the last three months, 7 (17.5%) indicated twice in the last three months, 6 (15%) have had disease attack twice in a month, while 3

(7.5%) indicated no attack in the last three months.

(ii) The Farmers point health situation: As stated under methodology, 40 farmers' blood and stool were analyzed at LUTH microbiology serology and parasitological laboratories for presence of some notable diseases. For malaria, blood sample was used; while stool sample was used for intestinal diseases, and wound swab and blood sample were used for skin infection test. Table 21 below shows the numbers of those positive to these diseases.

Table 21: Farmers Positive to some diseases during the clinical test at LUTH

Diseases	Ibese		Alapere		Ajegunle		Majidun		Total	
	F	%	F	%	F	%	F	%	F	%
Malaria	6	70	7	50	6	60	7	70	26	65
Intestinal diseases	3	10	2	30	2	10	3	20	10	25
Typhoid fever	1	10	2	0	1	10	0	0	4	10
Skin diseases	0	10	2	10	1	10	0	0	3	7.5

Source: Field work (2006)

As shown above in Table 21, most of the farmers – 26 (65%) tested have presence *trophozoites* of *plasmodium falciparum* (the commonest species of plasmodium in Nigeria) in their blood samples, and this indicates presence of malaria in the blood. However, only 9 (22.5%) of these positive ones required immediate treatment because there was thick and high *trophozoites* of *plasmodium falciparum* in their blood samples.

Regarding intestinal disease, only 10 (25%) samples of farmers stool tested positive with few ova of *diphyllobothrium latum* (tape worm) in 4, ova of *ascaris lumbricades* (large round worm) in 3, ova of *entamoeba coli* (intestinal parasite causative agents of *amebiasis* and *entamebosis*) in 2, and ova of *trichuris trichiura* (whip worm) in 1 blood sample. According to the parasitologist, the presence of intestinal diseases parasites in the stool of some of the farmers can be as a result of their exposures to poultry wastes and the bad sanitary condition of their farming environments.

As shown above, only 4 (10%) of the farmers tested positive to typhoid fever with high concentration of the parasite in 2 of 4 farmers. On the other hand, only 3 (7.5%) of the farmers tested positive to skin diseases. A mycology test was conducted on the farmer and this shows that 1 of the 3 farmers has *malignant melanoma* and the *pseudominas aeruginosa* was isolated for treatment. The serologist stated that this was a result of unhygienic handling of poultry waste and other fertilizers by the farmers that cause the recorded skin diseases in the farmers.

(2) Health situation before going into agricultural activities and after

When the farmers' health conditions before and after going into agricultural activities were compared, the result shows that most of the farmers (31 [77.5%]) indicated that their state of health has improved with the frequency of disease attacks reducing and their ability to afford good food and medical treatment/care enhanced by their improved financial status. However, 9 (22.5%) indicated that the frequency of disease attacks has increased since their involvement in agricultural activities.

(3) Disease Vector - Malaria

The presence and changes in diseases (malaria) vector was examined using the responds from the questionnaire (inhabitants and farmers), focus group discussion (with farmer) and conducting field observation along with a microbiologist from university of Lagos on the presence of lava and disease agents around the farmers and its environs. However, for other diseases the research depends on results of clinical test conducted at Lagos University Teaching Hospital (LUTH).

The results from the interview about people's perception of wetlands usage for agricultural purpose and the presence especially of mosquitoes the agent of malaria is presented below in Table 22.

Table 22: Inhabitants' Perceptions of Wetlands usage for crop production and presence of Mosquitoes

Remarks	Ibese		Alapere		Ajegunle		Majidun		Total	
	F	%	F	%	F	%	F	%	F	%
It has led to increase in presence of mosquitoes in the environment	5	16.7	10	33.3	11	36.7	7	23.3	33	27.5
It has led to decrease in presence of mosquitoes in the environment	22	73.3	20	66.7	18	60	21	70	81	67.5
Don't know	3	10	0	0	1	3.3	2	6.7	6	5
Total	30	100	30	100	30	100	30	100	120	100

Source: Field work (2006)

As shown above, in the study area most inhabitants – 81 (67.5%) remarked that cultivation of wetlands has led to decrease in the presence of mosquitoes; while 33 (27.5%) indicated otherwise and 6 (5%) indicated that they do not know. However, when cross-tab with distance of respondents' residence to farmlands the result shows that most of those that live near the converted wetlands indicated increase in presence of mosquitoes. Table 23 below is the cross-tab of the distance of respondents' house to converted wetlands and their perceptions on presence of mosquitoes.

Table 23: Cross-tab of distance of Respondents' house and perception on presence of mosquitoes

Distance of your house to the farmlands		Total		
		It has led to increase in presence of mosquitoes in the environment	It has led to decrease in presence of mosquitoes in the environment	Don't know
Ibese	Less than 500m.	4	2	2
	500 – 1,000m.	1	5	1
	1,001 – 1,500m.	0	7	0
	Above 1,500m.	0	8	0
Alapere	Less than 500m.	6	2	0
	500 – 1,000m.	3	7	0
	1,001 – 1,500m.	1	10	0
	Above 1,500m.	0	3	0
Ajegunle	Less than 500m.	7	3	0
	500 – 1,000m.	3	6	1
	1,001 – 1,500m.	0	7	0
	Above 1,500m.	1	2	0
Majidun	Less than 500m.	5	4	1
	500 – 1,000m.	1	8	1
	1,001 – 1,500m.	1	7	0
	Above 1,500m.	0	0	0
Total	**Less than 500m.**	**22**	**11**	**3**
	500 – 1,000m.	**8**	**26**	**3**
	1,001 – 1,500m.	**2**	**31**	**0**
	Above 1,500m.	**1**	**13**	**0**

Source: Field work (2006)

As shown above in Table 23most (22) of those that indicated that the conversion of wetlands for agricultural purpose (cultivation) has led to increase in the presence o mosquitoes resides near the farmland (less than 500m.); most of those that resides far (above 500m.) indicated that it has led to decrease in the presence of mosquitoes the agent of malaria.

From the farmers, the responds differ with most of the farmers [28 (70%)] indicating that their activities expose them to mosquitoes. During the focus group discussion the presence of mosquitoes and the problem of malaria were generally acknowledged as one of their major problem working on the farm.

The analysis of field observation of possible presence of mosquitoes by a micro-biologist shown that inside the farms and the immediate environs have low presence of mosquitoes' lava, while areas near the existing wetlands have high presence of mosquitoes' lava. According to the micro-biologist, mosquitoes' lava can not survive in water that is generally disturbed and unsettled but in stagnant water. In addition, it was noted that there is high presence of mosquitoes' lava in the shallow drainage system of the study area where most are blocked with domestic waste.

CHAPTER SEVEN

RESULT DISCUSSION, SUMMARY AND CONCLUSION

7.0: Introduction

This section is the presentation of discussions on the entire results, that is, the general overview of the result from the spatio-temporal analysis, the socio-economic, gender consideration in terms of roles, the benefits of farming on wetlands, the products and their values, and the health implications on the general public as well as the farmers. In addition, issues raised by the result of this research will be presented in this chapter. Furthermore, summary of the entire research is presented in this section, with recommendations given and the conclusion presented.

7.1: Discussions

Firstly, the spatio-temporal analyses through the use of remote sensing and GIS techniques shows that in 1986 the total areal extent of forested wetlands, non-forested wetlands and cultivation were 68.28 sq. km, 3.97 sq. km and 107.877 sq. km respectively. In 1994 the research shows that forested wetlands and non-forested wetlands decreased to 64.689 sq. km and 3.907 sq. km respectively; while cultivation also decreased to 100.723 sq. km. Thus, between 1986 and 1994 the three landuse/landcover under investigation loss physical area of coverage. However, in 2000 cultivation and non-forested wetlands increased to 109.239 sq. km and 4.367 sq. km respectively; while forested wetlands decreased to 57.55 sq. km. Generally, forested wetlands is the most affected with more area been taken over by other landuse/landcover. As shown in the study, more and more forested wetlands are being cut down either for development purpose or for cultivation.

The trend and rate of change analysis revealed that forested wetlands continuously experience loss with all negative annual rates of change during the period under investigation (-0.449 for 1986-1994, -1.190 for 1994-2000, and -0.766 for 1986-2000). On the other hand, non-forested wetlands experienced loss mainly between 1986 and 1994 with annual rate of change been -0.008; while between 1994 and 2000 the annual rate of change was 0.077, and between 1986 and 2000 the annual rate was 0.028. Regarding cultivation, loss was recorded only between 1986 and 1994 with annual rate of change of -0.894; while between 1994 and 2000 cultivation recorded gain at the rate of 1.419 per annual, and the annual rate of change of 0.097 was recorded between 1986 and 2000. Generally, there was decrease in agricultural activities in the study area during the period 1986 – 1994 and this period happened to be during the military regime in Nigeria when people were mostly concerned with their survival and safety with little socio-economic activities and people were moving away from metropolitan Lagos to adjoining areas such as the study area. However, during the period 1994 and 2000 agricultural activities were re-embraced especially urban agricultural activities on wetlands. This can be attributed to the desire to survived and alleviate their poverty state of living due to inadequate job opportunities and the uncontrolled and unprotected aspects of the wetlands in the area.

In terms of nature of changes and location, the study shows that built-up areas encroached almost all other landuse/landcover especially wetlands. Thus, the region during this period experienced influx of people that are mostly low income earners and in need of employment and food. The cultivation of these uncontrolled and unprotected wetlands was viewed as solution to these noted problems of unemployment and food security. As observed, the wetlands in the study area are not controlled by any authority and it is like ‘free area’ for any activity; hence, those inhabitants of the area that can work on farm moved in to produce mostly vegetables.

The study reviled that most of the farmers are into cultivation of wetlands as their main source of income, while few are into it to supplement their family’s food supply. Generally, the farmers are mostly low income earners with low educational background and within the active age group (they all uses crude tools and equipment. Women are deeply involved in the agricultural activities with some (76.5% of women) operating the farms as owners; however, most of the women indicated that the initial clearing of the wetlands is done mainly by men who are mostly family members or hired laborers. Thus, women and men are involved in every aspects of the agricultural activities expect the clearing which men do. In terms of products, vegetables (both exotic and local) formed the main type of product along with maize and cassava. The vegetables produced include *Lettuce, Radish, India spinage, Spring onions, Garden egg, Aloe Vera, Green pepper, Parsley, Ewedu C Oliferus, Okra, Tomatoes, Bitter leaf, Water leaf, Fluted pumpkin, Amaranth spp and Eweroko (Ugu leaf).*

Regarding nutritional values of the agricultural products, the research results indicated that the produced vegetables are mostly rich in vitamins. **…**

The health implication was examined, with the study reviling that malaria ranked as the main disease followed by intestinal diseases in the communities as indicated by both the local inhabitants and the farmers. In addition, the point health situations of the farmers’ shows that most of the farmers (65%) tested have presence *trophozoites* of *plasmodium falciparum* (the commonest species of plasmodium in Nigeria) in their blood samples, and this indicates presence of malaria in the blood. However, few (22.5%) of these positive ones required immediate treatment because there was thick and high *trophozoites* of *plasmodium falciparum* in their blood samples. Other diseases such as intestinal diseases, skin infections, and typhoid fever were also tested with varying numbers of affected farmers. Furthermore, the research shows that there has been change in malaria vector, with low presence of mosquitoes' lava in and immediate surrounding of the farmers because the stagnant water around here are generally unsettled due to the activities of the farmers. However, the near-by wetlands there are high presence of mosquitoes' lava as well in the blocked drainage systems in the communities.

Generally, it was acknowledged by both the local inhabitants and the farmers that farming on wetlands has increase their access to fresh and cost-effective foods especially vegetables. In addition, most of the farmers indicated that it has increased their income there-by reducing the impacts of poverty on them. It has served as a good source of employment to the farmers and it also provide the local inhabitants with good security system especially when they are at work and the farmers are around the neighborhood. However in terms of health implication, it has increased the inhabitants and the farmers' in-take of fresh food rich in vitamins with destruction or disruption of mosquitos' vector in the areas. On the other hand, some farmers indicated that the frequency of attack they recorded from some diseases especially malaria as increased with their involvement in farming. Also the medical expert stated that the exposures of the farmers to poultry waste and unhygienic working condition has led to some of the farmers having intestinal and skin diseases.

7.2: Summary

Wetlands are land transitional between terrestrial and aquatic systems where the water level is usually at or near the surface or the land is covered by shallow water. Each wetland is composed of a number of physical, biological and chemical components such as soils, water, plants and animal species, and nutrients. This wetland ecosystem structure (that is, the tangible items) yields benefits, which are of direct use value to humans. Many tropical wetlands are being directly exploited to support human livelihoods as in the case of wetlands within the study area. Here people are presently involved in cultivation of the wetlands for food crops production, some are fishing from the rich wetlands, and others are into gathering, sand mining, and harvesting of plants for medicinal purposes. However, this research is interested in the use of these wetlands for agricultural purpose which in this case is farming. It should be noted that this use / conversion of wetlands for agricultural purposes connotes change in landuse/landcover which can be study under landuse science.

However, landuse science addresses multiple aspects of the complex interactions between humans and the land surface such as: why does landuse change occur? where does it occur? and what are the consequences for human health, soil productivity, and other ecosystem services? In this field substantial progress has been made on understanding the complex socio-economic and biophysical factors underlying landuse change (the 'why'?) and observing and projecting landcover change (the 'where'?). Less attention within the science of landuse has been directed towards the consequences of landuse changes (the 'so what'?). Landuse change has many consequences ranging from changes in disease vectors to downstream flooding to far-away climate feedbacks through atmospheric 'teleconnection'. However, research on the ecosystem consequences of landuse change is dispersed among many disciplines.

Thus, the is need to examine the health implications of such conversion using the ecosystem approach, which allows for contributions from transdisciplinary approach with the goal of viewing the benefits, in terms of food security and diet diversity; the agro-ecosystem conditions, as well as the negatives health implications. This study tackled the quantification of landuse/landcover (especially wetlands), causes, landuse dynamics for agricultural purposes (Land cultivation for urban agricultural purposes) and the health implications through direct observations using remote sensing, questionnaire administration, disease vector studies, nutritional value studies and GIS models of landuse/landcover within an ecosystem approach.

The main goal of this research is to evaluate the spatio-temporal wetland changes for agricultural purposes (land cultivation) and examine the health implications of such changes in Lower Ogun River Basin using the ecosystem approach. However, the research set-out to achieve some objectives such as the mapping and generation of the inventory of wetlands within the study area during the period of investigation; evaluation of the spatio-temporal wetland changes for agricultural purposes within the study area over a specific period; identification of the agricultural products being generated from the converted wetlands and their nutritional values; examination of the effects on food security, agro-ecosystem condition, poverty alleviation, the roles of gender and the socio-economic situation of the farmers and the local people in general; and the examination of the health implications on the people using ecosystem approach.

This research is based mainly in the holistic ecosystem approach to human health which is transdisciplinary (contribution from various experts), participatory (input from the local communities with their contributions noted in the research) and equity (gender mainstream with research into the roles of gender, the input on gender base and gender consideration of the health implication). In addition, the research methodology is based on concepts such as system approach in geography and landscape concept.

This research involved the integration of remote sensing techniques and socio-economic survey (through questionnaire administration and focus group discussion) within a Geographic Information System (GIS) framework along with contributions from other disciplines using the ecohealth approach. The research made used of both spatial and non-spatial (attribute) data. The spatial data include topographic maps, satellite imagery, Global Positioning System (GPS) and administrative maps of the study area. The non-spatial data include responses from questionnaire, field observations, focus group discussions, disease vector studies, clinical records during health point situation study among the farmers, nutritional studies and other relevant data.

In the landuse/landcover change analysis conducted, two change detection methods were used and these are the area analysis and the point by point (or area specific) analysis. This analysis resulted in the generation of landuse/landcover maps, trends and rates of changes, the nature and location of changes with emphasis placed on wetlands and cultivation.

The research shows that in 1986 the total areal extent of forested wetlands, non-forested wetlands and cultivation were 68.28 sq. km, 3.97 sq. km and 107.877 sq. km respectively. In 1994 the research shows that forested wetlands and non-forested wetlands decreased to 64.689 sq. km and 3.907 sq. km respectively; while cultivation also decreased to 100.723 sq. km. However, in 2000 cultivation and non-forested wetlands increased to 109.239 sq. km and 4.367 sq. km respectively; while forested wetlands decreased to 57.55 sq. km. Regarding the change trends and rates, the research indicated that there was decrease in areal extent of cultivation during the period 1986 to 1994, while there was noted a rise in the areal extent of cultivation during the period 1994 to 2000. On the other hand, forested wetlands continue to experience reduction in areal extent due to the various anthropogenic activities of man especially urbanization and urban farming on wetlands. For non-forested wetlands, with more and more wetlands' plants being harvest and cleared for farming more areas are being loss but relatively low when compare with that of forested wetlands.

Regarding the socio-economic aspects of the farming activities, it was discovered that most of the farmers are low income earners with low educational background and within the active age group (they all uses crude tools and equipment. In addition, the research reviled that women are deeply involved in the agricultural activities with most of them operating the farms as owners / workers; however, most of the women indicated that the initial clearing of the wetlands is done mainly by men who are mostly family members or hired laborers. The main agricultural products generated from the use of wetlands for agricultural purposes in the study are vegetables (both exotic and local), maize and cassava, which are produced during the two cropping seasons (dry and wet seasons). However, the numbers of plots under cultivation during the dry season are more than that of the wet season when the water level of the wetlands increases and reduced accessibility into the area. The products from these farmlands which as stated above are vegetables are very rich in vitamins and protein, while maize and cassava offers the local people and the farmers' access to carbohydrate. Thus, food security in terms of quantity and nutritional values intake are seriously enhanced. The consumers of these agricultural products indicated that their diet variation and consumption of fresh vegetables has improved greatly since they started patronizing the products from the farmers in the area.

In terms of major communal health problem, malaria ranked as the main problem of both the local people and the farmers, with most of the farmers testing positive to malaria parasite. Other health problems include typhoid fever, intestinal diseases and skin infections. However, the clearing of wetlands for farming purposes has resulted in change in mosquitoes' vector with the constant disturbance of the water. The frequency of diseases attacks has however increased among the farmers but the farmers can now afford cost of having better health care with their economic powers enhanced from their farming income. The use of poultry waste on the farms, the blockage of drainage systems resulting in presence of stagnant water in the communities and the general low sanitary condition of the study area were identified by medical experts as reasons for the high prevalence rate of malaria, typhoid fever, intestinal diseases and skin infections in the area. However, the intake of fresh vegetables produced by farmers working on wetlands and the improve economy situation of the farmers and the local communities were some of the identified benefits accrued to the farmers and local inhabitants of the study area from cultivation of wetlands.

7.3: Recommendations

Relating to how to improve the use of wetlands for agricultural purposes especially cultivation (crop production) recommendations were given by the farmers, the local inhabitants, urban agriculture experts, medical experts etc. Some of the suggestions given include the following:

1) The quality control of poultry waste usage, with considerations given to the needed quality and the handling process.
2) The needs to have clean and constantly flowing drainage system in the communities to removed the problem of stagnant waters in the drainage system which provide good habitat for mosquitoes and their lava.
3) The farmers need to improve their sanitary condition in terms of their hygienic handling of every activity on the farmers.

4) The provision of storage facilities for the farmers to preserve the excess products during the harvesting seasons and this will lead to more economic gain for the farmers producing mainly perishable crops.
5) The control and proper planning of the activities around the existing wetlands by Government to avoid unsustainable encroachment of the fragile wetlands.
6) The introduction of lowland rice production into the wetlands in the study area in a mechanism way backed with the use of modern and environmentally friendly techniques.
7) Improve access to land for urban agricultural activities through good and controlled land tenure system to avoid the total taking over of the remaining marginal land by urbanization and other developmental activities.
8) Improved access to health care services in the area to cater for the low income earners in the communities.
9) The need for more sensitization and enlightenment programs on relationship between major human activities and their health as well as the ecosystem in general.
10) The need for government agencies in charge of environment, urban agriculture, urbanization, poverty alleviation, food security etc to work together under a sustainable plan that is holistic in approach.

Furthermore, this research has raised issues relating to some notable academic needs, thus for academic purposes the following recommendations are being made:

- The needs to conduct research into the soil components and nutrients value as well as the best agricultural products that can be produced for the area.
- Investigation into the general health implications of converting wetlands into other uses especially for human's developmental purposes.
- Organization of more workshops and conferences especially in developing countries at local level where contributions of the local people are considered.

7.4: Conclusion

The holistic understanding of the links between man's socio-economic activities, culture and the environment as well as the impacts and implication on human health is essential for sustainable development of earth's resources. Thus, an approach that integrates information from various or multiple disciplines with contributions from local people along with gender main-stream consideration is important in today’s developmental issues. Ecosystem approach to human health (eco-health) offers this great opportunity for researchers worldwide. The approach is transdisciplinary, with participations of the local people and with research into the variations into men and women relations in terms of roles, effects and implications.

Generally, wetlands are being loss daily due to various human and natural factors. Both the physical and biodiversity of wetlands are being destroyed or depleted; and this is with great impacts on the ecology of the immediate community and the region in general. Basically, the conversion of wetlands into agricultural landuse has over the years leads to increase in food production and security, and poverty alleviation. More and more people especially the urban poor are getting engaged in urban agriculture using the mostly the unprotected and uncontrolled wetlands in the lower basin of Ogun river. This has offered the local communities fresh and readily available food crops especially vegetables.

However, this situation is with some negative health implications which need to be address by local authorities. In the study area, the main health problem being faced in the study area is the high case of malaria. In addition, there is high use of poultry waste along with crude equipment, which makes the farming activities difficult and time consuming. The research also shown that women are playing great roles in the production of agricultural products with some being owners and workers.

In conclusion, this research has demonstrated the use of ecohealth approach along with GIS and remote sensing in the evaluation of wetlands use/dynamics for agricultural activities in the lower Ogun River basin. Thus, it has generated some important information which can be integrated into any developmental policies and implementations especially relating to wetlands and crop production.

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