ANTHROPOGENIC IMPACT ON SWAMPS IN SAPELE

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CERTIFICATION

This is to certify that this project was carried out by **OYIBORHORO OGAGA** in the Department of Geography and Regional Planning, Faculty of Social Sciences , University of Benin, Benin City in partial fulfillment of the requirements for the award of Bachelor of the Science (B.Sc) Honour Degree in Geography and Regional Planning.

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DEDICATION

This Research is dedicated to the Blessed Virgin Mary the mother of our Savior Jesus Christ.

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I sincerely thank my parents Mr. and Mrs. S.K. Oyiborhoro who sponsored my University Education may God richly bless your efforts in Jesus name amen.

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ABSTRACT

This research investigates the impact of human activities on wetlands areas in Sapele, The study revealed that majority of Swamps have been negatively impacted by anthropogenic factors such as deforestation, land reclamation and indescriminate disposal of domestic and industrial waste. The research also took into cognizance the Spatial pattern of wetland areas in Sapele with the application of LANDSAT ETM SATELLITE images, the research includes laboratory test results of soil samples collected from various Swamp located within Sapele, the obtained results were subjected to Statistical analysis. The research also adopts the identification of various buildings that were developed on Swampy areas as well as those in close proximity to wetlands, The Ugbeyiyi axis was used as a case study to this effect. From findings, it was revealed that some houses were developed directly on Swamps. Finally, the study suggest alternative and viable measures on how Swamps (Wetlands) can be properly managed and utilized for developmental purposes and the protection of these wetland ecosystem and the environment.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Wetland referred to swamps or marches are among the most important as ecosystem in the world. They are essential for performing many ecosystem services such as food control, maintenance of biodiversity, fish production, carbon storage, aquifer discharge and flood control as well as providing habitat for many endangered species (Barbier et al., 1997). Most importantly, Fresh water swamps serve as habitat to numerous species both fauna and flora alike with numerous floristic diversity and heterogeneous distribution.

Many wetland and swamps, particularly those near cities, have been threatened by human activities. With continuous occurrence of habitat loss as a result of urban growth or expansion, poor environmental practices among city dwellers and rural communities, Nigeria is fast loosing most of its wetland potentials.

The Niger Delta region is endowed with fresh water or inland swamps scattered at various locations within the region, this has contributed to the unique hydrological and topographical structure of the region. These wetlands host numerous species of plants and animals.

The region spans over 20,000 square kilometers and has been described as the largest wetland in Africa and among the three largest in the world, about 2,370 square kilometers (CREDC 2007). The Niger Delta area consists of rivers, creeks and estuaries and while stagnant swamp covers about 8600 square kilometers. As opined by Iyayi (2004), it is richest wetland in the world.

However this region has experienced a number of environmental challenges over the years.

The Niger Delta wetland ecosystem is of high economic importance to the local dwellers and the nation in general. The region is rich in both aquatic and terrestrial biodiversity and serves as a main source of livelihood for rural dwellers as well as stabilizing the ecosystem. Tremendous changes have occurred recently in the Niger Delta wetlands due to anthropogenic activities, thus raising awareness on the need for effective monitoring, protection and conservation of the wetland ecosystem. A good knowledge of the services provided by wetland ecosystems is an important key for an effective ecosystem management (Okonkwo et al., 2015).

The Niger Delta question is an epic case of resource exploitation without environmental, social and sustainable developmental responsibilities (Ikelegbe and Ezemonye, 2009). The Niger Delta wetlands are changing rapidly, raising concern for the wetlands health and for communities relying upon its ecosystem services. Knowledge on ecosystem service provision is important for effective ecosystem and livelihoods management. Effective wetland management will be aided by: recognition of ecosystem services contributions to community well-being; understanding how benefits are distributed over time, space, stakeholder; and how these changes in response to pressure. Since key pressures in wetland are anthropogenic, understanding the role of institutions in relation to the Niger Delta's ecosystem services is imperative (International Journal of Biodiversity Science 2011).

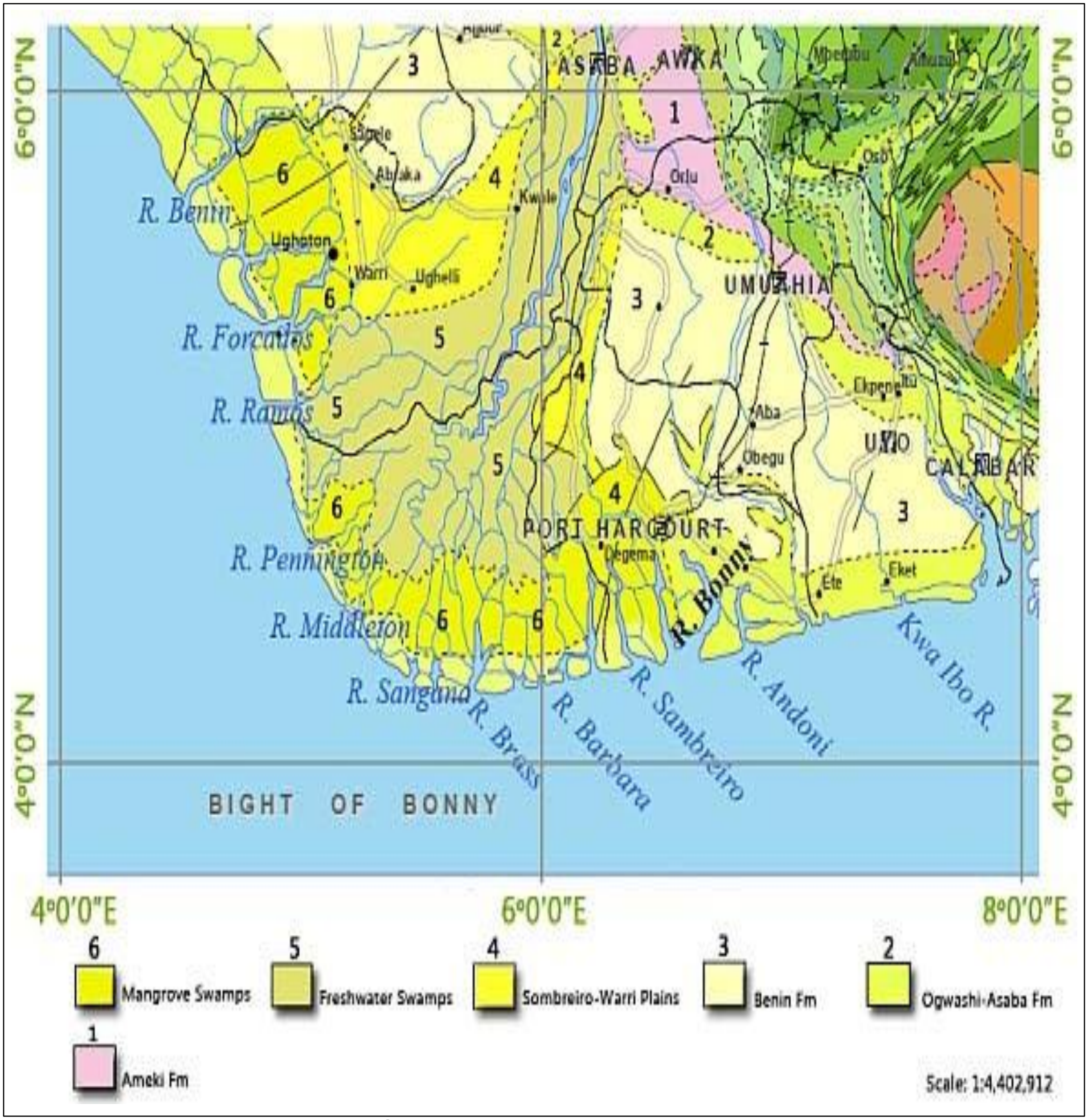

Fig 1.1: Geological map of the Niger Delta region showing the aerial distribution of mangrove swamps and the Benin Formation

Source: Adapted from NGSA, 2004

1.2 STATEMENT OF THE PROBLEM

The area of the globe covered by wetlands (swamps, marshes, lakes, etc.) has dropped by 6% in fifteen years. This decline is particularly severe in tropical and subtropical regions, and in areas that have experienced the largest increases in population in recent decades (CNRS 2012). However, it had been reported that a large percentage of wetlands have been lost in the last century, apparently due to drainage and land clearance as consequence of agricultural, urban and industrial development activities (Frenken, 2002; Williams et al., 2009).

Human activities have become a major threat to the survival of wetlands. These activities which range from construction of dams, irrigation, conversion of wetlands for commercial and industrial developments, drainage, extraction of minerals, etc. as a result of these human activities, most wetlands have become vulnerable and degraded. However, degradation alone does not only affect the existence of wetlands but also causes local suffering and affect the ecosystem as a whole; this eventually results to environmental problems (Faith U.E and Itoro U.A 2014). Environment Tobago (2008) reported that most of the wetland areas in Tobago have been destroyed and that less than one percent (1%) of the land area is covered by wetlands, this is due to factors like drainage or conversion for development, illegal dumping of solid waste, pollution from domestic sewage, industrial waste, pesticides and fertilizers, siltation due to runoff from cleared areas, overhunting of wildlife, over fishing and illegal harvesting of mangrove as well as natural threats. In many parts of the world, wetlands are drained and reclaimed for development activities, or to create room for forestry and farming or as part of public health and sanitation initiatives (IUCN, 1999; Keddy, 2000). Once developed, wetlands are permanently destroyed and lose their potential to be rehabilitated. In many developing countries, wetland reclamation is often done illegally in areas where population growth causes a shortage of land, especially in and around cities and towns (Ntabirweki, 1998).

1.3 AIM AND OBJECTIVES

The aim of this study is to determine the management of swamps in Sapele local Government Area of Nigeria. Secondly, to determine how urban growth has resulted to habitat loss among various swamps in Sapele.

The objectives of this study are to determine the following:

i. To determine the spatial pattern of swamps in Sapele
ii. To access the level of contamination of swamp soils in Sapele
iii. To ascertain the various utilization of swamps in Sapele
iv. To identify the encroachment of buildings on swamps in Sapele

1.4 RESEARCH QUESTION

The following questions are important in this research.

Why does man encroach into swampy areas by construction activities and land reclamation?

Why are swamps not utilized to their full potential in Nigeria?

Why are swampy areas prone to waste deposition?

Why are swampy areas and wetlands losing most of its rich biodiversity?

Can swampy areas be used for controlling environmental hazards?

1.5 SIGNIFICANCE OF STUDY

The significance of this study are numerous and important in the following ways. First, it helps to monitor trends and interaction level of man's activities on wetlands in Sapele, secondly, this research helps to create awareness of the role and importance of lowlands such as swamps to local communities, it also highlights the environmental contributions of swamps to the ecosystems and how delicate and sensitive these landforms could be, this research indicates suggestive measures on how these landforms can be optimally utilized without being destroyed or degraded by man. It emphasizes the cultural, historical, environmental and socio-economic relevance of swamps to man using Sapele as a case study. Wetlands are not 'waste lands' rather, they are 'wealth lands' that play significant role in poverty alleviation.

They are life wires to many economic activities such as crop cultivation, fishing, livestock rearing etc (NCF 2013).

1.6 SCOPE OF STUDY

The scope of this research is focused on Sapele, one of the local government areas in Delta state. Sapele is located within the Rainforest belt, the River Ethiope forms the major hydrological body and almost covers the land area, it is justified that the presence of this hydrological body contributes immensely to the presence of various swamps within the region. This research is restricted to swamps concentrated within this region, these swamps are mainly fresh water swamps scattered randomly within the town some of which are quite extensive with great depth and are permanent all year round, and others are relatively small in size and dry up during the dry season. Some of these swamps directly flow from the River Ethiope or are directly connected to it; others exist alone on the interior part of the town.

1.7 STUDY AREA

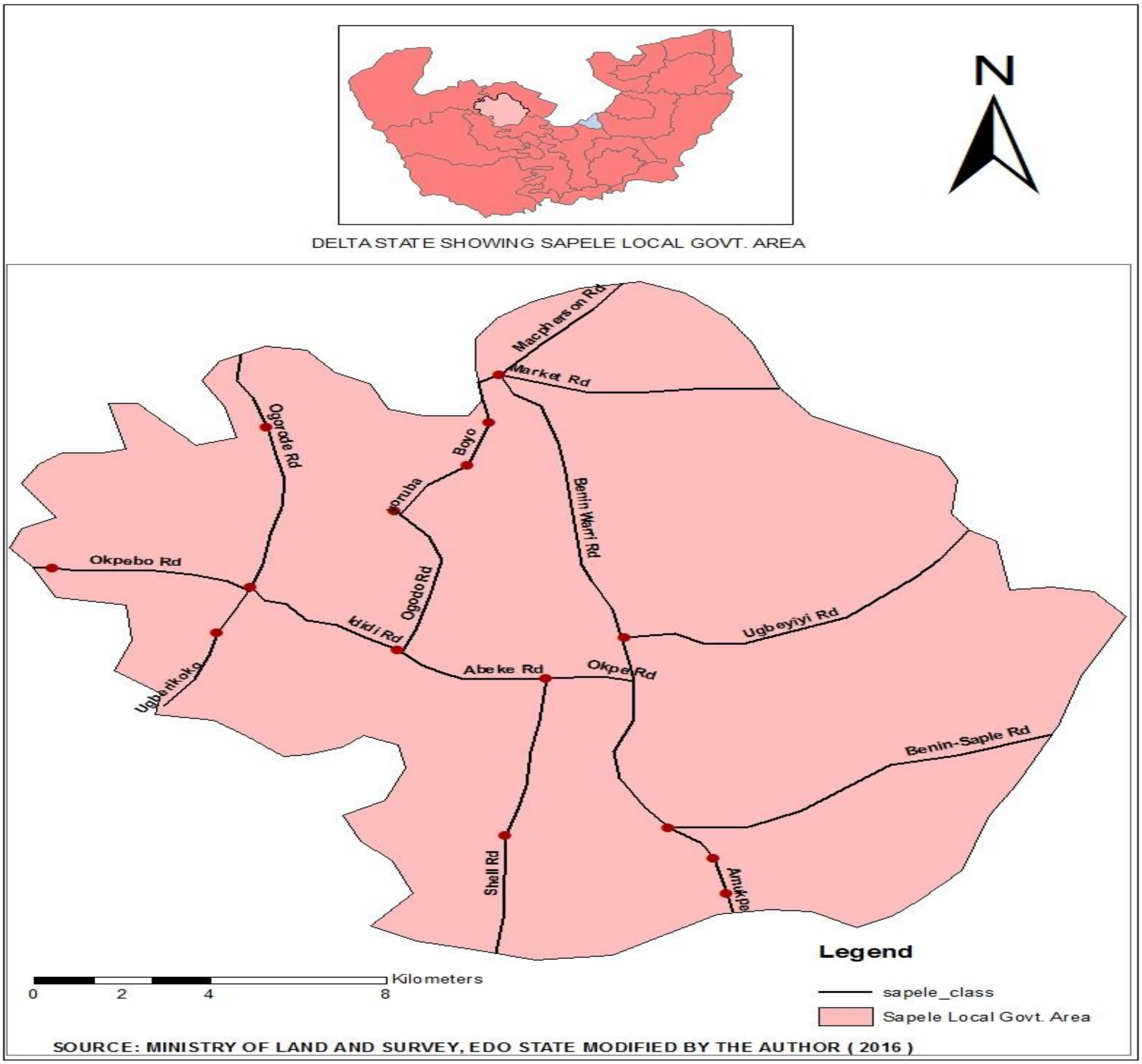

Figure1.2: Sapele

Source: Ministry of Land and Survey, Edo State

Sapele is located in Delta State with geographical coordinates 5°54′ North and 5°40′ East. A port town known for timber production, The African Timber and Plywood Company (AT&P) a major producer of timber is situated in Sapele. Located within the Tropical Rainforest belt of Nigeria, Sapele is bounded to the North and East by Ethiope West Local Government Area, to the South by Okpe Local Government Area and West by Warri South Local Government Area. The major economic activity engaged by local people includes trading, fishing, furniture and wood processing mills amongst others. In terms of weather and climate, Sapele has a tropical climate. There is significant rainfall in most months of the year. The short dry season has little effect on the overall climate. This location is classified as (Am) by Köppen and Geiger. The average annual temperature is 26.6 °C in Sapele. The average annual rainfall is 2406 mm (CLIMATE DATA.ORG).The major cash crops grown in Sapele include; rubber, cassava, palm fruit, maize, cashew etc. Sapele is mainly a lowland area with abundance of sandy soils.

1.8 LIMITATIONS OF THE STUDY

A number of limitations arose in the course of this research; firstly it is difficult to ascertain the exact number of swamps distribution as a result of the inaccessible terrain in which some swamps are situated, also the physiochemical characteristics of swamps often vary seasonally and spatially, thus it is difficult to determine the exact quality of swamps which usually require a long range of analysis.

1.9 JUSTIFICATION OF THE STUDY

Wetlands are losing much of its value as a result of encroachment caused by urban growth, majority of plants and animals have gone into extinction due to exploitation. It is necessary to put in place adequate checks and track studies on anthropogenic effect on natural environment in order to project necessary plans and measures to protecting and preserving the natural environment.

Half of the world's wetlands have disappeared since 1900. Development and conversion continue to pose major threats to wetlands, despite their value and importance (WWF 2016). Wetlands are valuable resources currently facing severe threats world over due to the drive for economic growth, development and agricultural practices. However, in order not to lose these wetlands, it is imperative that studies be carried out to ensure the sustainable use of wetland resources (Faith U.E and Itoro U.A 2014).

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

Fresh water swamps are the typical habitat where water oozes from the soil surface(Sharma and Joshi 2008). They offer many important benefits including flood control, groundwater recharge, pollution cleanup, wildlife habitat, and recreation (Sharma and Joshi 2008). Wetlands (Swamps) are land areas covered with water or where water is present at or near the soil surface all year or varying periods of the year (US EPA 2009).These areas are capable of supporting water related vegetation (Nwankwoala 2012). Wetlands provide food, store carbon, regulate the water flows, store energy, and are crucial for biodiversity. Their benefits to people are essential for the future security of humankind (Rasmar Handbook 2010).

2.2 SIGNIFICANCE OF SWAMPS

Wetland ecosystems are the most diverse and productive ecosystems on earth and include marshes, lakes, rivers, flood basins, estaurine deltas, ponds, rice fields and marine water areas where the depth at low tide does not exceed 6m(Convention on wetlands 1971).Wetlands (Swamps) provides mammals, plants, amphibians, reptiles, birds and fish with food, habitat, breeding grounds and shelter. Wetlands have also played important role in the development of Nigeria (Olomukoro and Ezemonye 2007). The quantity of water present and the timing of its presence partly determine the functions of a wetland and its role in the environment (Mulamoottil, Edward and Barry, 1996). Wetland wildlife such as several species of frogs, snakes, turtles, tortoises and terrapins and soft-shelled turtles, freshwater stingrays, molluscs, crabs, insects and birds are important sources of supplementary protein, and are not only consumed domestically but also sold in local markets providing an additional household income source(Snivongs, Choowwaew and Chinvanno, 2003). Wetlands provide fibre and wood for fencing and housing materials as well as raw materials for cottage industries, matting and handicrafts, and compost. (Snidvongs et al., 2003). The services delivered by wetlands have been arguably valued at US$14 trillion annually. Economic valuation now provides a powerful tool for placing wetlands on the agenda of conservation and development decision-makers (Rasmar Handbook 2010). According to the Ramsar Convention on Wetlands, inland wetlands also include shrub or tree dominated swamps, as well as marshes and wet meadows dominated by herbaceous plants, which are usually manmade, Many of these wetlands are seasonal and may be wet only periodically.(Mulamoottil et al., 1996). Amphibians, reptiles and birds are vital to agro-ecosystems and to rural economy in the basin as they play an important role in rodent and insect control. Some animals such as crocodiles and snakes are also exploited for food and skins, Aquatic plants and vegetables are harvested for food as well as for traditional medical purposes, also Several kinds of aquatic plants are grown in wetlands for animal feed and for sale, Through the harvest and sale of wetland produce such as morning glory *Ipomoea aquatica*, duckweed *Lemna sp.*, and water hyacinth *Eichhornia crassipes*, wetlands also provide daily income and economic opportunities for many unemployed and the under-employed inhabitants(Snivongs et al., 2003).

Wetlands deliver a wide range of critical and important services (e.g. fish and fiber, water supply, water purification, coastal protection, recreational opportunities, and increasingly, tourism) vital for human well-being. Maintaining the natural functioning of wetlands will enable them to continue to deliver these services (Rasmar Handbook 2010).

2.3 SWAMP DISTRIBUTION

Wetlands exist in every country and in every climatic zone, from the polar regions to the tropics. They are distributed around the world and cover an area that is 33% larger than the USA(Wetlands International Africa 2012). Wetlands constitute only two percent of the world’s land mass. Yet, a total of 10% of the world population live in wetlands. Also, about 13% of global urban settlements are found in wetlands.(Ajah , Ekpeyong and Aniedi, 2015).

Africa's wetland ecosystems are estimated to cover more than 131 million hectares(Wetlands International Africa 2012).

The Fresh wetlands are Niger delta, Niger River, Benue River, Cross river and Imo River, Ogun-Osun River, and Lake Chad occupying 117,700, 8,150, 242,000, 250,000 and 26,000, 380,000, 55,000 acres respectively. The freshwater swamp portion of the wetland is estimated to be 2,130,000 hectares (Ojekunle 2013). Wetlands encompass a significant proportion of the area of the planet; the global estimate is 1280 million hectares (equivalent to approximately 9% of land surface) and is recognized as an underestimate (Rasmar Handbook 2010). The wetland ecosystems cover 6 percent of the land area of the world (Bullock and Acreman, 2003 Schuyt and Brander 2004). put together this amounts to as much as 1,280 million hectares; a territorial mass that is equivalent to 50 % the land area of Brazil or 33 % the land area of USA (MEA 2005). In Nigeria, an estimated 28,000km2 (about 3%) of the 923,768 km2 land surface area of the country area is covered with wetlands (Uluocha and Okeke, 2004).

2.4 SWAMP ECOSYSTEM

Wetlands support a rich diversity of plants and animals. These species and their genetic diversity help to maintain wetland processes such as water storage, sediment trapping and nutrient cycling. Wetlands are especially important for many migratory birds. As wetlands, like all ecosystems, change over time, there is no specific baseline state against which to measure the condition of a particular wetland (water policy briefing 2006).

Wetlands are an important storehouse of plant genetic materials. A wide range of floral species are found in wetlands, including rice, the staple food of more than half of the world's population. Wild rice in wetlands is an important source of new genetic materials in developing disease- resistant and higher-yield strains. (Snidvongs, et al., 2003).

Wetlands are dynamic landforms which vary in both time and space. Natural wetlands are dynamic and short lived in geological time and have vanished and emerged since the formation of the earth. Areas which now supply limestone, coal, peat, phosphate, salts (evaporites) and diatomite were once wetlands. Today's wetlands are a source of food and cash but unfortunately also disease. The wetlands observed on the earth's surface result not only from the morphology of the land in which they occur but are due to regional tectonic and climatic influence (Mwanukwuzi 1991).

According to International Training of Trainers on Wetland Management, wetlands are hugely diverse but whether they are ponds, marshes, coral reefs, peat lands, lakes or mangroves, they all share one fundamental feature: the complex interaction of their basic components soil, water, animals, and plants (ITTWM, 2009).

2.5 ADVERSE HUMAN ACTIVITIES ON SWAMPS

However, socio-economic pressures mean that we are now pushing wetlands to work even harder, for example, by producing more crops or grazing more cattle. History shows that 'over-working' wetlands can cause them to change significantly, often with negative effects on the communities or even civilizations that depend on them (water briefing 2006).Tangible and intangible diverse resources and products of wetland functions such as fodder, fishes, fuelwood, nontimber forest products, ecotourism, and flood control have historically provided a source of income and livelihood for human beings, However, population growth and associated anthropogenic interferences have depleted these resources and reduced the rates of flow of ecosystem services

(Pramod, Lamsal, Krishna, Lalit, and Kishor 2015). Its benefits and values to the society have attracted increasing global importance, but unfortunately, wetland areas are under increasing pressure stemming from developments and industrialization, including oil exploration and spillage (Chidumeje, Lalit and Subhashni, 2015).

The millennium ecosystem assessment (2005) stressed that global wetland loss is more rapid than those of other ecosystems (Agardy and Alder, 2005). The majority of European wetlands have for centuries been subject to anthropogenic modification, principally through drainage and conversion to other land uses. Indeed, it has been estimated that more than 70% of all European wetlands existing at the beginning of the twentieth century have since been lost to urbanization, peat extraction, or agriculture (Joosten & Clarke, 2002), and those remaining are fragmented and often in a degraded state. This has culminated in the situation we face today, in which wetlands are recognized as one of the most threatened ecosystems in Europe and throughout the rest of the world (Millennium Ecosystem Assessment, 2005). More than 50% of the world's wetland have been altered, degraded, or lost in the last 150years (O'Connell 2003). Wetland reclamation exists in the form of forest clearing for agriculture and road constructions, which drastically change the natural state of the wetlands and impacts heavily on the flora and fauna of the wetland ecosystem (Chidumeje, et al, 2015).

During the El Nino event, over 2 million hectares of peat swamp forests were burned. The burning of peat swamps directly contributes to climate change because these swamps can hold around 30 times more carbon than tropical rainforests. Thus, forest fires and land-use change can release this stored carbon into the atmosphere, thus causing increased warming and added fires (Case, Ardiansyah and Spector, 2007).

Nevertheless, Nigeria's wetland resources are currently being threatened by certain anthropogenic and bio-geophysical factors. Notable among such factors are population pressure, rapid urbanization, mining, pollution, uncontrolled tilling for crop production, over-grazing, logging, unprecedented land reclamation, construction of dams, transportation routes and other physical infrastructure, marine and coastal erosion, subsidence, ocean water intrusion, invasion by alien floral and faunal species, sand storm, desertification, and droughts. Human activities continue to adversely affect wetland ecosystems. The alarming rate at which the country's wetlands are vanishing obviously portends some dire consequences. In particular, wetlands destruction is affecting water supply and water resources management in various parts of the country. There is no gainsaying, therefore, that the degradation of wetland ecosystems in Nigeria increases the task of water resources management in the country (Oluwapamilerin, Orimoogunje, Oyinloye and Soumah, 2009).

The conversion of wetlands to settlement and infrastructural development has led to the destruction of most of wetlands plant species such as reeds, sedges and grasses. In the absence of these plant species, the wetlands are failing to play their important functions such as trapping of sediments, removal of waste materials and purification of water. The habitat required by wetland-dependent species is frequently lost. This is also leading to the total destruction of the wetlands and this has impacts on the ecology of the area because it is making the area to change from wetlands to a settlement area (Oluwapamilerin, et al., 2009). The degradation and loss of wetlands is more rapid than that for other ecosystems. Similarly, the status of both freshwater and, to a lesser extent, coastal species is deteriorating faster than that of species in other ecosystems. Wetland-dependent biodiversity in many parts of the world is in continuing and accelerating decline (Rasmar Handbook 2010).

Sewage disposal includes used water from domestic activities such as laundries, car wash, lavatories whereas solid waste includes suspended matter especially bones from abattoir, floating matter such as tins, plastics and scraps of old motor vehicles. As a result of this, the waters natural purification process in the wetland will cease as more and more solid and sewage is disposed in to the wetlands (Oluwapamilerin, et al., 2009).

2.6 SWAMP SOIL DEGRADATION

When metals and hydrocarbons in stormwater runoff from the CDA enter wetlands, they eventually accumulate in wetland sediments. Pollutants trapped in wetland sediments can re- enter the water phase or migrate downward, and in some cases, into the groundwater.(Tiffany, Jennifer, Tom, Karen, Anne, and Dave 2006).

If a wetland soil is extensively disturbed, an opportunity exists for aggressive invasive species to establish themselves. Impacts to wetland soils that affect vegetation may include cultivation, subsidence or erosion of muck soils, soil compaction due to cattle grazing or driving heavy machinery over a wetland, and placing telephone poles, pipelines, sewer lines or underground cables. Agricultural activities can cause soil erosion from fields to dump directly into adjacent wetlands. Sediments carry nutrients from manure and fertilizers, which may lead to changes in a wetland's vegetation and wildlife habitat (WWA 2004). Urban stormwater runoff carries with it many different pollutants, including hydrocarbons and metals such as cadmium, copper, lead, nickel, and zinc.(Tiffany et al., 2006). In a review of sediment chemistry in more than 50 stormwater wetlands and ponds, trace metal concentrations were five to 30 times higher in the muck layer than underlying soils and had a distinct signature and vertical distribution (Schueler, 2000a).metal distribution was found over time in a natural urban forested wetland that received urban stormwater runoff (Sanders, 2002).

2.6.1 Impact of Waste Deposition on Swamps

Wetlands accumulate pollutants from adjacent areas through intentional discharge of sewage or industrial wastes, runoff of agricultural fertilizers and pesticides, and discharge from municipal storm drains. The effect of these accumulation pollutants on wetland ecology and wildlife health needs to be recognized (Kathryn A. Converse 1995).Wetlands have been subjected to wastewater discharges from municipal, industrial and agricultural sources, and have received agricultural and surface runoff, irrigation return flows, urban storm water discharges, leachates, and other sources of water pollution for centuries (Rebecca and Elizabeth 2006).These nutrients cause rapid increases in phytoplankton and aquatic plant growth. The high levels of organic matter may cause massive deoxygenation of the wetland resulting in a decline in water quality and severe loss of aquatic life (Queensland Government, Department of Agriculture and Fisheries 2012).

Chloride can be a major wetland stressor in Northern latitudes due to the application of road salt

in winter, Numerous studies document chloride discharges to wetlands in northern latitudes, and the subsequent impacts to wetland plant and animal communities

(Tiffany et al., 2006).

One important aspect concerns the negative impacts on public health and environmental quality due to increasing pollution from inadequate urban sanitation and improper wastewater management. This situation is exacerbated by the high population density, unplanned settlements and uncontrolled industrial development, which contribute to the large quantities of indiscriminately discharged wastewater and high pollution loads into the environment (Najib, Diana, Mohammed and Thomas 2015).

2.7 IMPACT OF URBANIZATION ON SWAMPS

A major threat is the draining of wetlands for commercial development, including tourism facilities, or agricultural land. In addition, unwise use of freshwater to feed these developments poses a further threat (WWF 2016). Land development results in loss of natural vegetation and open spaces and a general decline in the spatial extent and connectivity of wetlands, wildlife habitat, and agricultural lands, landscape fragmentation and biodiversity loss (Kuchay and Sultan 2014). Urban sprawl has a considerable impact on ecosystems and other environmental resources, which provide societal and environmental benefits simply by existing and functioning. These essential biological and physical systems include, among others, the wetlands and lakes that provide water for drinking and irrigation purposes, flood control and wastewater renovation (Kuchay and Sultan 2014). Wetland loss and degradation has primarily been driven by land conversion and infrastructure development, water abstraction, eutrophication and pollution and over-exploitation. Losses tend to be more rapid where populations are increasing most and where demands for increased economic development are greatest (Rasmar Handbook 2010).Non-point source pollution resulting from broad-scale land-use practices such as land clearing, urbanization, cropping and grazing is a more widespread issue. Changed land use has led to the eutrophication of wetlands due to increased nutrients in the form of sedimentation, fertilizer run-off and organic wastes entering wetlands (Queensland Government, Department of Agriculture and Fisheries 2012). “The hypothesis that urbanization can have direct and indirect impacts on the environment, and that wetlands are particularly susceptible to negative change, has long been proven, Yet despite this, the march of urbanization continues to destroy and degrade natural capital.”(UNHABITAT 2009). Rapid urbanization, especially in tropical regions, has been linked to intense degradation of the landscape and aquatic ecosystems including wetlands (Najib et al., 2015).

2.8 CONSERVATION, PROTECTION AND MANAGEMENT OF SWAMPS

Modifications to the ecosystem, however, significantly affect wetland ecology and functions often decreasing other potential benefits. Installing irrigation, for instance, may lower the quantity of water or amount of fish that the wetland provides. Simply put, working wetlands represent an informed compromise between conserving wetland services and development (water policy briefing 2006). Conservation and the wise and use of wetlands are vital for people, especially the poor. Human well-being depends on many benefits provided to people by ecosystems, some of which come from healthy wetlands (Rasmar Handbook 2010).The need of community participation in the conservation and management of wetland resources is understood globally (Williams 2002). It has now been realized that "if the wetlands had been preserved rather than drained, much property damage and crop losses could have been avoided." (EPA 2001). Wetland managers need to acknowledge people's awareness and perception of change as mediating variables when examining the effects of their decisions on local environmental quality. The consequences for human health may persist or arise over the long term, so interventions must operate with all relevant temporal scales rather than just the short or medium term. Since many of these matters operate at, or are driven by factors at, the global scale, the attention of wetland managers must also be focused beyond the local and regional scale. Despite an important role of wetlands in providing ecosystem services that support human health and well-being, there is a significant danger that these will be overlooked or under considered in decision-making processes. Application of economic valuation techniques has yielded useful economic estimates of the contribution of wetlands towards health objectives to guide sound decision-making (Rasmar Handbook 2010). Industries, including agriculture, should improve their best management practices to reduce the effects of non-point source pollution on wetlands and the surrounding environments (Chidumeje et al., 2015).

wetland ecosystems are important from conservation and sustainable management viewpoints because of their rich diversity of flora and fauna (Pramod, Krishna, Lalit and Kishor, 2015).

For successful conservation and management, the participating local communities should be fully aware of the importance of wetlands as parts of water cycles, as well as the nature and effects of human impacts (Williams 2002). The Ramsar convention on wetlands was established at the international level to protect wetlands (Frazier, 1999). Public attitudes towards wetlands are changing rapidly, with laws set out to protect them (Chidumeje et al., 2015).

2.8.1 Environmental Benefit of Swamp

Wetlands provide significantly environmental benefits. Important wetland functions include water storage, groundwater recharge and discharge, storm protection, flood buffering and control, shoreline stabilization, erosion control, and retention of carbon, nutrients, sediments and toxicants, and regulation of local and global climates (Dugan, 1990).Wetland ecosystems provide direct and indirect benefits which may be tangible or intangible to people living in the vicinity. Wetlands provide “products” which are the basic needs, augmenting the diet, curing the sickness, providing housing materials, and enhancing the occupation and income of rural and urban inhabitants (Snidvongs et al., 2003). Notwithstanding the persistent negative and hostile attitudes to wetlands, man has consistently enjoyed the immense benefits that wetlands offer, since the establishment of the earliest urban conurbations in Mesopotamia nearly five millennia ago (UN-HABITAT, 2009). Within the context of the contemporary worldview on wetlands, they make very significant contributions to the human environment, namely: food, water supply, water purification, flood control, climate regulation, coastline protection, recreation and tourism (EPA 2001 and MEA 2005).

Shifts in wetland habitat may also have important implications on surface water hydrology, through feedbacks of vegetative resistance to flow, local evapo-transpiration demands, or organic sediment accumulation and topographic patterns (Fitz, 2008). The economic contributions of wetlands constitute another significant consideration pertaining to wetlands; these contributions can be better understood through the application of some environmental resource valuation frameworks (Ajah et al., 2015).

The estimate for the total economic value 63 million hectares of wetlands located in various regions of the world has been computed and placed at 3.4 billion US dollars per year. For Africa, this computation has placed the total economic value of its 5.5 million hectares of wetlands at US$256.7 million per year (at year 2000 values) (Schuyt and Brander 2004).

Welcomme (1976) stated that in Africa, a continent where protein shortage continues to cause malnutrition, the area of wetlands in watersheds strongly predicts fish harvests. (Chidumeje et al., 2015). Benefits provided by wetlands are quite enormous, with increased importance worldwide, hence the need to protect the remaining wetlands (Millenium Ecosystem Assessment, 2005).

2.8.2 Swamps and Human Development

Communities value wetlands differently from place to place and over time. Some developed societies place very high values on wetland aesthetics and biodiversity, to the extent that they pay farmers to rehabilitate rather than cultivate wetlands on their land (water policy briefing 2006). Wetland ecosystems, such as rivers, lakes, marshes, rice fields and coastal estuaries, provide many benefits that contribute to human well-being. These include fish and fiber, water supply, water purification, climate regulation, flood regulation, coastal protection, recreational opportunities and, increasingly, tourism. The livelihoods of people living in, or on the borders of, wetlands often depend partially or entirely on wetland ecosystem services. Loss or degradation harms them directly. In Cambodia, for example, fish from the freshwater Tonle Sap wetland ecosystem provides 60-80% of the country's animal protein. In Malawi, local people use the fruits, seeds, tubers, roots and leaves of around 200 plants from the wetlands surrounding Lake Chilwa. In Malaysia, rural households earn up to US$80 a month selling medicinal plants gathered from wetlands. Worldwide, most freshwater for human use comes from inland wetlands-lakes, rivers and swamps. The Everglade wetlands in Florida, USA, supply five million people with water. Laguna El Jocotal, a shallow floodplain lake in El Salvador, provides 10,000 people with water in the dry season. Checking a wetland's contribution to social welfare involves looking at five main concerns: reliance on wetland resources; livelihoods dependent on current wetland agricultural activities; differences in the benefits to different genders and socioeconomic groups; benefits beyond the wetland, for example downstream; and benefits on the global scale. Ideally, much of the information would be gathered through participatory assessments (water policy briefing 2006). Wetlands are closely linked with the economic well-being and ecological balance in the Mekong River basin. Wetlands are valuable resources that supply many goods and services (or products, functions and attributes) to people

(Finlayson 1996). The role of wetland resources in the livelihood of the poor is particularly important in developing countries, for example, wetland activities at the pece Wetland in Uganda provide > 50% of the monthly income of the dependent population (Opio, Lukale, Masaba, and Oryema 2011).

CHAPTER THREE

METHODOLOGY

3.1 INTRODUCTION

This chapter involves the methodological approach in which data acquired from field survey, laboratory test results of soil samples and Satellite images were subjected to the following techniques: Statistical techniques of data analysis such as pie-chart, bar charts, line graphs, tabular representation of data, mean, median, variance and standard deviation. Acquired Satellite images was analyzed using computed grid-lines and geographic coordinates in the description of spatial patterns. Laboratory test results were subjected to statistical techniques mentioned above.

3.2 RESEARCH METHODS

The research methods adopted include:

3.2.1 Laboratory Analysis of Soil Samples

Soil samples was collected from 5 Swamp sites using Soil Auger with a depth of 0-15cm, the Geographic Coordinates of the sampling sites was equally identified, 5 soil samples was collected on the 14th of August 2016. Soils collected were stored in polythene bags for safe preservation of soil content, this was tagged with names of sites visited. Soil samples were taken to the Laboratory of the Department of Chemistry, University of Benin, Benin City for analysis. Laboratory test for the following heavy metals (Copper, Nickel, Lead, Zinc and Chromium) was carried out for the 5 soil samples.

3.2.2 Procedure for Laboratory Analysis

i. Samples were calibrated for the following heavy metals, Ni, Pb, Cr and Zn in 2, 4, 6, 8 and 10 (ppm) respectively (Buck Scientific : 2010VGP).

3.2.3 Method of Digestion

ii. This involves the mixture of two acid; HCL and HNO3 (Aqua Regia), 10ml of mixture was measured and mixed with 1gram of each soil sample and was measured into a Kjeldahl flask, this was heated until the colour of the mixture suddenly disappear.

iii. The next level of the chemical reaction involves the filtration of the mixture with Whatman filter paper.

iv. The filtrate is then marked for each samples and then the Atomic Absorption Spectrometer (ASS) was used to determine the concentration of the five heavy metals in each soil sample.

3.2.4 Field Survey of Swamp Spatial Pattern

A field survey was carried out to determine the spatial pattern of swamps in Sapele. A total of 44 swamps was identified in the survey; 41 swamps have been affected by human activities such as deforestation, Agriculture, waste deposition and land reclamation for building development. Only 3 swamps are in their natural state. This was plotted in tabular format and was analyzed statistically.

3.2.5 Interpretation of Acquired LANDSAT ETM Maps of Sapele

Four LANDSAT ETM maps were interpreted; this includes:

i. Map showing the area coverage of continuous geographical phenomena such as forest, swamps, built-up areas and river. This map was interpreted using the Raster method to calculate the area covered by the various geographical phenomena; the map was divided into grid-cells in rows and columns, the computed data was used to calculate the area covered by the various geographical phenomena.

ii. Map showing the spatial pattern of major swamps in Sapele. This map was interpreted descriptively using geographical coordinates in explaining the distribution pattern of swamps.

iii. Maps showing the spatial pattern of buildings at Ugbeyiyi road; these maps were in two categories, this include map depicting the entire distribution of buildings and map showing the distribution of buildings built on swamps and those not on swamps.

3.3 DATA ANALYSIS PROCEDURE

Acquired data was analyzed using statistical techniques and descriptive approach in explaining anthropogenic impact on swamps, photographs of some swamps affected by human activities (deforestation, waste deposition on swamps and land reclamation) was also added to aid quantitative approach.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION OF RESULTS

4.1 INTRODUCTION

This chapter consists of the presentation and analysis of data collected in the field and from secondary sources (GIS Maps) and the discussion of results using appropriate statistical techniques as reflected in the methodology; Google Earth application and ArcGIS 9.3 Software was used in the production of maps; Microsoft Excel 2007 was used in the production of pie charts, bar charts and line graphs. Data was also presented in tabular format. Acquired data was presented, analyzed and interpreted sequentially as follows: first, the interpretation and analysis of Landsat images, interpretation of data sourced from field survey and interpretation laboratory soil sample results.

4.2 THE AREA COVERAGE OF SWAMPS IN SAPELE

Sapele is one of the 25 local government area of Delta State, which lies on latitude 5°54´N and longitude 5°40´E. Sapele is a lowland area with average elevation of 100-150m above sea level, Sapele has huge potential of natural biodiversity such as Forests and Hydrology (Rivers, Lakes, Swamps etc).

However the rapid rate of urbanization has led to a reduction in these natural resources.

Figure 4.1a is a satellite image from Landsat ETM Images of Google Earth of Sapele which captures the area coverage of natural and human geographical phenomena such as Rivers, Forests, Swamps and Built-up areas.

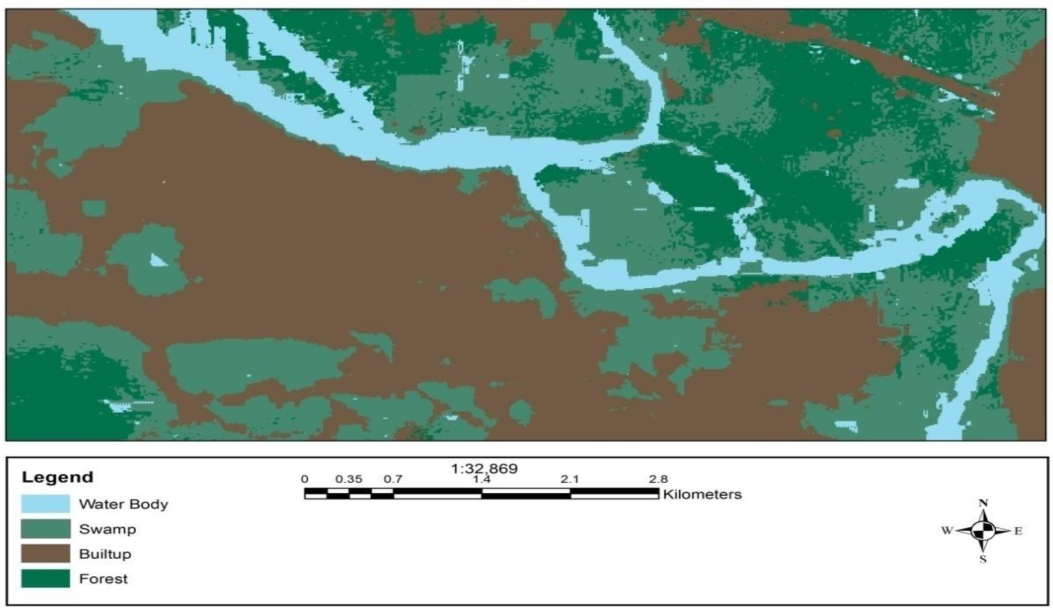

Fig 4.1a The Area Coverage of Forest, Swamp, River and Built-up Areas of Sapele

Source: Landsat ETM Images of Google, 2015

From figure 4.1a, The total area of Sapele captured by the Satellite Image is 58621400 (m2) Square Meters.In order to arscertain the area covered by the individual geographical phenomena, the Raster method was applied to calculate the area covered by Forest, Swamp, River and Built-up areas. As highlighted in figure 4.1b, this involves the computed grid-line techniques whereby the captured image is divided into cells or pixels in rows and columns. This was done using the ArcGIS 9.3 Software. The captured image was divided into 15 rows and 20 columns, each

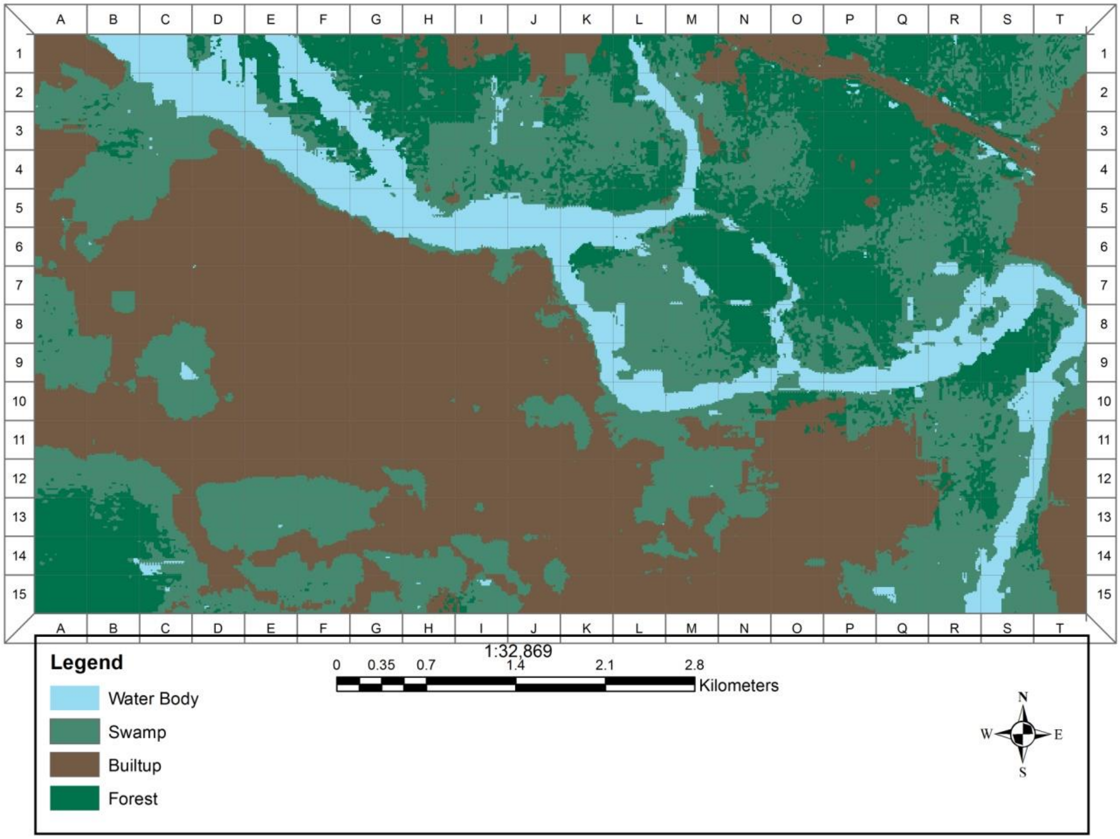

Figure 4.1b The area Coverage of Forest, Swamp, River and Built-up areas of Sapele

Source: Landsat ETM Images of Google Earth, 2015

Geographical phenomena fall into the cells; hence the area covered by the individual geographical phenomena can be calculated using the scale of the map.

Table 4.1 Show the area coverage and percentages of the various geographical phenomena

Table 4.1: The Area Coverage of Swamps, Forest, Built-up Areas and River in Sapele

S/N	Geographic Phenomena	Area Coverage in (%)	Land Area in Square Meters
1	Swamp	23.030	13500700
2	Forest	25.169	14754200
3	Built-up areas	45.274	26540300
	Water Body	6.527	3826200
Total		100	58621400

Source: Field Survey, 2016

Table 4.1 Show the area covered by Swamps which is 23.030%, Forest is 25.169%, Built-up Areas 45.274% and River 6.527%.

The information reveals that built-up areas occupy almost fifty percent of the total landmass, an indication of rapid Urbanization taking place in Sapele, this could result to pressure on Swamp areas. The percentages of Forests (25.169%) and Swamps (23.030%) indicate rich biodiversity, while only a fraction is occupied by River; which is the Benin River or River Ethiope.

The addition of forest and swamp as expressed in percentage is 48.47% which is just about 3% above the area covered by built-up areas alone. A number of deductions can be drawn from the above information:

i. There is rapid urbanization in Sapele

ii. The rate of urbanization is encroaching on existing natural resources like forest and wetlands

iii. There is the possibility of habitat loss among natural ecosystems and environmental degradation.

4.3 THE SPATIAL PATTERN OF SWAMPS IN SAPELE

The spatial pattern of swamps in Sapele is such that the land area is surrounded almost entirely by fresh water swamps, these swamps are concentrated more at the North Eastern and South Western part of the town, these areas are usually covered by forest; this often make accessibility to these swamps difficult.

Figure 4.2 show the spatial distribution of major swamp areas in Sapele, these swamps are concentrated at longitude 5°39´20´´E, 5°41´40´´E and 5°42´50´´E and latitude 5°52´5´´N and 5°53´0´´N.

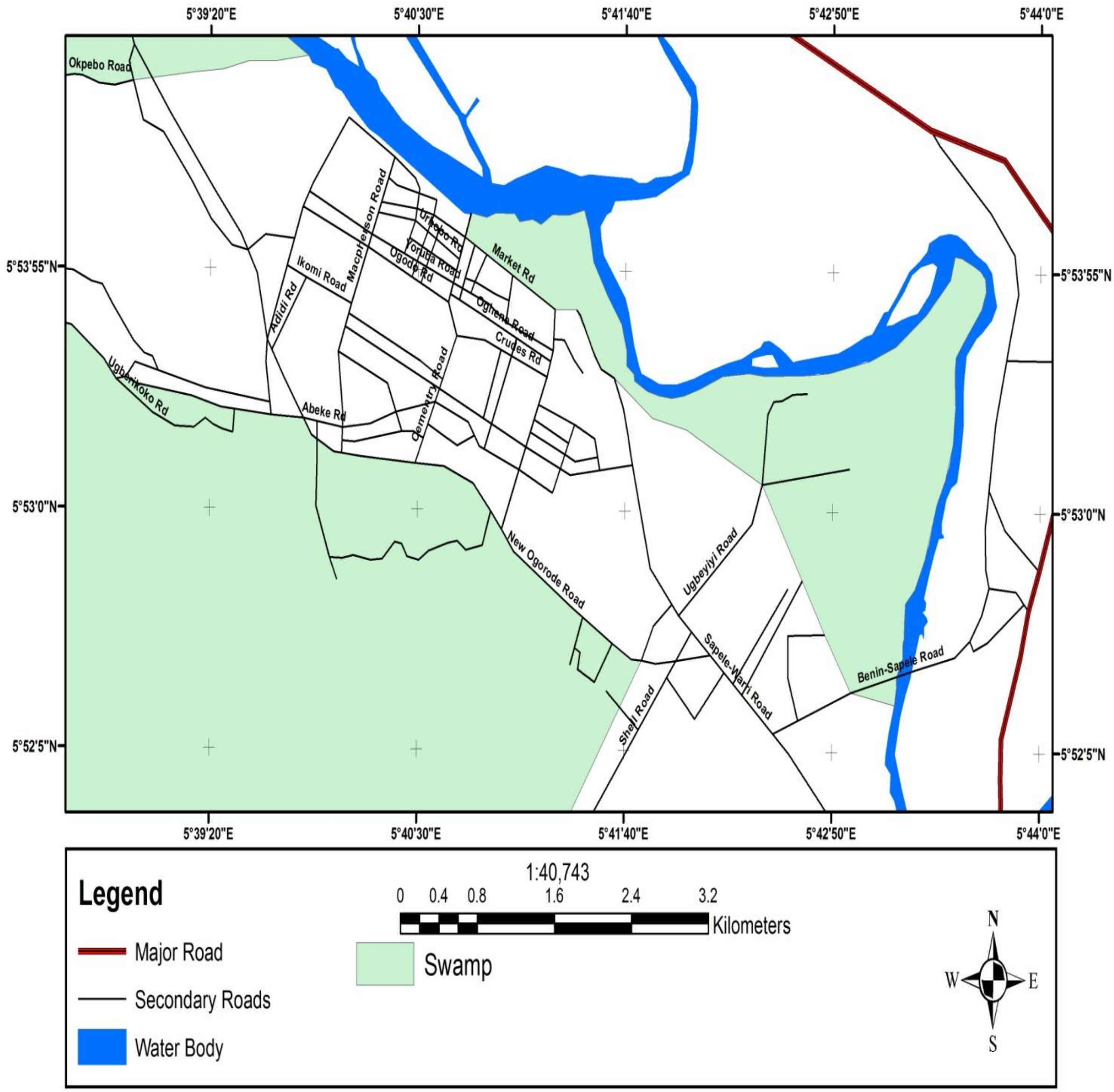

Fig 4.2 The Spatial pattern of major Swamps in Sapele

Source: Landsat ETM Images of Google Earth, 2015

Figure 4.2 Show that these swamps act as linkages between land and River as reflected in longitude 5°39´20´´E, 5°41´40´´E and 5°42´50´´E and latitude 5°52´5´´N and 5°53´0´´N. also as a result of rapid urbanization, some streets have expanded into swamp areas. This includes Okpebo road, Ugberikoko road, Shell road, New Ogorode, Market road, Ugbeyiyi road and Benin-Sapele road. Thus it can be deduced that anthropogenic factors on swamps such as waste deposition, deforestation and land reclamation will be highest at these adjacent areas.

4.4 UTILIZATION OF SWAMPS IN SAPELE

The utilization of accessible swamps or wetlands in Sapele is such that more than 80% of swamps have been affected or modified by anthropogenic factors which have adversely affected the ecosystems in these areas. The major anthropogenic factors include deforestation, waste deposition, poor agricultural practices and land reclamation for building development, however observation from field survey show that about six 6% of swamps are in their natural state. Also observation shows that the major anthropogenic factors affecting swamps in open spaces were waste deposition and deforestation. While in the interior areas were affected basically by poor agricultural activities such as fish farming and poultry farming.

4.4.1 Deforestation

Several acres of wetlands have been lost to deforestation in areas such as New Ogorode road and Ajimele road, Reclamation road and Owumi road. The impact of deforestation on these wetlands is that this often results to loss of biodiversity and wetland degradation such that animals that naturally inhabit these swamps will have to migrate to other suitable environment. Consequently; this often results to invasion of new species and exposes swamp soils to erosion processes.

Deforestation also increases the vulnerability of these swamp areas to other anthropogenic factors such as waste deposition and land reclamation.

Plate 1. Show a deforested swamp at New Ogorode road Sapele.

Plate1. A Deforested Swamp at New Ogorode Road, Sapele

Source: Field Survey, 2016

4.4.2 Waste Deposition and poor Agricultural practices

This is another major anthropogenic factor that affects swamps negatively in Sapele, major swamps on open spaces have been converted to sites for refuse disposal, often untreated waste have been deposited indiscriminately on swamps; this is paramount at New Ogorode road where several tonnes of waste have been deposited on swamps. This have a lot of negative implications On swamps which include, pollution of swamp water quality that will adversely affect aquatic organisms, pollution of swamp soils by the introduction of heavy metals which often result to swamp soil degradation and destruction of micro organisms in swamp soils.

At the interior areas, the major anthropogenic factors affecting swamp areas include Agricultural activities such as poultry farming and fish ponds. This is very common in areas such as Ugbeyiyi and Ugberikoko road; where large areas of swamps are isolated for fish farming, poultry farms are equally built directly on swamps. The problem in these areas is that environmental standards are not adopted, as a result, organic waste from farms are directly deposited on swamps

Plate 2 Agricultural Activities on Swamps at New Ogorode Road, Sapele

Source: Field Survey, 2016

Table 4.2 Show the utilization of some swamps gotten from field survey at different location in Sapele. These were swamp sites visited during field survey, 94% have been impacted by human activities. While only 6% are undisturbed or in their natural state. Among the swamp site visited, 29.54% where used for agricultural activities such as poultry farming, fish farming and growing of crops. 25% was used as waste dump sites while 38.64% have been deforested.

Table 4.2 The Utilization Of 44 Swamps in Sapele

S/N	LOCATION	UTILIZATION	ANTHROPOGENIC IMPACT	NUMBER OF SWAMPS	PERCENTAGE (%)
1.	IRETO RD(1), UGBEYIYI RD(2), DIDEN LANE(1)	FISH POND	YES	4	9.08
2.	UGBERIKOKO RD(1), UGBEYIYI RD(2)	POULTRY	YES	3	6.82
3.	NEW OGORODE RD(6),	CROPS	YES	6	13.64
4.	NEW OGORODE RD(1), ATUFE RD(2)	NATURAL STATE	NO	3	6.82
5.	OWUMI RD(2), RECLAMATION RD(2), NEW OGORODE RD(6), SAPELE-WARRI RD(1)	WAST-DUMPSITE	YES	11	25
6.	RECLAMATION RD(2), OWUMI RD(2), NEW OGORODE RD(9), SAPELE-WARRI RD(2), AJIMELE RD(2)	DEFORESTATION	YES	17	38.64

Source: Field Survey, 2016

4.4.3 The Encroachment of Buildings on Swamps in Sapele

The most rapid anthropogenic factor ravaging wetland areas in Sapele, is wetland reclamation for development of residential buildings. This is very common in areas such as Ugbeyiyi and Ugberikoko road; where swamp areas are land filled for building development.

Plate 3. Stores built on Swamps at New Ogorode Road, Sapele

Source: Field Survey, 2016

For the purpose of this research, the Ugbeyiyi Neighbourhood was used as a case study to show the impact of wetland reclamation on existing wetland areas. The Ugbeyiyi Neighborhood was chosen as a case study to reflect the encroachment of buildings on swamps in Sapele, because rapid development activities is taking place in the neighborhood, secondly from field observation, it was discovered that construction activities is encroaching at alarming rate towards the swamps in the region.

To achieve this, a supervised image classification and digitization was used at the street level to capture the distribution of buildings developed on swamps and those not on swamps.

Figure 4.3a Show the total number of buildings at Ugbeyiyi road, while figure 4.3b Show the distribution of buildings developed on swamps and those not on swamps.

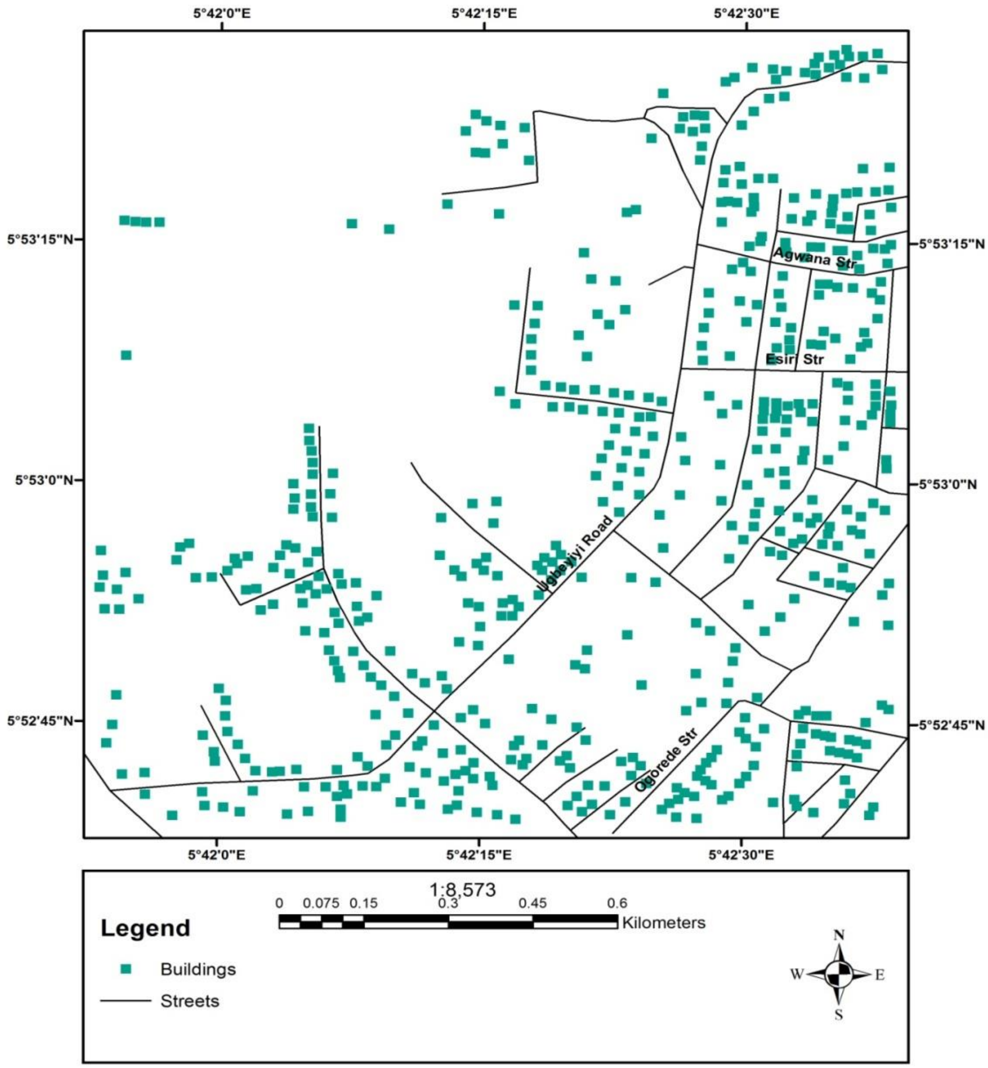

Fig 4.3a Total number of buildings at Ugbeyiyi road

Source: Landsat ETM Images of Google Earth, 2015

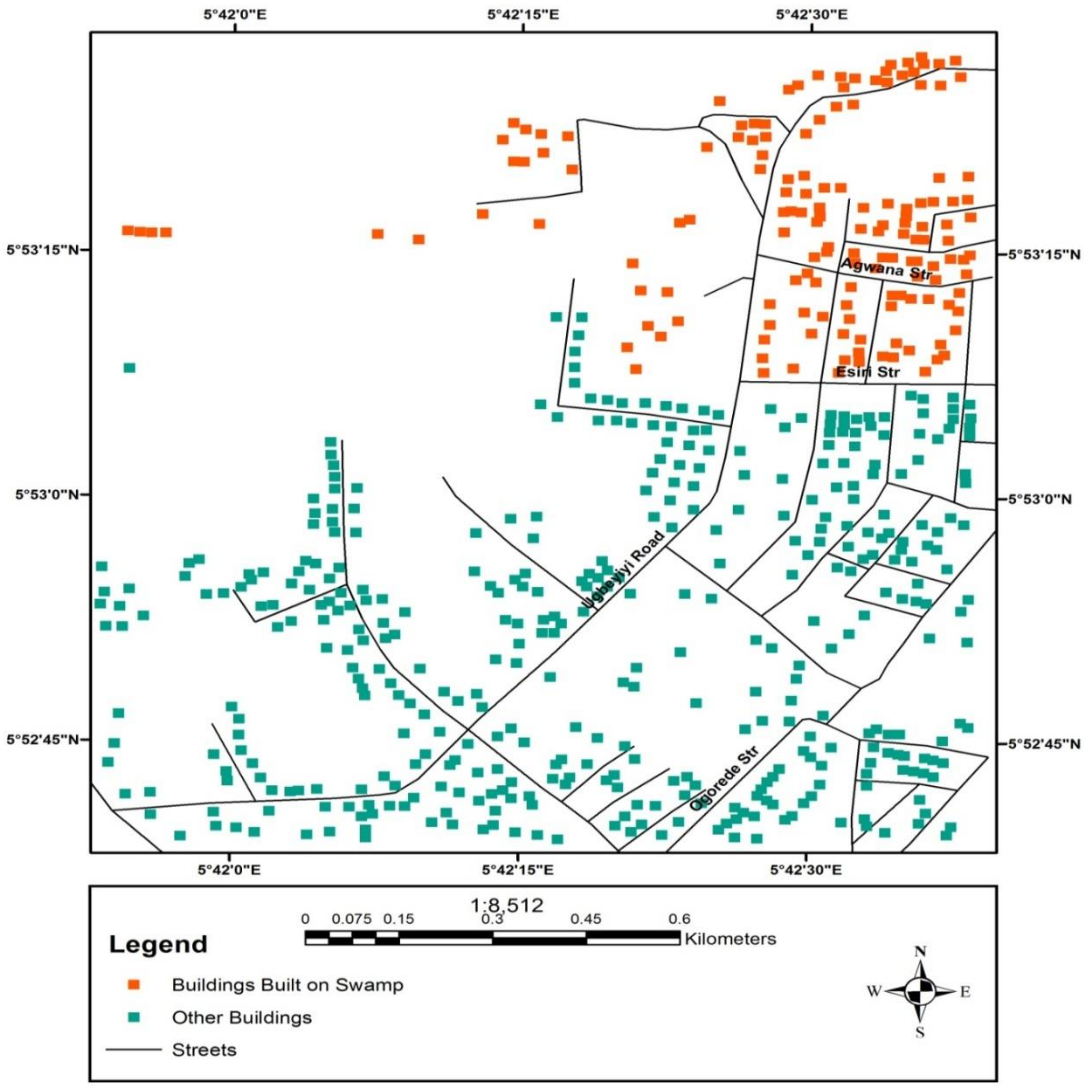

Fig 4.3b Total number of buildings developed on Swamps and those not on Swamps

Source: Landsat ETM of Images Google Earth, 2015

Figure 4.3a showed the total number of buildings which are clustered around the streets, buildings are concentrated mainly at the North Eastern and South Eastern part of Ugbeyiyi road, precisely longitude 5º42´30´´E and latitude 5º53´15´´N and 5º53´0´´N. the total number of buildings in figure 4.a is 551.

Figure 4.3b Show two categories of buildings; which includes those built on swamps and those not on swamps; the total number of buildings on swamps is 150, these buildings are clustered at the North Eastern part of Ugbeyiyi road basically at longitude 5º42´15´´E and 5º42´30´´E and latitude 5º53´15´´ around Agwana and Esiri street.

Figure 4.4 is a sectoral representation of the two categories of buildings at Ugbeyiyi.

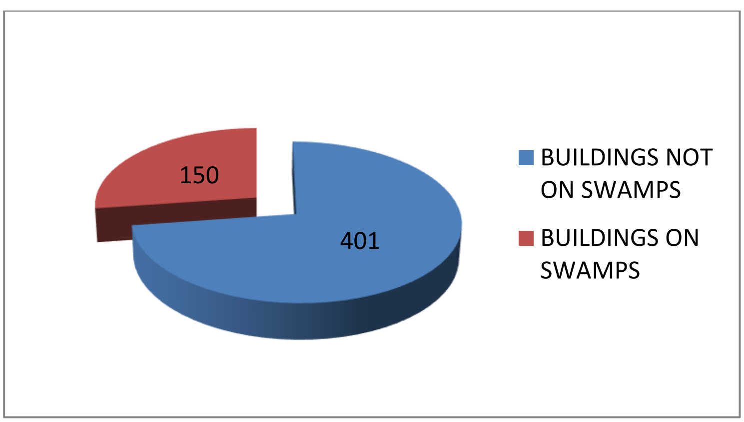

Fig 4.4 Sectoral representation of buildings at Ugbeyiyi, Sapele.

Source: Field Survey, 2016

Conclusions can be drawn from the spatial distribution of buildings:

i. There is rapid building development at Ugbeyiyi road
ii. There is encroachment of buildings on swamps in Ugbeyiyi
iii. About 27% of buildings are built on swamps which indicate anthropogenic impact of reclamation of wetland areas.

4.5 INTERPRETATION OF LABORATORY RESULTS OF SWAMP SOIL SAMPLES

Swamp soil samples were also collected from five swamp sites, these samples was taken to the laboratory to test if these soils were contaminated with heavy metals.

Anthropogenic impact can affect swamp soils negatively by high concentration of heavy metals such as Copper (Cu), Nickel (Ni), Lead (Pb) and Zinc (Zn) in the soil; which often pose threat to plants and animals.

Heavy metal concentration sometimes occurs as a result of waste deposition on swamp soils or the location of industries in close proximity to swamp sites. However swamp soils can equally be contaminated through other means.

Table 4.3 Show the geographic coordinates, names of location and land use of the swamp sites where samples were collected.

Figure 4.5 Show the map of Sapele depicting the location where soil samples were collected.

Soil samples were collected from New Ogorode road, Reclamation road, Owumi road, Akpoisi road and Ireto road.

Table 4.3: Geographic Coordinates and Land use Pattern of Swamp Soil Sampling Sites

SITE S/N	NAME OF LOCATION	LATITUDE	LONGITUDE	DESCRIPTION OF LANDUSE IN THE AREA
1.	NEW OGORODE ROAD	5°52′44″N	5°41′21″E	Open Space
2.	RECLAMATION ROAD	5°53′30″N	5°40′30″E	Residential
3.	OWUMI ROAD	5°53′27″N	5°40′04″E	Residential
4.	AKPOISI ROAD	5°52′48″N	5°42′33″E	Residential
5.	IRETO ROAD	5°52′48″N	5°40′16″E	Residential

Source: Field Survey, 2016

Soil samples were collected using Soil Auger to extract soil from swamp surfaces with a depth of 0-15cm. these samples were stored in polythene bags in order to preserve soil content before taken to the laboratory of the Department of Chemistry, University of Benin for analysis.

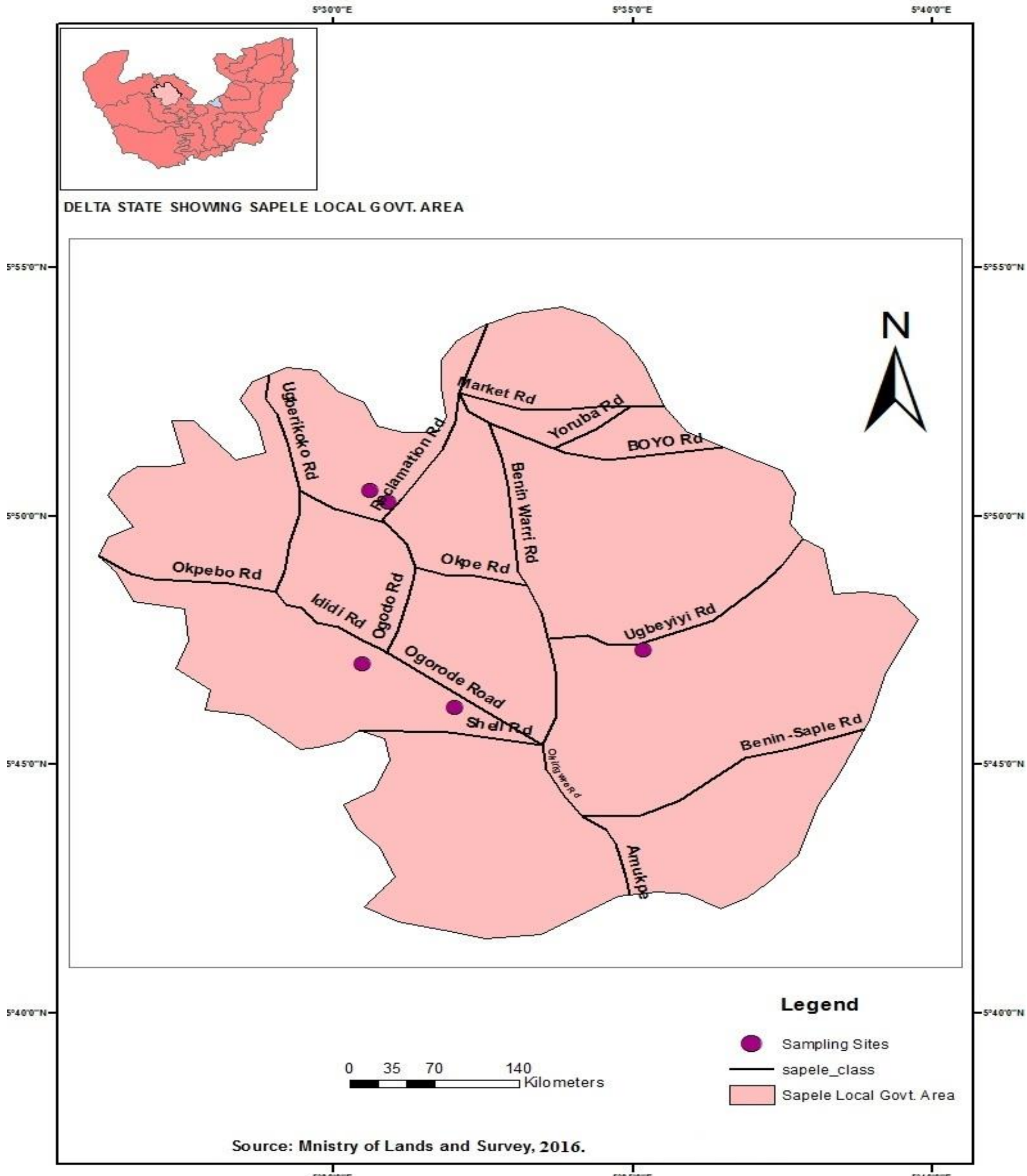

Fig 4.5 Map of Sapele Showing Sampling Sites

Source: Ministry of Lands and Survey, Edo State 2016

Table 4.4 Show the concentration of heavy metals at various sampling sites, some of the samples reveal high contamination; others have low or no contaminant of some heavy metals. The heavy metals tested include Copper (Cu), Nickel (Ni), Lead (Pb), Chromium (Cr), and Zinc (Zn).

4.5.1The Integrated Pollution Index

The integrated pollution Index (IPI) classification was used as a standard in the categorization of the five heavy metal concentration in the five soil samples tested in the laboratory.

Thus (IPI) is classified as:

IPI<1 low level of pollution; 1<IPI< 2 moderate level of pollution; 2<IPI<5 high level of pollution; IPI> 5 extreme high level of pollution (Chen et al., 2005; Wei et al., 2009).

Table 4.4 Level of Heavy Metal Concentration in Sampled Sites

SITE S/N	NAME OF LOCATION	Copper (Cu) Mg/L	Nickel (Ni) Mg/L	Lead (Pb) Mg/L	Chromium (Cr) Mg/L	Zinc (Zn) Mg/L	Percentage (%)
1	NEW OGORODE ROAD	0.59(L)	0.20(L)	2.48(H)	0.24(L)	6.40(E.H)	3 (Cu)
2	RECLAMATION ROAD	0.09(L)	0.00(L)	2.47(H)	0.09(L)	9.98(E.H)	4 (Ni)
3	OWUMI ROAD	0.12(L)	0.30(L)	0.96(L)	0.31(L)	0.85(L)	27 (Pb)
4	AKPOISI ROAD	0.09(L)	0.40(L)	0.87(L)	0.39(L)	0.29(L)	4 (Cr)
5	IRETO ROAD	0.01(L)	0.20(L)	1.19(M)	0.26(L)	1.22(M)	62 (Zn)
TOTAL		0.9	1.1	7.97	1.29	18.74	100

Level of pollution H = high, L = low, M = moderate, E.H =extreme high

Source: Field Survey, 2016

4.5.2 Statistical summary of Soil sample results

Table 4.5 Statistical Summary of Soil Sample Results obtained from the Laboratory

Statistical Variable	Copper (Cu) Mg/L	Nickel (Ni) Mg/L	Lead(Pb) Mg/L	Chromium (Cr) Mg/L	Zinc (Zn) Mg/L
Average	0.18	0.22	1.59	0.26	3.75
Minimum	0.01	0.00	0.87	0.09	0.29
Maximum	0.9	0.40	2.48	0.39	9.98
Standard deviation	0.466	0.297	1.63	0.221	8.52
Median	0.12	0.30	0.96	0.31	0.85
Variance	0.217	0.08	2.64	0.049	72.6

Source: Field survey, 2016

Table 4.5 show the statistical summary of results obtained from soil samples; from the results Zinc has the highest variance, Chromium has the lowest variance. On the average Zinc is 3.75Mg/L which is the highest while copper is 0.18Mg/L which is the lowest. From the minimum result, Lead is 0.87Mg/L and Copper 0.01Mg/L. from the maximum result, Zinc has the highest of 9.98Mg/L and Chromium has the lowest of 0.39Mg/L.

4.5.3 Interpretation of Heavy Metal Pollution Level in Swamp Soils Using The Integrated Pollution Index (IPI)

The heavy metal concentration at the five sites visited show some variation in concentration, while some heavy metals have low concentration at some sites, the concentration at some other sites is quite high. Generally, low concentration signifies little or no contamination by such heavy metal; while high concentration implies contamination by such heavy metal.

Figure 4.6 to 4.11 Show the various concentration level of the five heavy metals at the five sampling sites visited:

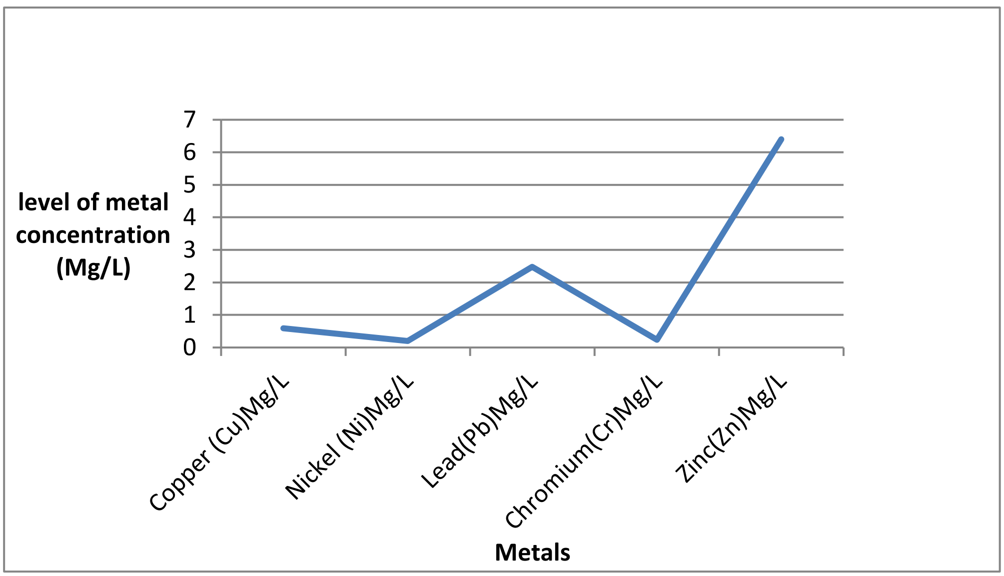

Fig: 4.6 Concentration of heavy metals at New Ogorode Road, Sapele

Source: Field work, 2016.

Figure 4.6 Show the concentration of the five heavy metals sampled at New Ogorode Road Sapele. Laboratory test results reveal Copper (Cu) concentration as 0.59Mg/L, this concentration is (LOW) according to Integrated pollution index of heavy metals in the soil. This reveals that the soil is not contaminated by Copper. The concentration of Nickel (Ni) is 0.20Mg/L, which also (LOW). The concentration of Lead (Pb) is 2.48Mg/L which is classified as (HIGH) according to the Integrated pollution index of heavy metal concentration, this means that the soil is contaminated by Lead. The concentration of Chromium (Cr) is 0.24Mg/L, this is classified as (LOW) in concentration. The concentration of Zinc (Zn) is 6.40Mg/L, this is classified as (EXTREMELY HIGH), and this could pose great threat to plants and animals as well as humans.

In conclusion, the soil laboratory analysis of New Ogorode Road reveals that the soil is contaminated by Lead and Zinc.

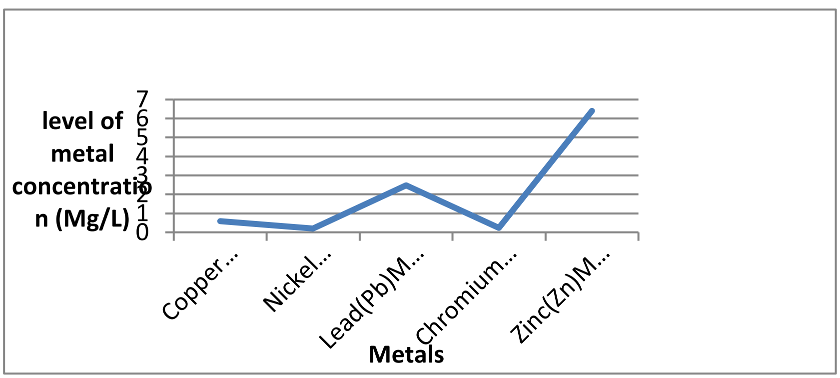

Fig: 4.7 Concentration of heavy metals at Reclamation Road, Sapele

Source: Field work, 2016.

Figure 4.7 Show the concentration of the five heavy metals sampled at Reclamation Road Sapele. Laboratory test results reveal Copper (Cu) concentration as 0.09Mg/L, this concentration is (LOW) according to Integrated pollution index of heavy metals in the soil. This reveals that the soil is not contaminated by Copper. The concentration of Nickel (Ni) is 0.00Mg/L, which indicate that the heavy metal is not present in the soil. The concentration of Lead (Pb) is 2.47Mg/L which is classified as (HIGH) according to the Integrated pollution index of heavy metal concentration, this means that the soil is contaminated by Lead. The concentration of Chromium (Cr) is 0.09Mg/L, this is classified as (LOW) in concentration. The concentration of Zinc (Zn) is 9.98Mg/L, this is classified as (EXTREMELY HIGH), this could pose great threat to plants and animals as well as humans.

In conclusion, the soil laboratory analysis of Reclamation Road reveals that the soil is contaminated by Lead and Zinc.

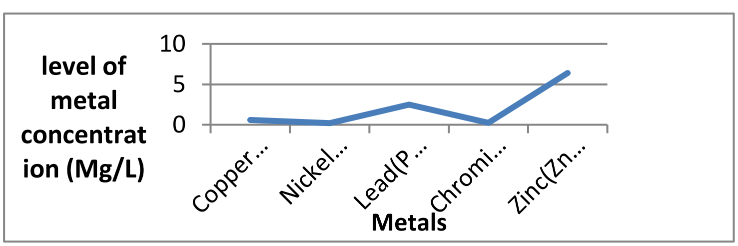

Fig: 4.8 Concentration of heavy metals at Owumi Road, Sapele

Source: Field work, 2016

Figure 4.8 Show the concentration of the five heavy metals sampled at Owumi Road Sapele. Laboratory test results reveal Copper (Cu) concentration as 0.12Mg/L, this concentration is (LOW) according to Integrated pollution index of heavy metals in the soil. This reveals that the soil is not contaminated by Copper. The concentration of Nickel (Ni) is 0.30Mg/L, which indicate that the heavy metal is (LOW) in the soil. The concentration of Lead (Pb) is 0.96Mg/L which is classified as (LOW) according to the Integrated pollution index of heavy metal concentration, this means that the soil is not contaminated by Lead. The concentration of Chromium (Cr) is 0.31Mg/L, this is classified as (LOW) in concentration. The concentration of Zinc (Zn) is 0.85Mg/L, this is classified as (LOW).

In conclusion, the soil laboratory analysis of Owumi Road reveals that the soil is not contaminated by any of the heavy metals. Thus it poses no threats to plants and animals.

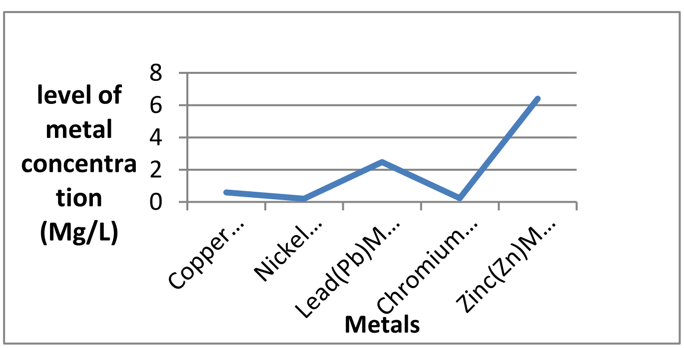

Fig: 4.9 Concentration of heavy metals at Akpoisi Road, Sapele

Source: Field work, 2016

Figure 4.9 Show the concentration of the five heavy metals sampled at Akpoisi Road Sapele. Laboratory test results reveal Copper (Cu) concentration as 0.09Mg/L, this concentration is (LOW) according to integrated pollution index of heavy metals in the soil. This reveals that the soil is not contaminated by Copper. The concentration of Nickel(Ni) is 0.40Mg/L, which indicate that the heavy metal is (LOW) in the soil. The concentration of Lead (Pb) is 0.87Mg/L which is classified as (LOW) according to the Integrated pollution index of heavy metal concentration, this means that the soil is not contaminated by Lead. The concentration of Chromium (Cr) is 0.39Mg/L, this is classified as (LOW) in concentration. The concentration of Zinc (Zn) is 0.29Mg/L; this is classified as (LOW).

In conclusion, the soil laboratory analysis of Akpoisi Road reveals that the soil is not contaminated by any of the heavy metals. Thus it poses no threats to plants and animals.

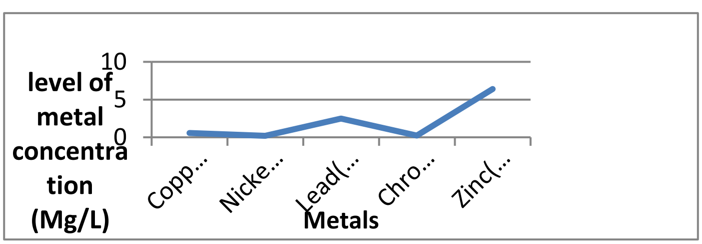

Fig: 4.10 Concentration of heavy metals at Ireto Road, Sapele

Source: Field work, 2016

Figure 4.10 Show the concentration of the five heavy metals sampled at Ireto Road Sapele. Laboratory test results reveal Copper (Cu) concentration as 0.01Mg/L; this concentration is (LOW) according to integrated pollution index of heavy metals in the soil. This reveals that the soil is not contaminated by Copper. The concentration of Nickel (Ni) is 0.20Mg/L, which indicate that the heavy metal is (LOW) in the soil. The concentration of Lead (Pb) is 1.19Mg/L which is classified as (MODERATE) according to the Integrated pollution index of heavy metal concentration, this means that the soil is not contaminated by Lead. The concentration of Chromium (Cr) is 0.26Mg/L, this is classified as (LOW) in concentration. The concentration of Zinc (Zn) is 1.22Mg/L, this is classified as (MODERATE).

In conclusion, the soil laboratory analysis of Ireto Road reveals that the soil is not contaminated by any of the heavy metals. Thus it poses no threats to plants and animals.

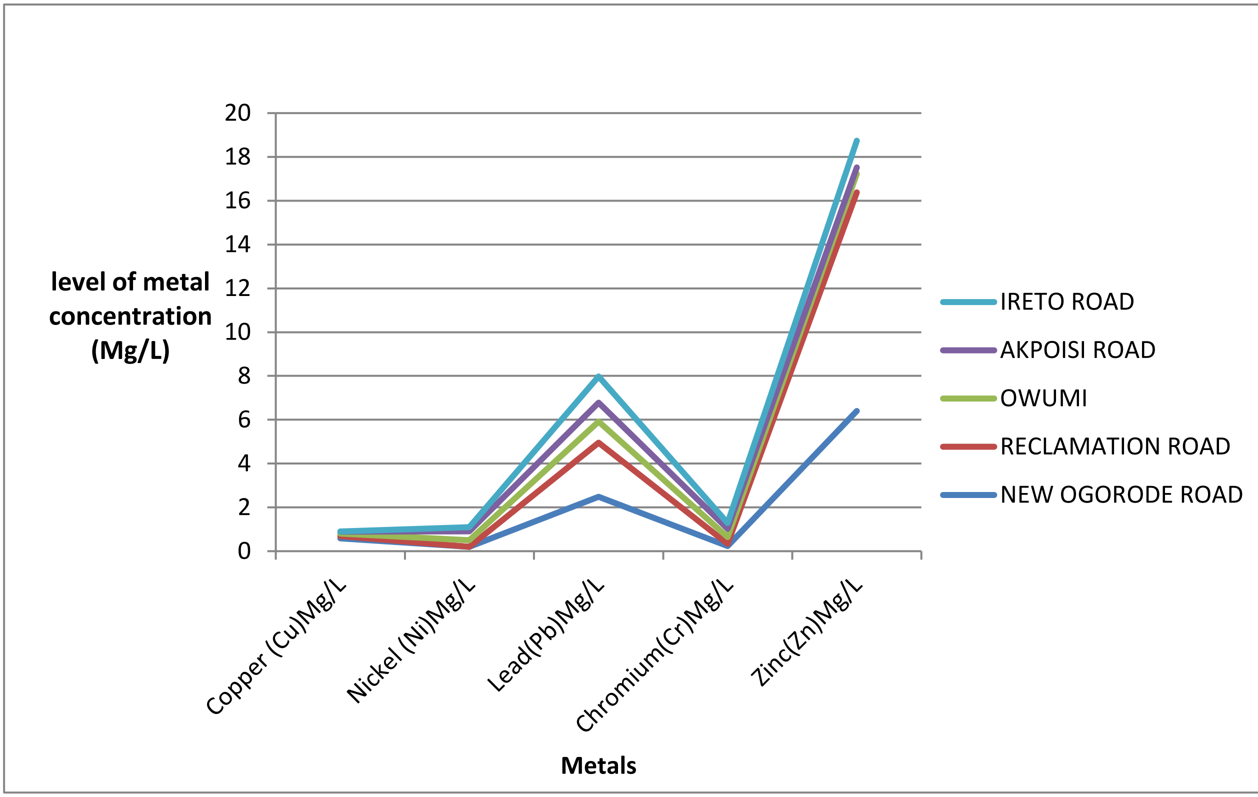

Fig 4.11 Total Concentration of the Five Heavy Metals

Source: Field work, 2016

Figure 4.11 show the total concentration of the five heavy metals at the five sampling sites in

Sapele, from the results gotten, Copper (Cu) has a total concentration of 0.9Mg/L, Nickel (Ni) has a a total of 1.1Mg/L, Lead (Pb) has a total of 7.97Mg/L, Chromium (Cr) has a total of 1.29Mg/L and Zinc (Zn) has a total of 18.74.

The results therefore reveal that the soils are contaminated basically with Lead (Pb) and Zinc (Zn) which formed the highest contaminant. Copper (Cu) has the lowest concentration followed by Nickel (Ni) and Chromium (Cr) respectively.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY

The following deductions were revealed from findings of this research:

1. The area of study (Sapele) has enormous potentials of wetland resources.
2. Anthropogenic activities have modified in great extent the nature of various wetland areas in Sapele.
3. The exploitation pattern of various wetlands in Sapele has adversely affected the natural state of these wetlands.
4. Wetlands are not utilized to their full potential.
5. There is poor management practice and conservation measures of wetland areas.
6. The level of awareness of the public on the importance of wetlands is low.
7. There are little or no environmental laws governing the use and management of wetlands in Sapele.
8. There is high level of biodiversity loss among wetlands in Sapele.
9. The poor use of these wetlands has direct and indirect implicating effect on humans, plants and animals.

10. The land area occupied by wetlands is about 23% percent.
11. The general hydrological setting of Sapele can stimulate rapid human development if properly utilized.
12. There is high level of urban expansion, which consequently result to pressure on wetland areas.

5.2 RECOMMENDATIONS

Wetlands or Swamp are vital resource in the environment and contribute measurably to the physical, human, economic and cultural wellbeing of man. The proper utilization of these landforms will stimulate rapid economic growth to localities where they are situated at the same time conserve and protect the ecosystem of these wetland areas.

These recommendations can be classified into categories (information, participation, decision making process). Thus the following recommendations are essential for optimum utilization of swamps in Sapele Local Government Area of Delta State:

5.2.1 Information

i. Management plans and programmes should be made available to the public on the importance of wetland resource through workshops, seminars and public lectures.

ii. The establishment of institutional bodies at the local level to enhance the awareness of wetland systems.

iii. Provision of Environmental Impact Assessment (EIA) information to local industries

iv. Enhancement of accessibility to planning bodies at the local level.

5.2.2 Participation

i. Community based management approach should be adopted by the government in the management of wetland areas to ensure full scale participation by local people.

ii. An integrated approach should be adopted by stakeholders and experts in the management of wetlands in order to realize optimal results in wetland management.

5.2.3 Decision making process

This involves the government taking the right decisions in wetland management process; it involves the establishment and implementation of environmental laws and assessment process of wetland management which entails monitoring and policy implementations. It also involves the establishment of planning bodies that will oversee that wetland or swampy areas are properly utilized.

5.3 CONCLUSION

This study has assessed the utilization of various swamps in Sapele Local Government Area of Delta State; the conclusion drawn from assessment therefore is that although the region is endowed with enormous wetland resources, the community is yet to tap optimally into this available resource. However, the exploitation pattern of the available swamp ecosystem has negative implication on the environment. This challenge should be addressed to ensure conservation and protection of the natural ecosystem.

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APENDIX 1

Table 4.3 Level of Heavy Metal Concentration in Sampled Sites

SITE S/N	NAME OF LOCATION	Copper (Cu) Mg/L	Nickel (Ni) Mg/L	Lead (Pb) Mg/L	Chromium (Cr) Mg/L	Zinc (Zn) Mg/L	Percentage (%)
1	NEW OGORODE ROAD	0.59(L)	0.20(L)	2.48(H)	0.24(L)	6.40(E.H)	3 (Cu)
2	RECLAMATION ROAD	0.09(L)	0.00(L)	2.47(H)	0.09(L)	9.98(EH)	4 (Ni)
3	OWUMI ROAD	0.12(L)	0.30(L)	0.96(L)	0.31(L)	0.85(L)	27 (Pb)
4	AKPOISI ROAD	0.09(L)	0.40(L)	0.87(L)	0.39(L)	0.29(L)	4 (Cr)
5	IRETO ROAD	0.01(L)	0.20(L)	1.19(M)	0.26(L)	1.22(M)	62 (Zn)
TOTAL		0.9	1.1	7.97	1.29	18.74	100

Source:Field Survey, 2016