Federal Environmental Protection Agency

Large Marine Ecosystem Project for the Gulf of Guinea

Coastal Profile of Nigeria

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Foreword

The world values the oceans so much that 60 % of its 5,5 billion people live within 60 kilometers of the coast. In Nigeria, the marine environment including lagoons, estuaries, bays, creeks, etc constitute a vast and dynamic storehouse of energy, food and mineral resources that hold a lot of promise for rapid socio-economic development.

Competing interests among a variety of marine and coastal resource uses often leads to social conflicts and environmental degradation. It is therefore appropriate for Nigeria to focus attention on the need for sustainable use of our seas and the adjoining coastal lands.

For far too long, we have regarded the seas as so full of bounties that they cannot be exhausted. Today, however, these seas are being exploited beyond carrying capacity and the situation is exaceberated by pollution pressures to which our seas are subjected from a wide variety of land and sea-based activities.

Our approach in the Federal Environmental Protection Agency (FEPA) for arresting the high spate of coastal and marine resources depletion and degradation and ensuring environmentally sustainable development is through Integrated Coastal Areas Management (ICAM). This helps to promote sustainable use of our marine natural resources as well as restore and maintain the integrity of our coastal and marine ecosystem. Recognition has been given to this approach in the Environment Agenda of Nigeria's Vision 2010.

Nigeria, however recognises the interconnectivity of the fact that in spite of our best efforts at the national level, there is a need to look beyond our frontiers in a bid to forge common ICAM policies and strategies with our neighbours, near and beyond.

It was in this context that Nigeria readily signed the Gulf of Guinea Large Marine Ecosystem Project that unites six countries. In the pilot phase, the project puts premium on the formulation and adoption of national integrated coastal areas management plans based on the identification of common transboundary problems and the institutionalisation of similar policies and strategies to combat them.

This National Coastal Profile being issued by FEPA is a necessary first step to a national Integrated Coastal Areas Management plan for Nigeria and is a significant step forward towards the ultimate national management of our coastal and marine environment and the natural resources therein.

For this effort, I wish to commend both Dr. (Mrs) Olushola Dublin Green of the Nigeria Institute of Oceanography and Marine Research (NIOMR) and Mr. Akin Awobamise of FEPA for producing the base document. I also wish to pay tribute to the more than 110 scientists and managers from government and non-governmental organizations,

including the organised private sector, that gathered at a national workshop in Lagos on 25th-27th August 1997 to debate, improve and adopt a definitive national profile that is precented in this volume. In this regard, I wish to recognise the guidance offered by the Regional Coordinator of the GOG-LME Project, Prof. Chidi Ibe.

I am pleased to be a part of this march towards the institutionalization of a national Integrated Coastal Areas Management plan for Nigeria. It is with great satisfaction therefore, that I issue this important national document and would welcome any suggestions for its further improvement.

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1. Introduction

Nigeria is a maritime state with a coastline of approximately 853 km and lies between latitude 4°10' to 620'N and longitude 2 °45' to 8 5'E. The Nigerian coastline stretches from the western border with the Republic of Benin to the eastern border with the Cameroon Republic (Fig.1).

Nigeria as a maritime state, is signatory to the Law of the Sea Convention. Her sovereignty extends beyond her internal waters to her territorial sea of 30 nautical miles. In 1978, Nigeria established an Exclusive Economic Zone which is an area beyond and adjacent to the territorial sea extending 200 nautical miles from the baseline. The surface area of the continental shelf is 46,300 km2 while the EEZ covers an area of 210,900 km2 (World Resources 1990), within which Nigeria exercises sovereign rights for the purpose of exploring, exploiting, conserving, and managing the natural resources.

Much of Nigeria's population and economic activities are located along the coast with over 20% of the population inhabiting coastal areas. Of the 36 states in the country, 9 (Lagos, Ogun, Ondo, Edo, Delta, Bayelsa, Rivers, Akwa Ibom and Cross River) are located in the coastal zone. The Nigerian coastal zone and its resources have vast implications for the economy. Some ofthe important resources include fish, shell fish such as shrimps, lobsters, Crabs and molluscs.

The Niger Delta, a major geomorphic feature in the Nigerian coastal zone is depository for oil and gas - Nigeria's main source of foreign exchange. Other uses of the Nigerian coastal zone include transportation, communication, defence, recreation, and haven for pollutants.

Several scientific studies have been carried out on the Nigerian coastal zone. However, data accumulated from these studies have not been comprehensively coordinated. : many studies carried out by oil-exploration companies are largely unpublished and consequently not available for dissemination.

The present state of knowledge on the Nigerian coastal zone is chiefly based on studies carried out by scientists in Universities, Research Institutes and some Government Agencies.

Definition of the Nigerian Coastal Area

The Nigerian coastal area lies with in the Atlantic ocean with its continental shelf, the Exclusive Economic Zone and the coastal fresh water and brackish wet lands ramified

by an atomising network of rivers and creeks. These water bodies are characterised by periodic tidal variations and ranges along water channels and the differences depend on the hydrological properties and the slopes of the various channels.

The Nigerian coastal area includes the area within the uppermost limit of tidal influence and the edge of the continental shelf (shelf break). It is bounded to the north by an extensive river (fresh water) flood plain. It is a low lying area with heights not more than 3.5 m above sea level.

Onshore, the Nigerian Coastal Area is dominated by extensive stretches of sandy beaches (barrier islands) lagoons, estuaries, mud beaches, creeks and a deltaic complex.

Figure1: The Nigerian coastal zone and important coastal towns and settlements

2. Physical characteristics of the Nigerian coastal zone

2.1 THE NIGERIAN CONTINENTAL SHELF

The Nigerian continental shelf is mounted on a voluminous relatively localised protrusion into the Gulf of Guinea ocean basin and consists of Tertiary sediments thickening seaward to a maximum of about 12,000 m. The continental shelf is narrow in the west and ranges in width from 28 - 33 km. The width increases to 63 km off Cape Formoso at the nose of the Niger Delta, increasing eastwards to about 75 km off Calabar.

According to Allen (1964), two series of later Quaternary sediments occur on the surface of the Nigerian continental shelf. The earlier series is quartzone sheet-like sand bodies which can be traced over most of the continental shelf. The older sand was deposited during late Pleistocene to early Holocene eustatic rise of the sea (transgression of the sea). The surface of the sand sheet is formed into terraces and ridges parallel to the shore and crossed locally by shallow valleys with channelled floors. These have been interpreted as drowned barrier beaches on island complexes.

The latter sediments, the Younger Suite, locally bury the Older Sands on the continental shelf They comprise sands near shore, silts in moderate depths and clays in deep water. They have been deposited during the seaward growth of the modern Niger Delta (Regression). River mouth bars and inshore terrace and rise are the principal morphological features of the modern continental shelfunderlain by Younger Suite.

Allen and Wells (1962) and Awosika (1990) described a system of dead Holocene coral banks in some parts of the middle and outer continental shelf. The dead coral banks which run parallel to the coastline between 80 - 100 metres depth attain heights of about 7 m in some places especially along the western shelf.

Three major canyons : Avon, Mahin and Calabar deeply groove the Nigerian Continental shelf and slope (Fig.2).

The Avon Canyon (approx. 06°10'N, 03°55'E) is located off the Lagos coast with the head at about 3 - 5 km off the coast in depths less than 18 metres of water. The Avon canyon is about 15 km wide and 730 metres deep.

The Mahin Canyon is located off the Mahin Mud Coast and at approximately (06°00'N, 08°14'E). It is smaller than Avon Canyon and heads further from the coast in deeper waters at about 55 metres. The canyon is approximately 1.6 km wide and depth varies between 180 - 900 metres.

The Calabar Canyon is located eastwards off Calabar approximately 03°53'N, 08°14'E. This canyon embays the shelf by about 8 km, width is about 3 km and depth varies from 180 - 450 metres.

These canyons have been reported to serve as conduits for the channelling of sand into offshore submarine fans on the slope.

The overall nature of the Nigerian continental shelf is mainly depositional as compared to adjacent parts of the continental shelf along the Gulf of Guinea where Basement Complex rocks appear close to the coast.

Figure 2: Bathymetric configuration of the Nigeria continental shelf

2.2 GEOLOGY

The geologic history of the Nigerian coastal zone is associated with the geologic evolution of the Nigerian continental margin. According to Emery et al (1974), the Nigerian continental margin evolved with the separation of the African plate from the South American plate during the Mesozoic. This separation of plates resulted in the opening up of the South Atlantic. These events spanned millions of years beginning from Upper Jurassic to Upper Cretaceous. The final separation of the Brazilian landmass from the Gulf of Guinea resulted in the development of the West African coast line.

In the Tertiary, the Nigerian coastline witnessed a succession of transgressions and regressions which resulted in an oscillating shoreline that advanced about 250 km southwards. During the Early Pleistocene, the shoreline probably coincides with the present 200m isobath as evidenced by relic pleistocene beach sands outcrops on the outer continental shelf (Allen 1965). The successive transgressions and regressions of the sea were responsible for the morphology of the Nigerian coast line and the continental shelf.

The Niger Delta is a major geomorphic feature in the Nigerian Coastal Zone. The evolution of the modern Niger Delta started in Early Tertiary with sediments being supplied by the Niger-Benue River system which over the years have built a large delta. The Niger Delta complex consists of formation deposited in a high energy constructive deltaic environment. Sediment build-up was accompanied by growth faulting normal to the direction of the progradation which resulted in a series of near parallel fault bounded depositional belts. These depobelts are successively younger from North to

South. Overlying these depobelts is the same stratigraphic sequence that consists of three sedimentary units :

(a) The Benin formation which is continental in origin is composed mostly of sandstone.

(b) The Agbada formation which is paralic is composed of alternating sands and shales and is the major hydrocarbon habitat in the Niger Delta.

(c) The Akata formation is mostly massive marine shale and is the most active source rock in the Basin.

The geology of the subaerial portion of the Nigerian coastal zone is given in Fig.3.

2.3 GEOMORPHOLOGY

The Nigerian coastal zone can be classified into four geomorphic units (Fig.4).

2.3.1 The Barrier-Lagoon Complex

The barrier-lagoon complex extends eastward for about 200 km from the Nigeria/Benin Republic border to the western limit of the transgressive mud coast. The morphology has largely been determined by coastal dynamics and drainage (Ibe 1988). The beaches are erosive due to lack of exoreic rivers which would have compensated for the sand lost from longshore current action. The Barrier lagoon complex is backed by the Badagry Creek, the Lagos Lagoon, Lekki Lagoon and numerous creeks whose only connection to the sea is through the Commodore Channel in Lagos.

The complex consists of narrow beach ridges which are aligned parallel to the coast. Due to the high energy associated with the coastline of the Barrier Complex, beach profiles are characteristically steep. Average slope of beaches is about 1: 6.

The textural characteristics of sediment from the Badagry beach (65 km west of Lagos) vary from medium to coarse, moderately well sorted sand. Beach sands from the Lekki beach (56 km east of Lagos) are similar to that of Badagry beach. The sands vary from medium to coarse and well sorted. There is a fining of grain size eastwards (Ibe 1988).

Figure 3: Geological map of the Nigerian coastal zone (Allen 1965)

Figure 4: Geomorphological map of the Nigerian coastal zone

2.3.2 Mahin Transressive Mud Coast

The medium to coarse sandy beaches of Badagry, Lagos and Lekki grade eastward into a mud beach off Lekki Lagoon. The mud beach extends for 75 km and terminates at the mouth of Benin River on the northwestern flank of the Niger Delta. The mud coast is low lying and almost totally devoid of sand. The absence of significant quantities of sand on the beach and the apparent failure of longshore currents to continue barrier island formation beyond the barrier-lagoon complex was attributed to Avon and Mahin canyons which channel away sand to submarine fans in the slope (Burke 1972).

The stratigraphy of the Mahin mud coast differs from the general stratigraphy of the Niger Delta by having a 60 m capping of mud overlying the continental sand of Benin Formation. The mud beach is backed by freshwater swamps and creeks (Appendix 1).

The Mahin mud beach has a gentle slope. The intertidal beach has a slope of 1:5 with very broad subtidal platform (1-2 km). Berm complexes are poorly developed due to erosion. The beach sediments are mainly medium - coarse, poorly sorted silt.

2.3.3 The Niger Delta

The Niger Delta is a major geomorphic feature in the Nigerian coastal zone. It stretches from the Benin River estuary for about 450 km eastward and terminates at the mouth ofthe Imo River estuary. A total of 21 estuaries open and discharge into the sea through the Delta. The Niger Delta consists of many distinct ecological zones such as fresh water swamp, mangroves, creeks, estuaries and barrier islands. Profiles of some of the beaches are in Appendix 2.

Allen (1970) recognised four major ecological zones in the Niger Delta. These include :

(i) the barrier island complexes

(ii) the vegetated tidal flats

(iii) the lower flood plain

(iv) the upper flood plain

(i) The Barrier-Island Complexes

A series of 20 beach ridge barrier island complexes extend from west to east of the Delta. These form an outer ring of island which help to protect the tidal basins of the Niger Delta from the direct impact of breaking waves. The islands range in length from 5 - 35 km and from a few metres to more than 10 km in width. These ridges are truncated by estuarine channels. The ridges stand at about 1.5 m - 3.5 m high and are fixed by palms, shrubs and grasses.

(ii) Vegetated Tidal Flats

This zone includes the mangrove swamps which are sandwiched between barrier-island complexes and the lower flood plain. The mangrove belt reaches a width of 30 - 40 km at the Delta flanks and the central Delta; the widest areas are in the tidal basins of Bonny, New Calabar, Sombrero and Escravos - Forcados rivers. The mangrove swamp of the Niger Delta covers an area of about 7,500 km2. The mangrove zone is wider in the east than in the west because very little fresh water is discharged into this part of the Delta during the dry season. Consequently, there is salt water intrusion further inland. Deposits in this zone consist mainly of fine organic rich clayey soils with abundant roots.

(iii) The Lower Flood Plain

This zone unit extends from the Nun-Forcados bifurcation to the levee indented margin of the tidal flats. The topography is relatively flat. The river alluvium is deposited in five sub environments - river channels, point bars, levees, back swamp and cut-off channels. These subenvironments are often difficult to recognise because they are covered by thick vegetation. At the peak of the rainy season, the area is usually flooded with most of the flood plain under water. The deposits of the lower flood plain are mainly fine clastics with the coarser ones deposited near the levees.

(iv) The Upper Flood Plain

This unit extends from the Onitsha gap to the bifurcation of the Nun and Forcados. The Orashi river flows parallel to the Niger river in this zone and draws part of its discharge from the Niger River when it overflows during the floods of the wet season. The Niger River is braided in upper flood plain with a channel width of about 2.5 km and a depth of 15 m. Deposits are coarse sand.

2.3.4 The Strand Coast

The Strand coast extends about 85 km east of the Niger Delta from Imo river estuary to the Cross-River estuary. The Strand coast comprises flat beaches which change into a beach ridge plain behind with a few swamp systems. The swamp is in direct contact with the sea at the Cross River estuary and the Rio-del Rey estuary. The swamp systems are backed by older sediments.

Two major breaks occur on the Strand coast at the Kwa Iboe River and Cross River entrances. There is a well developed delta at the entrance to the Kwa Ibo river, while the Cross River entrance represents a typical estuarine complex.

The whole Strand coast is backed by mangrove swamps which inland are in direct contact with older sediments.

The Calabar Canyon is located off the Strand coast. The coast is characterised by a gently sloping beach (1:20) and is erosional. The sediments vary from fine to very fine and very well sorted (Ibe 1988).

2.4 SOILS OF THE NIGERIAN COASTAL ZONE

The climatic conditions along the Nigerian coastal zone (heavy rainfall and high temperature) especially in the Niger Delta have made chemical weathering the dominant geomorphic process in the region. This has resulted in the formation of clay minerals and silt particles from the parent materials. Most of the soils of the Niger Delta are richer in silt-clay fraction than in sand.
Soil types in the Nigerian coastal zone include :

(i) Fresh water alluvium and levee slope soils
These are alluvial deposits. Textures grade from sandy loam to clay loams or clays and grey in colour. The soils are heavy in texture with poor drainage. The natural vegetation of these soils is fresh water forest. Oil palms are also common.

(ii) Flood Plain Soils
These soils are low lying stretches of land bounded by the natural levees. The soils are clay loams to clay. They are strongly acidic with pH in the range of 4.1- 4.6. Organic matter content is betveen 4 - 5%. Vegetation consist of broad leaved forest with an incomplete canopy.

(iii) Mangrove Swamp Soils
This include recently deposited soft mud which consists mainly of silt and clay. These soils are colonised by tall mangrove trees, especially Rhizophora racemosa. The soils contain iron sulphides, if exposed to the air the sulphides oxidise to sulphuric acid. The air-drying of a sample over a period of 2-3 days reduces the pH from 7 to 3.0, organic matter content of these soils vary from 2-22% (Dublin-Green 1985).
Peaty clay or "Chikoko" soils develop under mangroves. On the death of a tree the roots remain in the soil without significant decomposition and after 2 or 3 generations the organic fibres are converted into a peaty clay. This peaty clay, known locally as "chikoko", will no longer support vigorous growth of mangroves. The trees are usually stunted. The peaty clays occupy about 90% of the area under mangroves. Texture is 80-90% silt and clay. Organic matter ranges between 7 - 52% (Anderson 1966). Colour is dark grey to black. The peaty clays have pH of 6.5 to 7 in situ, but like the soft muds develop intense acidity on exposure to air.

(iv) Saline Sands
Saline sands are derived from the erosion of sandy deposits of the older sand suite. The saline sands usually contain about 75% of sand. Fine sand predominates, while the clay

content range from 4-29%. Colour vary from dark grey to light brownish grey. Saline sands support Rhizophora mangrove. Organic matter content 0.25 to 15%.

(v) Beach Ridge Sands

Most of the sand carried by the Niger River and other rivers in the Nigerian coastal zone are discharged into the sea at their mouths and settle as river mouth bars. The rest of the sand is carried by waves and currents and distributed along the shoreline to build up as beach ridges. Some of the ridges are water logged, some are well drained, while some develop an iron humus pan. Beach ridge sands are of low fertility.

In summary, the coarsest and most pervious soils of the Niger Delta are to be found on the natural levees of the upper rivers (sand and silt soils). Solid clays are found in the back swamps behind the levees, silt and clays are deposited long the lower courses of the river and the finest clays in the tidal swamps. The agricultural value of the soil decreases in this order ; drainage conditions also worsen in the same order.

2.5 HYDROLOGY

The Nigerian Coastal Area can be divided into three main hydrological areas (Akintola 1986). The western littoral, the Niger Delta and the eastern littoral.

2.5.1. Western Littoral Hydrological Area

This include the rivers on the Barrier-Lagoon complex, the mud coast and the western delta flank. Some of the major rivers are : Yewa, Ogun, Oshun, Shasha, Oluwa, Siluko, Benin, Escravos and Forcados (Fig.5). Many of these rivers are long and originate within the Basement complex, except those in the western delta flank.

2.5.2 Niger Delta Hydrological Area

This hydrological area comprises the rivers of the arcuate Niger Delta. The zone consists of a dense network of rivers and creeks. The major rivers include : Ramos, Dodo, Pennington, Sengana, Nun, Brass, Santa Barbara and Sombrero. Most of these rivers are short coastal rivers and are distributaries to the Niger river. They originate within the coastal plain sands of the Benin Formation. The waters are transparent and acidic. The Ase and Orashi rivers are located within this hydrological area and both run parallel to the Niger river (Fig.6).

2.5.3 Eastern Littoral Hydrological Area

This zone includes the rivers on the eastern Delta flank and the Strand coast. These are : Bonny, Andoni, Imo, Kwa Iboe and Cross Rivers. The Imo and Cross rivers are large river systems that originate from the Basement complex (Fig.7).

The various rivers in the Nigerian Coastal Area have varying lengths and widths and are subjected to tidal activities which may extend several tens of kilometres (50 - 80 km) inland. The general hydrological cycle in the Nigerian Coastal Area has a dry season period of about 4 months, December to March. In April, the stage gradually rises in the rivers reaching a peak around September - October. Table 1 gives the freshwater discharge in some of the rivers.

Figure 5: Western littoral hydrological area (Akintola 1986)

Table 1: Freshwater Discharge in Some Coastal Rivers (NEDECO 1961)

RIVER ENTRANCE	AVERAGE DISCHARGE OF TIDAL AND FRESH WATER M^3/SEC	AVERAGE DISCHARGE OF FRESHWATER M^3/SEC
RAMOS	9,300	950
SENGANA	8,400	850
NUN	10,300	1,400
ST. NICHOLAS	4,700	60
SANTA BARBARA	5,320	-
SAN BARTHOLOMEN	5,070	200
SOMBREIRO	10,530	196
NEW CALABAR	8,800	-
BONNY	18,750	-
ANDONI	10,560	-
IMO	6,990	230

2.6 VEGETATION

According to RPI/NNPC (1985), three major forest formations occur within the Nigerian coastal area; brackish water swamp forests (comprising mangrove forests and coastal vegetation), freshwater swamp forests and riparian forests.

The coastal vegetation of the barrier-lagoon complex is sparse and dominated by coconut trees and palms especially on Badagry beach and Lekki beach. The Lagos Lagoon shoreline near the University of Lagos is devoid of mangroves. The natural shoreline vegetation was disturbed and dominated by Phoenix reclinata. East of the Lagos Lagoon at the Ogun River estuary, the shoreline vegetation is dominated by the halophytic red mangrove variety, Rhizophora racemosa. The easternmost extension of the Lagos Lagoon at Epe exhibits a variety of vegetation. There is a transition from Rhizophora racemosa dominated vegetation to a fresh water swamp flora towards Lekki Lagoon. In some area, the shoreline is backed by well-developed high forest with a closed canopy.

The vegetation of the Mahin mud beach is dominated by mangroves, Rhizophora racemosa being the most common variety. Due to erosion and anthropogenic activities, much of the vegetation on the mud coast has been destroyed and replaced by hardy grass Paspalum vegetatum interspersed with strands of stunted red mangrove. The white mangroves, Avicennia africana are found in Awoye and Molume areas.

The Niger Delta is characterised by extensive freshwater and mangrove swamps. The fresh water swamps consist of silt rooted trees, shrubs, Juncus sp, Pandanus sp, Raphia hookeri, R. vinifera. Also present are aquatic plants dominated by Nymphaea and Jussiaea.

Figure 6: Niger delta hydrological area (Akintola 1986)

Figure 7: Eastern litoral hydrological area (Akintola 1986)

The main vegetation of the mangrove swamps of the Niger Delta is dominated by the red mangrove, Rhizophora racemosa which forms more than 90% of the saline swamps. The mangrove vegetation is closely related to the soils and the extent of salt water intrusion. Recently deposited soft mud usually carries tall red mangrove trees, Rhizophora racemosa which could grow to heights of over 20 meters (Onofeghara

1986). Two other species of the red mangrove, R. harrisonii, and R. mangle which are commonly found in the fibrous peaty clays, are smaller but resistant to high salinity. The soil is generally acidic with pH ranging from 4.6 to 6.7. The soils when dried become much more acidic, pH value dropping down to as much as 2.2 (Dublin-Green 1985).

The white mangrove Avicennia africana occurs scattered rather sparsely amongst the red mangroves and thrives in less water logged areas. The soil under Avicennia mangrove is non-fibrous, less acidic and on drying, the decrease in acidity is less pronounced.

Besides mangroves, the other common vegetation in areas where salt water content is not too high include ferns, Acrostichum aureum, Nipa palm (Nypa fruticans), and herbs, Paspalum vaginatum. A major feature in the mangrove swamp in the eastern flank of the Niger Delta is the conspicuous presence of Nypa palm, an exotic species which has out-competed native mangroves over very large areas.

The Strand coast comprises a wide variety of vegetation to the west. Behind the active beach, there is an extensive beach-ridge plain which is heavily forested with a few small swamps.

In the Calabar and Cross River estuaries, the mangrove forest fronts the sea and is dominated by the red mangrove, Rhizophora racemosa. In some places, it has been replaced by the exotic palm Nypa fructicans. Other Rhizophora species in the Strand Coast include; R. harrisonii, R. mangle and the white mangrove Avicennia africana.

A vegetation map for the Nigerian Coastal Zone is presented in Fig.8.

Figure 8: Vegetation map of the Nigerian coastal zone`

3. Climate and oceanography

3.1 CLIMATE.

The Nigerian coastal zone experiences a tropical climate consisting of rainy season (April to November) and dry season (December to March). The climatic characteristics of the area is influenced by the general circulation patterns in the equatorial tropics associated with the movement of the sun and the relative position of the Inter-tropic Discontinuity (ITD). It is also governed by two air masses, the south westerlies and the north east harmattan dry wind. As the ITD oscillates to its northerly position, the areas south experience heavy rainfall.

3.1.1 Air Temperature

Temperatures in the Nigerian coastal zone are relatively high varying from 30.5oC to 25.5oC. Highest values are recorded in February and March which is the onset of the rainy season, with temperatures ranging between 28.8oC and 30.5oC. Lowest temperatures of between 24.5oC - 26.9oC are recorded in June, July and August.

3.1.2 Surface Wind

The Nigerian coastal area experiences mainly the southwesterlies which are onshore and confined generally to azimuths of 215-266o with velocities of 2-5 m/s and force range of 2 - 3 Beautifort (Ibe et al, 1984). During the peak wet season (June - September) wind speed exceeding 10 m/s in the form of thunderstorms and line squalls are more persistent while the dry season (December to March) offshore north-easterly trade winds which reach the coastline with less intensity (between 2 - 5 m/s) . However, the full effects of these winds are minimised by the effect of local onshore winds.

During January and February, dust haze which usually concentrates in the northern area of Nigeria may reach the coast in spells which may last between one to two weeks. During this period, low visibility and cold conditions are experienced at sea.

3.1.3 Rainfall Regime

Seasonal variations in rainfall are controlled by the seasonal displacements of the ITCZ (Hastenrath, 1985). Maximum rainfall occurs in the coastal area where the thickness of the humid southwesterly monsoon airmass is greater than 1.5 km. There are two periods of peak rains as this band passes over the coast. The primary peak is in May - June and a secondary peak is in October -November. The coastal rainfall is additionally modulated by the coastal ocean temperature. Rainfall increases in duration from the

coast inland except where local relief results in higher total annual rainfall for inland areas. Mean annual rainfall pattern varies along the coastal locations (Table 2).

Table 2: Mean Annual Rainfall Data for some Coastal Towns

	1990	1991	1992	1993	1994	1995
MARINE, VICTORIA ISLAND	**1844.5**	**1761.8**	**1077.2**	**1064.4**	**1082.1**	**1364.2**
WARRI	**3083.9**	**2920.7**	**3000.9**	**3010.8**	**2867.6**	**3437.4**
BENIN	**2470.1**	**2547.6**	**2074.4**	**1860.8**	**2553.4**	**2668.9**
CALABAR	**2729.1**	**2551.9**	**2896.4**	**2511.3**	**2904.2**	**3687.4**
PORT HARCOURT	**2157.2**	**2094.4**	**1882.1**	**2384.0**	**2194.3**	**2480.8**

3.1.4 Humidity

The Nigerian coastal zone is a region of high surface humidity. Highest humidity occur along the coast. High values are recorded in August ranging from 80 - 100% while lowest values 60 to 80% occur from November to March. Periods of very low humidity 20 - 40% may occur in January to February during the harmattan spell.

3.2 OCEANOGRAPHY

The entire Gulf of Guinea is highly stratified with a thin surface layer of warm fresh tropical water (25o - 29oC, 33-34 PSU), overlying high salinity subtropical water (19o - 28oC, 35-36.5 PSU). An additional contribution of saline water comes from subducted subtropical water from the North Atlantic. The lower salinities characteristic of the coastal surface water reflect the excess of precipitation over evaporation in the Niger Delta. On this shelf tropical surface water mass becomes much influenced by river discharges through the existence of a discrete plume of river discharge water. The stratification of the upper water column along the Gulf of Guinea coast is generally very strong except in areas subject to upwelling events. The upper limit of the thermocline along the Nigerian coast is generally shallow about (12 - 14 m). The depth of the thermocline tends to increase with increasing distance offshore at least over the continental shelf. The thickness of the mixed zone varies between 30 - 40 m.

3.2.1 Sea Surface Temperature

The surface water off the Nigerian coast is basically warm with temperature generally greater than 24oC. Sea surface temperature show double peaked cycles which match quantitatively the cycle of solar heights. Between October and May, sea surface temperatures range from 27o-28oC while during the peak rainy season of June-September, the range is between 24o-25oC. This decline has been ascribed to an expression of the overall cooling of the South Atlantic and the Gulf of Guinea during this period of the year (Longhurst, 1964).

The sea surface temperature cycle observed in Lagos (Fig.9) is broadly repeated along the whole of West African coast where the same climatic regime is experienced (Oyewo et al, 1982). Sea surface temperature data recorded by the Next Generation Water Level Measuring System for 1992-1995 at the Nigerian Institute for Oceanography's jetty is given in Appendix 3.

3.2.2 Sea Surface Salinity

The surface water is typical oceanic surface water of the Gulf of Guinea with salinity generally less than 35.00‰. The coastal surface water receives run-off water from land and from annual precipitation. There is not sufficient evidence to support the contention of Longhurst (1964) that the basic sea surface salinity follows a rainfall regime. Maximum and minimum values were not recorded at the beginning and end of the rainy season, neither were the salinity values remarkably reduced in subsequent months following heavy rains (Oyewo et al, 1982). However, salinity in the Niger Delta shelf range between 27 - 30‰ in January to March and 28-30‰ in June to September.

These low salinity values are due to the influx of freshwater from the numerous estuaries of the Niger Delta.

3.2.3 Waves

The waves affecting the Nigerian continental shelf are wind generated with intensities generally determined by the wind velocity, duration and fetch. Plunging waves are dominant in the Barrier-Lagoon coastline in the west and the Niger Delta. Longhurst (1964) found that maximum swells of between 1.06 to 1.22 m conditions usually occur at Escravos in July to August.

Waves reaching the adjacent coastline of Brass and Bonny have heights averaging 1.5 m. The Mahin mud coast is subjected to less intense wave action and is characterised by spilling waves. The reason for this low wave dynamics along this coastline is due to the fact that the inner shelf is very wide with very gentle gradient. The waves are hence forced to dissipate a large part of their energy before reaching the coastline.

Figure 9: Victoria Beach monthly means of sea-surface and air temperatures

3.2.4 Tides

The tides offshore Nigeria generally approach from the south west and are of the semi-diurnal type with two inequalities. Tidal amplitude along the coast increases from west to east. Tidal parameters at important river entrances and coastal areas are presented in Table 3.

Table 3: Tidal Information at important Coastal Locations

STATION	MEAN HWS*	MEAN HWN*	MEAN LWS*	MEAN LWN*	MEAN MSL*
LAGOS BAR	0.945	0.701	0.091	0.213	0.457
ESCRAVOS RIVER	1.616	1.281	0.303	0.640	0.975
FORCADOS RIVER	1.402	1.128	0.152	0.427	0.823
WARRI	1.402	1.373	0.366	0.462	1.036
PORT HARCOURT	2.530	2.134	0.183	0.732	1.463
BONNY BAR	2.347	1.890	0.488	1.006	1.433
CALABAR	3.048	2.652	0.488	1.036	1.951
RIOL DEY REY ENTRANCE	2.439	1.920	0.152	0.762	1.402

* HWS - High water spring; HWN - High water neap; LWS - Low water spring;

LWN - Low water neap; MSL - Mean sea level.

3.2.5 Currents

The current affecting the Nigerian Coastal zone consist of longshore, tidal, rip and oceanic currents.

3.2.5.1 Longshore Currents

Prevailing south-westerly winds produce large powerful swell waves which approach the coastline from the south west direction. The waves break obliquely on the Lagos barrier coast and the Niger Delta coast thereby generating long-shore currents and consequently produce a high energy environment. The currents sweep sediments along the West coast (Lagos - Lekki barrier Island) and along each flank of the Niger Delta away from the axis. Velocities of longshore current as estimated by Allen (1965) ranged from 0.22 m/sec to 1.0 m/sec.

3.2.5.2 Tidal Currents

The semi-diurnal tides affecting the coastline generate tidal currents which are in phase with tidal cycles. Elevated water close to shore during the two daily high tides generally assist the tides to progress more inshore wards, causing flooding and degradation of the coastline. Tidal currents are strongest at the inlets and could vary from about 2.0 m/sec to over 5.0 m/sec. Tidal currents are very important in sediment transportation and dynamics along the Nigerian coastline.

3.2.5.3 Rip Currents

Rip currents along the Nigerian coastline are not very strong, however, during high tides and storm surges, plumes of sediments perpendicular to the shoreline can be observed.

3.2.5.4 Ocean Currents

The west-east Guinea current is the dominant ocean current affecting the Nigerian coastal zone. Eastwards, the Guinea current joins the Equatorial counter current which transport warm saline waters formed along the southern edge of the North Atlantic eddy. From the south, the cold saline Benguela current flows northwards becoming the South Equatorial current. The Guinea current attain a speed of 0.3 m/sec with some reversals. The Guinea current could be important for the dispersal of suspended fines beyond the influence of wave and tide generated currents.

3.2.6 Coastal Circulation

The surface oceanic circulation systems in the Gulf of Guinea derive their origin from the two gyral currents of the North and South Atlantic which are fuelled by the wind systems. The cold Benguela current which flows northwards along the coast of Namibia and Angola warms up near the equator. The warm current streams up near the equator till it hits the Bight of Bonny where it probably contributes to the reversals of the Guinea current. The east flowing Equatorial counter current, is embedded between the North and South Equatorial currents with its landward end contributing to the eastward flowing Guinea current (Appendix 4).

3.2.7 Seasonal Upwelling

The western part of the Nigeria coastal zone lies at the periphery of the northern major upwelling zone between Cape Palmas and Cape Three Points in the western Gulf of Guinea. According to Oyewo et al (1982), sea surface temperature measurements from off Lagos coast have not indicated the presence of upwelling conditions. Abrupt changes in the hydrography expected during upwelling seasons have not been detected.

Phylander (1978) shows the intensification during the summer of winds at the south of the equator which can intensify the Guinea current and cause a shoaling of the thermocline near the northwestern coast of the Gulf of Guinea. He argued that favourable conditions thus exist for the creation of upwelling along the coast where local winds drive an offshore Ekman drift.

Ibe and Ajayi (1985) reported the possibility of wind related upwelling in Nigeria's inshore waters between July and September. They corroborated their study with the prevalence of petroleum source beds, glauconite, phosphorite and the periodic abundance of some fish including Sardinella maderensis, Engraulis encrasicolus, and Bonga - Ethmalosa fimbriata which are pelagic and are associated with upwelling phenomenon. However, there are gaps in information as to the details of causes, timing, persistence and effects of possible upwelling phenomenon off the Nigerian coast.

3.2.8 Storm Surges

Storm surges occur periodically along the Nigerian coastline. This happens when plunging waves overflow the beach berm spilling waters onto the beach. The months of April and August are usually associated with the development of low pressure systems far out in the South Atlantic Ocean (Roaring forthes). These low pressure systems usually generate large swells at sea.

The swells travel land ward sand gather more energy depending on the fetch. These swells are associated with rough seas, high waves and high tides in the form of surges. On reaching the shoreline, the waves produced by the storms break with high ferocity. Normal wave heights along the Victoria beach range from 0.9 m to 2 m. However, during these swells, wave heights could exceed 4 m. These oceanographic conditions are aggravated when the swells coincide with high tides and spring tides.

3.2.9 Sediment Transport Dynamics

Longshore drift is the prevalent sediment transport mechanism along the Nigerian coastline and is basically within the nearshore zone (1-5m water depth). There are three main longshore drift directions along the Nigerian coastline (Awosika et al 1996).

(i) The west-east littoral drift along the western coastline

This drift occurs along the Badagry-Lagos-Lekki barrier lagoon coast where waves break at an oblique angle to the coast resulting in a west-east drift direction.

At the Mahin mud coast, east of the barrier lagoon coast, the waves break almost parallel to the coastline hence little or no longshore current is generated. Most of the

sediments transported by the west-east littoral drift on the Badagry - Lagos - Lekki barrier lagoon coast are deposited as shoals in the nearshore areas off Arimedu and off the head of the Avon canyon.

(ii) The littoral drift off the northwestern flank of the Niger Delta

The NW - SE trending coastline of the western Niger Delta results in waves breaking to the Northwest. This generates a second littoral drift direction originating from the nose of the Niger Delta (Akasa Point). The north-westerly drift is fed by fluvial sediments transported by Ramos, Forcados, Escravos, Warri and Benin Rivers. Burke (1972) estimated this littoral drift to carry about 500,000 cubic meters of sand annually between Ramos and Forcados estuaries. Much of the sediments in this littoral drift is channelled into the Mahin Canyon.

(iii) The west-east littoral drift between Akasa point and the Calabar estuary

The southwesterly waves break at an oblique angle to the coast along this eastern coastline resulting in a west-east drift. This zone is fed by sediments transported by rivers such as Nun, Sombrero, New Calabar, Bonny, Imo and Kwa Ibo. A substantial amount of these sediments are channelled into the Calabar Canyon.

4. Coastal resources

4.1 BIOLOGICAL RESOURCES

4.1.1. Aquatic Flora and Fauna

The aquatic flora and fauna of the Nigerian Coastal Zone are well represented by numerous plants and animal communities. The flora consists of phytoplanktons and macrophytes, while the fauna consists of zooplanktons, macrobenthos and invertebrates/vertebrates.

RPI/NNPC (1985) recorded 91 freshwater phytoplanktons from the Nigerian Coastal Zone. Predominant families include : Bacillarophyceae, Chlorophyceae and Cyanophyceae. The phytoplankton assemblage in the brackish waters varied with season. Densities and diversities are higher in the dry season. Dominant group include diatoms, green and blue algae. The most common species of diatoms are : Coscinodiscus spp, Pleurosigma spp.

Major zooplankton groups recorded in the Nigerian Coastal Zone include copepods, calanoids, amphipods, bivalve larvae, brachyuran larvae, rotifers. Coelenterates, gastropod larvae and natantia larvae and ostracods.

Dense macrophytic communities occur in many of the water bodies especially non-flowing waters. In flowing rivers, submerged and free floating forms are restricted to back waters. The submerged portion of aquatic macrophytes support a large variety of insects and worm species. Principal macrophytes in the freshwater zone include water lettuce (Pistia sp), the hornwort Ceratophyllum spp, bladder wort - Utricularia spp, and water hyacinth - Eichnornia crassipes, Azolla africana. Typical rooted aquatics include Nymphaea lotus and Vossia Cuspidata.

The benthic macrofauna consists of important groups such as; oysters, brachiostoma, bloody cockle (Senilia spp), molluscs, crustaceans and polychaetes.

4.1.2 Forest Resources

Many forest resources are located within the Nigerian Coastal Area and are located mainly in Ondo, Edo, Delta, Bayelsa, Rivers and Cross River States. The forests are extensive and often regarded as inexhaustible with the result that little attention is given to conserving this resource.

Logging, farming, particularly of the bush-fallow/land rotation type associated with bush burning have reduced the true forest area considerably. Forest reserves occupy about 2.4 million ha or about 10% of the forest land area (Nest 1991).

Some of the forest resources include timber trees such as; mahogany (Khaya spp, Entandrophagma spp), obeche (Triplochiton spp), afara (Terminalia spp), iroko Chlorophora/Milicia), African walnut (Lovoa), abura (Mitragyna ciliala) and mansonia.
Other important forest resources include species that yield spices (Xylopia, Piper, Dennettia, Tetrapleura), leaves, barks, roots and fruits that play vital roles in rural cultures particularly in ethnomedicine and nutrition.

4.1.3 Mangrove Resources

Nigeria has the largest mangrove forest in Africa. It covers an area of about 9,723 km2 forming a vegetative band of 15 - 45 km wide above the barrier islands and running parallel to the coastline. About 305 km2 of the mangrove forest are in reserves.
The Nigerian mangrove resources is dominated by the red mangroves (Rhizophoraceae), in association with white mangroves (Avicenneaceae).
The red mangrove Rhizophora racemosa is the most common species, covering over 90% of the area and can grow to a height of 45 m under favourable conditions. It is the pioneer species, and is followed by R. harrisonii and R. mangle as the land gets drier and salinity deceases. Avicennia spp, a smaller tree than Rhizophora spp, grows singly on firm land.
The mangrove forest is a source of timber and due to its high thermal capacity, it is widely used as fuel for firing small scale industrial boilers. The red mangrove Rhizophora racemosa is the most exploited species and is used for firewood, poles and timber. The numerous roots as well as stumps are used locally for the preparation of salt. The bark of the tree provides a cheap source of tannin for dyeing cloths and leather. The mangroves provide breeding and nursery grounds for many commercially important species of fish and shell fish. The tilt roots of the mangroves and mud surface usually support a varied fauna of oysters, crabs and other invertebrates. Table 4 shows the distribution of mangrove forest in the Nigerian Coastal Area.

Table 4: Distribution of Mangrove Forest in the Nigerian Coastal Area (NEST 1991)

State	**Area of Mangrove (Km^2)**	**Mangrove in Forest Reserve (Km^2)**
Lagos	42.20	3.13
Ogun	12.18	-
Ondo	40.62	-
Edo/Delta	3,470.32	143.75
Rivers/Bayelsa	5,435.96	90.62

Cross River/Akwa Ibom	721.86	67.19
T O T A L	**9,723.14**	**304.69**

4.1.4 Wildlife

Very little information is available on wild-life distribution in the Nigerian Coastal Zone. The RPI/NNPC (1985) study provided some useful data on the wildlife in the Niger Delta.

Field observation made by RPI Scientists suggest that, with the exception of birds, there is little conspicuous wild-life. Also a considerable percentage of the animal population lives in the upper layers of forest vegetation, making observations difficult.

Some of the ecological zones support a distinct wildlife assemblage. The barrier-complex wildlife assemblage include dwarf antelopes, monkeys, manatees and hippopotamus. The wildlife of the mangrove ecological zone include monkeys, otters, crocodiles and other reptiles. The forest ecological zone has the most diverse wildlife assemblage. This include, pygmy hippopotamus, spotted genet, chimpanzee, black squirrel, monkeys, antelopes, elephant, leopards and black pigs.

Some of these species are endangered or endemic, their continued survival depends greatly upon management measures taken to protect them. These include pygmy hippopotamus and manatees.

The avifauna in the Nigerian coastal environment is very diverse and the most conspicuous form of wildlife. The distribution of birds in the Nigerian Coastal Zone is influenced by the distribution of basic ecological zones. These include mangrove swamps, estuaries, beaches and forests. Each of the zones support distinct avifauna.

The Nigerian avifauna include : grey-crowned negro finch, West African thrush, fruit-pigeon, pelican, vulture, blue swallow, black kite, fishing owl, wood dove, sunbird, pied crow, sparrow, egret, weaver, parrot, heron and king fisher.

4.1.5 Fisheries Resources

Fish provides an estimated 40% of the total animal protein in the diet of the average Nigerian. In some parts of the country e.g. Rivers, Bayelsa, Akwa Ibom and Cross River States, fish may account for up to 80% of the animal protein consumed by the people. Fish production in Nigeria in 1994 was 283,193 metric tonnes.

Table 5 gives fish production for the maritime states while Table 6 presents domestic fish production by sector between 1985 - 1994.

Nigeria has a diversity of fin fish and shell fish of about 199 species belonging to 78 families in the brackish and marine environments (Dublin-Green and Tobor 1992).

Commercially and scientifically important fish and shell fish resources in the Nigerian Coastal Area are presented on Table 7.

Table 5: Fish Production for Maritime by States (1991-1995) - metre tonnes

Maritime States	**1991**	**1992**	**1993**	**1994**	**1995**
Akwa Ibom	40,297	44,139	10,713	14,927	29,472
Edo/Delta	34,186	34,186	15,454	31,655	50,923
C. River	10,727	10,942	4,725	8,289	10,454
Lagos	18,396	21,462	18,605	17,675	19,534
Ogun	2,419	3,371	944	5,269	2,473
Ondo	13,731	12,555	13,726	14,848	15,064
Rivers	48,393	57,752	26,653	31,454	45,299
TOTAL	**168,211**	**184,407**	**90,820**	**124,117**	**173,219**

Source : Federal Department of Fisheries

- Inshore demersal fisheries
- Offshore Demersal fisheries
- Shell fish

Table 6: Domestic fish production by sector 1985-1994 (Metric tonnes)

	1985	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
LAKES AND RIVERS	**60,510**	**106,967**	**103,232**	**112,443**	**132,168**	**113,075**	**123,075**	**99,536**	**94,900**	**110,484**
AQUACULTURE	**15,000**	**14,881**	**15,221**	**15,764**	**25,607**	**7,297**	**15,840**	**1,770**	**18,703**	**18,104**
INSHORE COASTAL AND BRACHISH WATER (INDUSTRIAL / ARTISANAL)	**167,015**	**185,211**	**170,655**	**220,789**	**204,977**	**195,245**	**203,179**	**219,372**	**137,696**	**153,887**
EEZ (OFFSHORE)				**941**	**-**	**743**	**1,258**	**4,400**	**4,224**	**718**
TOTAL(S)	**242,525**	**307,059**	**289,108**	**349,937**	**362,752**	**316,360**	**343,352**	**343,078**	**255,523**	**283,193**

Source: Federal Department of Fisheries

Table 7: Important Marine and Brackish Water Fishes of Nigeria

FAMILY	COMMON NAME	SCIENTIFIC NAME
Alopidae	Big eye Thresher Thresher Shark	Alopias supercilliosus A. vulpinus
Carcharhinidae	Bull Shark Black tip shark Atlantic weasel Milk shark	Carcharhinus leucas C. limatus Paragaelus pectoralis Rhizoprionodon actus
Hexanchidae	Six gill shark	Hexanchus griseus
Laminidae	Great white shark	Carcharodon carcharias
Odontaspididae	Sand tiger shark	Eugomphodus taurus
Pseudocarchariidae	Crocodile sharks	Pseudocarcharias Kamoharai
Sphyrinidae	Smooth hammer head	Sphyrna zygaena
Sphyrnidae	White fin hammer	Sphyrna couardi Cadenat
Triakidae	Tope shark	Galeorhinus galeus
Pristidae	Large toothe Sawfish Small tooth Common sawfish	Pristis microdon Pristis perotteti P. Pectinata P. Pristis
Dasyatidae	Rough tail sting ray Daisy sting ray Common string ray	Dasyastis centroura D. pasinaca Taeniura grabata
Mobulidae	Giant Atlantic Manta	Manta birostris Mobula rochebrunei
Myliobatidae	Common eagle ray	Myliobatis aquila
BONY FISHES		
Acanthuridae	Monrovia doctor fish	Acathurus monroviae
Albulidae	Bone fish Longfin bone fish	Albula vulpes Pterothrissus belloci
Ariidae	Rough head sea Catfish Giant catfish Smooth mouth sea	Arius gambiensis A. latiscutatus A. gigas A. heudeloti
Ariommatidae	Silver-rag drift fish Brown drift fish	Arimona bondi A. melanum
Balistidae	Grey trigger fish	Balistes capricus B. punctatus
Batrachoididae	Hairy toad fish	Batrachoides liberiensis

Bothiadae	Capse scald fish	Arnog lossus A. imperialis Bothus podas africanus Sycium micrurum
Carangidae	Alexandria pompano Blue runner Crevalle jack Atlantic bumper Roundscad Rainbow runner Two-colour jack African moonfish Greater amberjack Long fin pompano	Alectis alexandrinus Caranx crysos C. hippose C. Senegallus Chloroscombrus chrysurus Decapterus punctuatus Elegatis bipinnulata Hemicaranx bicolor Selene dorsalis Seriola dumerili Trachurus trachurus
Chloropthalmidae	Atlantic greeneye	Chloropthalmus atlanticus
Citharidae	Spotted flounder	Citharus einguatula
Clupeidae	Bonga West African shad West African herring	ethmalosa fimbriata Ilisha africana Sardinella aurita S. maderensis
Corphaenidae	Pompano dolphin fish	Coryphaena equiselis
Cynoglossidae	Nigerian tongue sole Ghanaian tongue sole Canary tongue sole Guinea tongue sole Senegalese tongue sole Elongate tongue sole	Cynogolssus browni C. cadenati C. canariensis C. monodi C. senegalensis Symphurus ligulatus
Dactylopteridae	Flying gurnard	Dactylopterus volitans
Drepanidae	African sickle fish	Drepane africana
Elopidae	West African Lady fish	Elops lacerta
Engraulididae	European anchovy	Engraulis encrasicolus
Ephippididae	African Spade fish West African spadefish	Chaetodipterus goreensis C. lippei
Fistualariidae	Blue spotted cornet fish	Fistularia tabacaria
Gerreidae	Flagfin mojarra Guinea stripped Mojarra	Eucinostomus melanopterus Melanopterus bleeker Gerres nigri
Grammistidae	Greater soapfish	Rypticus saponaceus
(Pomadasyidae)	Big eye grunt Sompat grunt Pigsnout grunt	Brachydeuterus auritus Pomadasys jubelini P. rogerii
Hemiramphidae	Bllyhoo halfbeak	Hemramphus brasiliensis

Lutjanidae	African red snapper African brown snapper Gorean snapper	Lutjanus agennes L. dentatus L. goreensis
Megalopidae	Atlantic tarpon	Megalops atlanticus
Mugilidae	Sickle fin mullet Large scaled mullet Flat head grey mullet	Liza facipinnis L. grandisquamis Mugil cephalus
Mullidae	West African goat fish	Pseudopeneus prayensis
Ophididae	Bearded brotula	Brotula barbata
Platycephalidae	Guinea flat head	Grammoplites gruveli
Polynemidae	Lesser Arican threadfin Royal threadin Giant African threadfin	Galeoides dacadactylus Pentanemus quiquarius Ploydactyls quadrifilis
Priacanthidae	Atlantic big eye	Priacanthus arenatus
Psettodidae	Spottail spiny turbot Rachycentridae	Psettodes belcheri Cobia Rachycentron cannadum
Sciaenidae	Blackmouth croaker Law Croaker Bobo Croaker Guineac Croaker Cassava Croaker Longnect Croaker Boe. drum	Pentheroscion mbizi Pseudotolithus brachygnatus Ps. elongatus Boodich Ps. epipercus Ps. senegalensis Ps. typhus Pteroscion peli
Scombridae	Frigate tuna Little tunny Skipjack tuna Atlantic bonito Albacore Yellow fin tuna Bie eye tuna	Auxis thazard Euthynnus alleteratus Katsuwonus pelamis Sarda sarda Thunnus alalunga Thunnus albacares Thunnus obesus
Serranidae	White grouper Dungat grouper Dusky grouper Esonue grouper Ghanaean grouper	Epinephelus aeneus E. goreensis E. gigas E. itajara Serranus accraensis
Soleidae	Four eyed sole	Microchirus ocellatus
Sparidae	Bogue Angola dentex Canary dentex Congo dentex Large eye dentex Senegal sea bream Red pandora Red banded sea bream	Boops boops Dentex angolensis Poll D. canariensis Steindachner D. congoensis D. macropthalmus Diplodus belloti Pagellus bellotti Pagrus auriga
Sphyraenidae	Great barracuda Guachanche barracuda	Sphyraena barracuda S. guachancho

Stromateidae	Butterfish	Stromateus fiatola
Synodontidae	Brazillian lizard fish	Saurida brasiliensis
Trichiuridae	Large head hair tail	Trichiurus lepturus
Xiphiidae	Swordfish	Xiphias gladius
Zeidae	John dory	Zeus faber

4.1.5.1 Inshore Pelagic Fisheries

The small pelagic marine and estuarine fisheries Bonga (Ethmalosa fimbriata), West African herring (Sardinella maderensis) and West African shad (Ilisha africana) are the target fishes of inshore pelagic fishery. Longhurst (1962) estimated that the annual potential of the resources in the estuaries and littoral zone of Nigeria is 28,000 tonnes.

The Bonga is the most valuable and abundant fish in the artisanal fisheries sector in Nigeria. They are present throughout the year, but mostly from November to April.

4.1.5.2 Offshore Pelagic Fisheries

The targets of Nigerian offshore pelagic fishery include the tuna and tuna-like fishes such as: skipjack (Katsuwonus pelamis), yellow fin (Thunnus albacares) and bigeye (Thunnus obesus). The tuna-like species are Euthynnus alleteratus, Sarda sarda and Elagatis pinnulata. All these species are found within Nigeria's Exclusive Economic Zone (EEZ) and the annual yield potentials is estimated at 9,460 tonnes.

Good catches of tuna species have been reported during exploratory fishing carried out by the Nigerian Institute for Oceanography and Marine Research (NIOMR) using fish aggregating devices and pole and line bait. A deep sea skipjack tuna resource which migrates to the coastal area was identified during the survey. However, the dearth of information on the life bait resources and their seasonality have been a major constraint in exploiting this resource on a commercial basis.

4.1.5.3 Inshore Demersal Fisheries

Demersal fish stock in the inshore area (0 - 50 m) depths vary from 27,000 to 38,000 metric tonnes. The targets of inshore demersal fishery are the croaker fauna of silver to grey fish such as croakers (Pseudotolithus senegalensis, P. typus, P. elongatus), the thread fins (Galeoides decactylus, Polydactylus quadrifilis), the ariid catfishes (Arius gambiensis, A. heudeloti), the soles (Cynoglossus spp.) and spade fish (Drepane africana). Ajayi (1982) reported an annual mean sustainable yield of 13,742 tonnes for the inshore trawl fishery.

4.1.5.4. Offshore Demersal Fishery

The offshore demersal fishery targets fish families such as Priacanthidae, Sparidae, Ariomidae. Tobor (1990) reported an average estimated figure of 6,370 tonnes as the annual potential yield of the offshore demersal fish resources in Nigerian waters.

4.1.5.5 Shell Fish

The shell fish resources in Nigerian coastal and marine waters include : shrimps, crabs, lobsters and molluscs (Table 8).

Table 8: Commercially Important Shell Fish Resources in Nigeria

FAMILY	COMMON NAME	SCIENTIFIC NAME
CRUSTRACEA		
Geryonidae	West African geryon	**Geryon** maritae = Geryon quindequens
Palaemonidae	Congo River prawn Niger river prawn **Brackish water prawn** African river prawn Estuarine prawn Creek shrimp	Macrobrachium dux M. felicinum M. macrobrachion M. vollenhovenii Nematopalaemon hastatus Palaemonetes africanns
Penaeidae	Guinea shrimp Deep water rose shrimp Caramote prawn	Parapenaeopsis atlantica Parapenaens longirostris Penaeus Kerathurus
MOLLUSCS		
Bivalves Arcidae	**Senegal ark**	Anadara senegalensis
Cardiidae	Costate cockle Gaping cockle	Cardium costatum C. ringens
CEPHALOPODS		
Loliginidae Octopodidae Sepiidae	European squid Common octopus Common cutle fish	Loligo vulgaris Octopus vulgaris Sepia 'officinalis' nierredda

The offshore Niger Delta supports a very rich shrimp fishery due to the heavy load of rich organic debris brought down by the various rivers. Shrimps are also found in abundance off shore of the Badagry - Lagos - Lekki lagoon system. About 7,884 metric tonnes of shrimps are caught annually from Nigeria coastal waters (Federal Department of Fisheries 1995). Among important species is the pink shrimp (Penaeus notialis), which dominates in 10-50 m depth. This specie occurs abundantly off Lagos and Benin River to Pennington river and from Bonny River estuary to Cross River estuary, its maximum sustainable yield being estimated at about 6,000 metric tonnes. The Guinea shrimp (Parapenaeopsis atlantica) occurs in coastal shallow waters between 0-20 m depth. The royal shrimp (Parapenaeus longirostris) occurs abundantly in deep waters 60-120 m deep. Nematopalaemon hastatus, an estuarine shrimp is found in coastal waters to a depth of 50 m. This specie is heavily exploited in brackish creeks and estuaries. The brackish waters of the Niger Delta are intensively exploited for a variety of prawns and shrimps. Target species include : Palamon maculalus, P. africanus, Macobachium vollenhovenii and M. macrobrachion. Crabs occur abundantly on the mudflats of the mangroves in the Niger Delta. The swimming crabs of the genus

Callinectes are the most important and are exploited for food. Marine crabs include members of the following families : Portunidae and Geryonidae, which form an important component of the benthic ecosystem on the continental shelf edge and slope.

Molluscs such as bivalves are highly exploited by coastal populations. The mangrove oyster (Crassostrea gasar) occurs abundantly in coastal swamps and estuaries where it is exploited at subsistence level. The oysters grow on the roots of mangrove trees and are harvested by cutting off mangrove prop roots. Other bivalves exploited in the coastal areas include the ark clams, Senilia senilis, Anadara senegalensis, bloody cockles, Cardium costatum and periwinkles Tympanotonus spp). Cephalopods - squids, cuttle-fishes and octopus-occur commonly in offshore depths of 90-250 m where they are taken as by-catch in bottom trawl catches. There is yet no assessment of the size of cephalopod stock in Nigerian waters.

The spiny lobster (Palinuridae) and locus lobster (cyllarodae) occur in Nigerian coastal waters. They are entirely marine and only one species Panulirus regius, the royal spiny lobster is common and prefers rocky substrate in depths of 5 - 15m.

Among the reptiles, only sea turtles have been found to occur in small numbers in Nigerian waters. There is no targeted fishery for sea turtles, but they are caught in trawl nets during fishing.

The Nigerian coastal zone is richly endowed with a variety of minerals. The most important presently is oil and gas.

4.2 MINERAL RESOURCES

Petroleum has become dominant in the Nigerian economy and over 90% of her foreign exchange earnings has been accruing from it annually for the past fifteen years. Other minerals include sand and gravel, clay, heavy minerals and salt. The economic exploitability of many of these minerals is yet to be assessed.

4.2.1. Oil and Gas

The Niger Delta is a prolific oil producing province where major oil discoveries have been made. Nigeria's current oil reserves are estimated at 21 billion barrels and its gas reserves are approximately 11 trillion cubic feet. The significant increase in crude oil reserves in the last few years is related to discoveries in the deep offshore zone. Nigeria is currently producing 1.9 million barrels per day of crude oil. Nigeria is also producing about 200,000 barrels of gas - condensate per day. Current gross natural gas production most of which is associated gas - is about 3,400 million cubic feet per day, of which about 10% is consumed domestically, 10% is re-injected and 80% is flared.

4.2.2 Sand and Gravel

Sand and gravel are mined onshore from stream beds, burrow pits, lagoons, estuaries and beaches. Several million cubic metres of sand is dredged annually by dredging companies operating for oil companies and also for the construction industry. Most of the sand mined is used for land reclamation, sand-crete block making, surfacing and construction in coastal towns.

The Delta Glass company, Ughelli located within the Niger Delta mines sand at the rate of 60 -100 metric tonnes per day and is used for the manufacture of glass.

Large quantities of sand and gravel occur within the shallow inner continental shelf (0 - 40 m) depth. Most of the on-going massive construction work and land reclamation schemes in Lagos and environs have been made possible because of proximity to billions of tonnes of sand in the submerged beaches offshore.

4.2.3 Clay Deposits

Clay deposits occur abundantly in the eastern part of Niger Delta and are utilised in the manufacture of ceramic tiles and wares and also in the brick industry.

Some of the clay deposits are reported to have large reserves ranging from 40 - 80 million metric tonnes per reserve.

Large accumulations of clays suitable for making refractory bricks occur in the Nigerian Continental shelf. Three clay mineral types -Kaolinite, illite and montmorillonite occur in recent sediments offshore Nigeria (Porrenga 1961, Ibe et al 1983).

4.2.4 Heavy Minerals

Studies carried out by the Nigerian Institute for Oceanography and Marine Research on non fuel minerals have shown that marine beaches and submerged beaches on the continental shelf are depository of heavy minerals such as garnet, rutite, apatite, zircon, tourmaline, illminite and sillimanite. These minerals are important raw materials for industries, while some are used as gemstone. High concentrations of heavy minerals (18 kg - 36 kg/ton) have been recorded from the mouth of Benin and Forcados Rivers. Results also indicate the possibility of the occurrence of higher concentration in subsurface sediments on the continental shelf. A United Nations publication (ST/ESA.139) on unconsolidated mineral deposits in the EEZ of West African coastal zone indicated a possible occurrence of heavy mineral deposits in shelf sediments between Badagry and Aiyetoro.

The Lekki Peninsular beaches, are being turned into tourist paradise by the development of private beaches and holiday resorts. Swimming, cruising and yatching are marine recreational activities around major coastal towns in Nigeria.

5. Socio-economic activities

5.1 INFRASTRUCTURAL DEVELOPMENT

Much of Nigeria's population and economic activities are located along the coast. According to the 1991 census, approximately 19 million people (20% of Nigeria's population) inhabit the coastal area. Population densities ranging between 133 - 1,700 per km2 have been recorded in the Nigerian coastal zone (Table 9).

Several urban settlements are located with the Nigerian Coastal Zone. They include; Lagos, Warri, Sapele, Port Harcourt and Calabar. Apart from these urban centres, many historical settlements such as Badagry, Forcados, Brass, Abonema, Buguma, Bururtu, Bonny, and Opobo have monuments of early European contacts and trade. The urban centres are characterised by high population densities. Provisions of infrastructures such as housing, potable water, roads, communications waste disposal, health facilities and educational infrastructure are limited.

Table 9: Land area and population density coastal states in Nigeria Census (1992)

STATE	1992 CENSUS	AREA (sq km)	DENSITY (per km^2)
DELTA/EDO	4,730,029	35,500	133
CROSS RIVER/AKWA IBOM	4,225,340	27,237	155
LAGOS	5,685,781	3,345	1,700
OGUN	2,338,570	16,762	140
ONDO	3,884,485	20,959	185
RIVERS/BAYELSA	3,983,857	21,850	182

The level of infrastructural development and services are particularly low in most of the rural communities. Many of the communities are inaccessible.

Rural communities depend on dirt-roads which are often impassable in the rainy season. Water transportation by canoes is the only means of transportation in remote communities of the Niger Delta.

5.1.1. Road Network

The Nigerian coastal area is served by a relatively fair net work of roads. A major coastal road built by the Federal Government runs from the west to the east, linking

Lagos with other coastal towns : Benin, Sapele, Warri, Port Harcourt and Calabar. The urban towns are served by an extensive network of tarred roads.

The various State Governments construct secondary roads that serve as feeder network to the coastal roads. These connect the coastal towns to small towns and communities within the zone. Some secondary and tertiary roads are built by oil companies in their areas of operation, while some are also built by Agencies such as; Directorate for Food, Roads and Rural Infrastructure (DFFRI) and Oil Mineral Producing Area Development Commission (OMPADEC).

Many of the rural communities along the Nigerian coastal area, particularly those in the swamp of the Mahin Mud Coast and the Niger Delta are not connected by road and depend solely on water transportation.

5.1.2 Water Transportation

The waterways in the Nigerian Coastal Area are extensive and are important means of transportation and communication. The coastal lagoons, channels, numerous rivers of the Niger Delta are all interconnected and extend from Badagry in the west to Calabar in the east. Water transportation is the only means of transportation among the rural communities and remote towns of the Niger Delta.

Water transportation in the rural communities range from dugout canoes to fibre glass engine boats. The oil companies use mechanised water transport ranging from sea trucks, tug boats, barges and highly specialised crafts.

5.1.3. Railway

The Nigerian Railway consists of 2 single-tract 42-inch gauge lines - a western and an eastern arm running north from the coastal cities of Lagos and Port Harcourt and terminating in the far north. The Nigerian railway provides long distance haulage of bulky and heavy commodities from the Lagos and Port Harcourt ports to the north.

There are no rail links between the coastal towns and consequently transportation by rail is non-existent in the Nigerian Coastal Area.

5.1.4. Ports

Several ports are located within the Nigerian coastal zone. The major ports are Lagos, Warri, Port Harcourt and Calabar. Other smaller ports include: Koko, Burutu and Sapele all located in Delta State. An Export Processing Zone (EPZ) is currently under construction in Calabar.

5.1.5 Air Transportation

Two international Airports : Lagos and Port Harcourt Airports are located within the Nigerian Coastal Area. There are also 3 local Airports - Benin, Owerri and Calabar. Besides these, there are airstrips and landing fields located in Warri, Escravos, Forcados, Brass, Bonny and Eket which are privately owned and operated mostly by oil companies.

5.2 ECONOMIC ACTIVITIES

5.2.1 Agriculture

Agriculture is the dominant economic activity in the Nigerian coastal Area. Many coastal dwellers are involved in either full or part time farming and fishing. The mangrove swamps and the beach ridges are not quite fit for arable agriculture due to the high salinization and the acidic nature of the mangrove soils. However, the flood plains of the Niger Delta and other major rivers are used for intensive agricultural production of local food crops and vegetables.

Food crops and cash crops are cultivated in the Nigerian coastal area. Major food crops include maize, plantain, yam, cassava and vegetables. The major cash crops are oil palm and rubber. Coconuts are grown on the barrier islands especially Badagry and Lekki peninsula, Bonny and Andoni.

There is a large scale rice cultivation in the fresh water swamp of the Niger Delta at Peremabiri, while rice is grown on small scales in Ogbia, Yenagoa (Rivers State), Oko and Igbuku (Delta State) Itoikin (Lagos State).

Over 150,000 ha of land in the Rivers State is used for oil palm cultivation. Most of these palms are grown in upland areas with a few in the swampy areas. The Sombrero-Warri Deltaic plain in the Niger Delta is used for intensive palm oil cultivation and production.

5.2.2. Forestry

Forestry is an important economic activity in Nigerian coastal area. Exploitation of forest resources is very intensive in Ondo, Edo, Delta, Bayelsa, Rivers and Cross River States. Industrial logging activities are carried out in the fresh water swamps and the barrier islands. The timber trade in southern Nigeria is highly commercial with over 500 saw mills.

Sapele, a coastal town in Delta State is the centre of the timber trade and has over 70 sawmills. The African timber and plywood company, Sapele is the biggest wood industry in Nigeria. There is also the Epe Sawmill located at Epe on the shores of the Lekki lagoon. Wood products produced by these sawmills include; Veneer, plywood,

pulp, kiln dried lumber, treated wood and particle board. Some of these products are exported.

Hunting for bush meat is another important economic activity in coastal forests. There are some professional hunters that move from one community to the other hunting for wildlife such as, elephants, antelopes, grasscutters, manatees, hippopotamus and bush pigs.

5.2.3. Fisheries

The Nigerian fishing industry consists of three major sectors; artisanal, industrial and aquaculture.

5.2.3.1 Artisanal fisheries

The artisanal sector consists of small subsectors such as lagoon, estuarine and inshore canoe fisheries. The sector operates small open crafts which may or may not be motorised, with fishing gear ranging from hooks, traps and gill nets. The sector is characterised by low capital out lay, low operational costs, low technology application, and labour intensity. Despite all these disadvantages, the sector remains the backbone of fish production in Nigeria and contributes over 90% of the yearly production of fish.

Artisanal sector provides full time employment for about 188,955 fishermen and 143,900 on part time basis. This sector also engages over 100,000 locally made canoes (FDF 1995). Fish production in 1994 by the maritime states is 124,117 metric tonnes. (Table 10).

Table 10: Fish Production by Artisanal Sector in Maritime States

MARITIME (STATES)	1990	1991	1992	1993	1994
EDO/DELTA	37,593	34,248	34,286	15,454	31,655
RIVERS/BAYELSA	55,787	48,393	57,752	26,653	31,454
AKWA-IBOM	32,285	40,297	44,139	10,713	14,927
CROSS RIVER	13,587	10,727	10,942	4,725	8,289
LAGOS	17,216	18,396	18,605	18,605	17,675
OGUN	364	2,419	944	944	5,269
ONDO	13,627	13,731	13,726	13,726	14,848
SUB-TOTAL	**170,459**	**168,211**	**18,407**	**90,820**	**124,117**

5.2.3.2 Industrial Fisheries

The industrial sector of the Nigerian fishery is characterised by high capital out lay on vessels, cold storage and advanced technology (fish finders, radar, navigation and

communication equipment). While the artisanal sector concentrates on local markets, the industrial sector targets both local and foreign markets. The major attribute of the industrial sector is its generation of foreign exchange through the export of shrimps. Its contribution to total domestic fish production is low, averaging about 3.7% annually (Tobor 1990).

The Federal Department of Fisheries (1995) statistical data reported that 304 inshore trawlers operated in the Nigerian nearshore waters in 1994. Seventy four of the trawlers were fishing for demersal fin fish, while 230 were shrimpers. Sixteen fishing trawlers were also licensed to fish in the Nigerian EEZ in 1994. Fish production from this subsector in 1994 is made up of 21,886 metric tons from inshore fishing; 7,884 metric tons of shrimps and 718 metric tons from the EEZ.

5.2.3.3. Aquaculture

Aquaculture in Nigerian mangrove swamps and lagoons has gained importance in the last ten years, with an estimated potential of 1,313,634 tonnes (Tobor 1991).

Despite this great potentials, aquaculture contributed only 25,607 tonnes to national fish consunptun in 1989 and accounts for only 0.3% of fish production (Anyanwu et al 1993). This low contribution is due to the fact that aquaculture is practised at subsistence level. Also, the acidic nature and soil characteristics of the mangrove swamps have not rendered this vast area very productive for aquaculture. These problems have resulted in low fish yields and mass mortality, (Dublin-Green 1985).

Aquaculture in the Nigerian Coastal Area is carried out mainly in small tidal ponds constructed on mangrove swamps. Other culture systems such as cage or penculture are still at experimental stage while "acadja" or "brush-park" method is practised by artisanal fishermen. Culture system is extensive to semi-intensive through polyculture of Tilapia sp in combination with Mugil sp, Liza so, Clarias gariepinus, Heterobranchus sp, Carpon sp, and Lutjanus sp. Fish production ranges from 0.8 t - 2 t/ha/yr in extensive system to 2.5 - 4.5 t/ha/yr in well managed semi-intensive culture system.

5.2.4 Industries

Nigeria has over 2,000 industrial establishments with about 80% of these concentrated in the coastal zone especially urban centres, mainly in Lagos and environs. Industries located in the Nigerian coastal zone include : oil and gas, petrochemical, Iron and Steel, fertilizer plant, aluminium smelting plant and manufacturing industries such as textiles, food, plastics, pharmaceuticals, cement, soaps and detergents, paints, brewing and wood pulp and paper. About 80% of Nigeria's manufacturing industries are located in Lagos and environs.

5.2.4.1 Oil and Gas Exploration/Exploitation

Oil prospecting began in Nigeria as far back as 1908, while production began in 1958 when Oloibiri field went on stream at 5,100 barrels/day. The Niger Delta basin is the site of most of the oil and gas produced in Nigeria, with Rivers, Bayelsa and Delta States producing 75% of the Nigerian crude oil.

Oil and gas exploration and exploitation in the Nigerian coastal zone is the most important economic activity. This is in view of the fact that the industry provides great employment opportunities to coastal dwellers and also provides the bulk of much needed Government revenue and foreign exchange. Industrial activities related to oil include three refineries and two petrochemical plants, eight crude oil terminals and several other oil facilities. Gas related industries located in the coastal zone include Oso Natural Gas Liquid (NGL) project, Escravos gas project, Ekpe gas injection project and the Bonny LNG project. Presently, there are ten multinational oil companies actively producing in Nigeria plus a host of other indigenous operators and, newer multi-national explorers. Details of oil production and contributions to Government revenue are given in Appendix 5 and 6.

5.2.4.2. Oil Refining

Three petroleum refineries are located in the Niger Delta. Two are in Port Harcourt, and one in Warri. The new Port Harcourt refinery plant has a production capacity of about 120,000 barrels/day. Refined products are marketed by a chain of multinational and indigenous oil marketing companies using various sizes of tankers, barges and marine tankers for the transportation of refined products.

5.2.4.3 Petrochemical Industry

There are two petrochemical plants located within the Nigerian Coastal Zone : the Eleme plant in Port Harcourt and the Ekpan plant near Warri. The petrochemical plants use oil and gas as raw materials for the production of chemical intermediates such as linear alkyl benzene, solvents, carbon black and polypropylene for a wide variety of petrochemical industries.

5.2.4.4 Fertilizer Industry

The National Fertilizer Company of Nigeria (NAFCON) is one of the two fertilizer plants in Nigeria. It is located at Onne close to a creek within the Bonny river system. The plant produces, nitrogen, phosphorous, urea and ammonia fertilizer. Effluents from the plant are dumped into the creek.

5.2.4.5. Iron and Steel Industry

The Delta Steel located at Aladja near Warri is the biggest steel plant in the West African sub-region. At full capacity, it produces 1 million tons of steel per annum. The steel plant engages over 3,000 workers. The various plant operations such as blast furnace, Coke, steel-plaiting and smelting produce a large amount of toxic waste and hazardous air emissions.

5.2.4.6 Aluminium Smelting

The Aluminium Smelting Company of Nigeria is located at Ikot-Abasi on the Imo River. It is the only aluminium smelting plant in Nigeria and was commissioned in 1997. The by-products of aluminiums melting are highly toxic and effluents are discharged into the Imo river.

5.2.4.7 Others

Manufacturing industries such as textiles, plastics, food and confectionery, pharmaceuticals, cement, soap/detergents, paints, brewing etc are located in urban centres of Lagos and Port Harcourt. Effluents generated by many of these industries in Lagos are dumped into the Lagos lagoon.

Nigeria is blessed with quite a number of sandy beaches along its 853 km coast line. Some of the important beaches are Badagry, Tarkwa Bay, Victoria Bar, Lekki, Alpha, Eleko, Brass, Bonny and Qua Ibo beaches.

Lagos State has the most famous beaches and has developed 7 of of thems into tourism zones :

(a) Bar Beach recreational zone.
(b) Lekki-Maiyegun beach resort.
(c) Kuramo Water recreational zone.
(d) Badagry beach resort.
(e) Epe-Marina beach front.
(f) Badagry Marina beach front.
(g) Alpha beach Resort.

Nigeria has quite a number of sandy beaches along the 853 km coastline.

6. Environmental problems in Nigerian coastal zone

Because of the nature of the topography, soil characteristics, rapid population growth, increased economic activities coupled with anthropogenic activities the Nigerian coastal zone has been experiencing several problems resulting in the degradation of the coastal environment. These problems include beach erosion, flooding, deforestation, sandmining, pollution, salt water intrusion, subsidence, introduction of exotic species and depletion of coastal resources.

6.1 COASTAL EROSION

Coastal erosion is very prevalent along the entire Nigerian coastline. Though natural forces such as intensive wave and tidal action, longshore currents, low lying topography, sediment characteristics, nature of self width, occurrence of offshore canyons are responsible for coastal erosion; anthropogenic activities such as the construction of harbour protection structures and oil production facilities, damning of rivers, sandmining and dredging, deforestation, subsidence due to fluid extraction, poor physical and land use planning are major causes of coastal erosion.

According to Asangwe (1993), more than 50 erosion sites have been identified along the 853 km coastline consequently, erosion poses great threats to coastal communities and their economic activities. Identified areas of major erosion along the Nigerian Coastal Zone are : Victoria beach, Awoye/Molume, Escravos/Ugborodo, Forcados, Brass, Bonny, Ibeno-Eket, Ikot-Abasi.

6.1.1. Victoria Beach, Lagos

Victoria beach is located on one of the barrier islands within the barrier-lagoon complex. It is a very popular beach and is widely used by tourists. It is also the site of the fastest eroding beach in the Nigerian Coastal Zone.

The erosion problem on the Victoria beach started with the construction of east and west moles at the mouth of the Commodore Channel between 1908 and 1912. The moles (break waters) were used to stabilise the dredged deep entrance into the Lagos harbour but it immediately touched off an erosion problem east of the inlet at Victoria Island. Between 1912 and 1959, the Bar-Beach retreated by over 1 km in the western extremity of Victoria Island near the east mole. This diminished to about 400 m some 3

km eastwards near the Kuramo waters and 250 m farther east at about 5 km from the east mole.

Within this same period, the light house Beach prograded about 600 m near the west mole (Ibe 1988).

A wide variety of remedial measures were applied to combat the erosion problems on Victoria Beach. The most widely used has been sand replenishment.

Monthly profiling carried out on the Bar-Beach revealed an average erosion rate of 25 - 30 m/year at the most active erosion sites. There is urgent need for immediate attention on a permanent solution to the problem of erosion on the Bar Beach in view of the multi-billion dollar real estate fronting this beach.

6.1.2 Awoye/Molume

Awoye/Molume is located on the transgressive mud coast of Ondo State. The mud beach is low lying and is subjected to rapid erosion. Topographic heights range between 0.8 - 1.8 m. The location of Mahin Canyon offshore plays a significant role in determining the nature and rates of erosion on the transgressive mud beach. A coastline retreat of between 200 - 600 m was estimated along the mud beach between 1964-1981. The greatest retreats occurred in the vicinities of tidal inlets.

The erosion problem in Awoye and Molume is believed to have been aggravated by slots dredged in the area by oil companies which resulted in marine invasion thus promoting erosion.

6.1.3 Escravos/Ugborodo

Escravos is situated on the coast in the north western flank of the Niger Delta. It is the site of a large tank farm belonging to Chevron Oil Company and the Nigerian National Petroleum Company.

The erosion problem in Escravos is linked to port development. Two stone moles were constructed between 1959 and 1964 to protect the dredged access channel to Delta ports of Warri, Sapele, Burutu and Koko. Although the moles stabilised the dredged entrance they however triggered off erosion on the down drift beach at Ugborodo. In contrast, longshore drifted sand has been accumulating behind the south mole leading to a build out of the light house beach. This situation is very similar to that on Victoria beach.

Past shoreline changes at Escravos were determined using old hydrographic charts and aerial photos (Ibe 1988). The study revealed that the light house Beach has upgraded about 1.2 km near the south mole but to about 300 m some 5 km further south between 1964 and 1984. In contrast, the downdrift Ugborodo beach to the north of the river has retreated about 0.55 km nearest the inlet and decreasing to only about 0.35 km some 4.5 km up north over the same period.

A recent study showed mean erosion rate of 4.55 m over a 2-month period. This rate was measured during the rainy season when the oceanographic forces are very intense.

6.1.4. Forcados (South Point)

Forcados South Point beach is located to the south of the Forcados river. The natural foreshore is a low coastal plain with an active beach of about 50 m wide. According to Ibe (1988) about 400 m of coastland has been eroded in the last two decades. Fresh tree stumps in water of 100 m from the present coastline confirms the rapid erosion.

Recent beach profiles showed an average beach retreat of 22 m per annum. Several oil wells belonging to Shell Petroleum Development Company has been lost as a result of erosion in Forcados.

6.1.5 Brass

Brass is situated on the coast at the nose of the Niger Delta. It is located at the proximal end of a beach ridge-barrier island demarcated to the west and east by the Brass and St. Nicholas rivers. The natural foreshore is a low coastal plain. The active beach is about 50 - 60 m wide. Brass is the site of an oil terminal belonging to AGIP Oil Company.

Erosion occurs on most part of the ocean front in Brass but the major site of erosion is at Twon Brass town. This site was replenished with sand between 1980 and 1981.

Analysis of historical data showed a coastline retreat of 250m between 1960-1980 (Ibe 1988). Recent data showed an average erosion rate of about 18 m per annum.

6.1.6. The Strand Coast

Erosion is very prevalent along the Strand coast, however, intermittent accretion has been reported at selected beaches. Ibeno-Eket is the base of Mobil Producing Nigeria Ltd and facilities include a large tank farm. It is located at the Kwa-Ibo estuary. The foreshore is a low coastal plain with an active beach of 50 m wide with very gentle slopes.

In 1981 artificial sand replenishment with about 1.5 million m3 of sand was carried out on the estuary front. By 1983, erosion had removed the replenished beach.

Analysis of sequential aerial photographs of the shoreline around Ibeno-Eket show a retreat of about 200 m between 1965 - 1985. Recent profiles showed a coastline retreat of 9 - 13 meters.

6.1.7. Remedial Measures

A wide variety of erosional measures have been carried out by the Nigerian Government to combat the menace of coastal erosion. Some of the measures employed include various sand replenishment of the Victoria Beach in Lagos between 1958 and

1996, construction of a palisade groin running parallel to the coastline in 1964, and construction of groin (rocks) perpendicular to the coastline in 1996. All these measures have not yielded the desired result. Other erosional sites where some form of control measures had been carried out include Bomadi, Patani, Burutu, Opobo, Brass, Bonny and Queenstown and Ibeno. There is need to focus attention in the following areas with respect to the problem of coastal erosion :

(a) The problem of coastal erosion in the Transgressive mud beach affected (30,000 - 40,000 km2) which is about 105 km of the national coastline. Consequently, it is a peculiar problem with regional implications. It presents a unique situation with regional implications in terms of remediation, and should therefore attract the express attention of the Federal Government. Victoria Beach is also seriously affected most especially because of the real estate facing the ocean shore. Bayelsa State is also seriously affected by coastal erosion.

(b) There is need for accurate information through constant research. The lack of an accurate and qualitative data and information base is seriously militating against informed decision making and planning in respect of coastal erosion and sustainable coastal management program for Nigeria.

Specific areas of concern are as follows:

i. Loss of land mass;

ii. Use of Remote Sensing and Satellite Imagery which can help in assessing the scale and extent of loss of land due to coastal erosive activity.

(c) The absence of empirically verifiable data and baseline studies is hampering the development of a sound National Profile on integrated coastal area management. Consequently, there is need to obtain benchmark/baseline data for effective management, evaluation and monitoring.

(d) Migration from the shore is a recurring phenomenon of the coastal area with specific reference to Awoye/Molume in Ondo State and as such there is a strong need to closely study and identify the remote and immediate cause of this.

(e) There has been difficulty in understanding the dynamics of the coastal flood plains. Consequently, there is a need to carry out studies on the scientific basis of flood plain dynamics.

(f) It has been observed from empirical study that there has been a rise in sea level, which has led to coastal inundation worldwide.

Consequently, the need was identified to obtain relevant technology for the measurement if sea level rise in coastal areas. It was observed that most of tide gauges along the coastline have been put in place by the oil companies. It is therefore necessary for the Federal Government to instal its new gauge.

(g) It was observed that though storm surges takes place in the Niger Delta area, they are not as pronounced as in the Lagos area, due to the presence of mangrove swamps which serve as a buffer to storm surges and reduce their effects on the coast of these areas. However, it has been observed that the reduction in sediment deposition and the deforestation of the mangrove swamp in certain cases have been found to reduce the buffering effects of the mangrove swamps in these areas.

6.2 FLOODING

The low nature and the topography of the entire Nigerian coastline area renders the area very susceptible to flooding especially at high tides and during the rainy season.

Large areas of the back-beach are perpetually wet and water logged. The coastal area especially the Niger Delta experiences high rainfall. The poor drainage allows storm waters to collect in the hollows which eventually flood large areas within coastal settlement. Many fishing communities have had to move upland during the rainy season to avoid flood waters. The adverse effects of flooding are more apparent when stormy weather coincides with high tides.

6.3 DEFORESTATION

The removal of vegetation has been identified as a critical problem in the Nigerian coastal zone. Deforestation involves the destruction of large mangrove areas for agricultural purposes, oil exploration activities, and as a source of fuel in the form of fire wood.

Uncontrolled felling of mangroves renders the environment very susceptible to erosion and flooding since mangrove trees tend to reduce the impact of waves, tides and longshore currents along the coast.

Mangrove trees also trap sediments brought in by tidal currents. In addition, the mangrove ecosystem is a very good natural environment for the spawning of different types of fish and crustaceans.

The destruction of mangrove ecosystem along the Nigerian coastal zone has resulted in the loss of habitat, biodiversity and breeding grounds of commercially important fish species and crustaceans.

It has been estimated that about 50% of mangroves in Nigeria have been lost as a result of deforestation (World Resources 1990). Many areas along the coastline where mangroves used to flourish have been replaced by hardy salt tolerant grass, Paspalum vaginata.

6.4 SAND MINING

Unregulated sand mining has contributed greatly to the degradation of the coastal zone. Sand mining activities for beach replenishment, land reclamation and construction purposes are common features in the Nigerian coastal areas. The sand used for the replenishment of Victoria Island beach, and a number of reclamation in Lagos area such as Victoria Island, Ikoyi and Lekki were dredged from the Lagos lagoon and the near shore. Over 13.22 million m3 of sand was dredged from the Lagos lagoon between 1984 and 1989 to sandfill 552 ha of Lekki Scheme-1 residential project. Sandfilling of the remaining part of the Lekki Scheme is estimated to deplete the lagoons of over 65.5 million m3 of sand (Awosika & Dublin-Green 1994). Such drastic depletion of sand from the lagoons has adverse effects on the dynamics of the lagoon and adjoining shores and consequently exacerbates shoreline erosion.

Other coastal areas such as, Bonny, Forcados, Escravos and Brass are also witnessing uncontrolled sand mining from the near shore areas. The sand used for reclamation of the New Finima resettlement scheme and the site of the LNG Project was dredged from the nearshore. The impacts include increased depth of the marine environment which could result in increased current wave activities and a change in the hydrodynamics of the area. Also the depletion of sandy bottom and increased depth could adversely affect the living resources especially the benthic organisms which require sandy bottom and shallow depths for spawning.

6.5 SUBSIDENCE

The entire Nigerian coastal zone consists of young sedimentary rocks which are still undergoing the process of compaction. Fluid extraction such as water, crude oil and gas has been recognised as a major cause of subsidence (Poland 1984).

In Nigeria, the extraction of crude oil and gas from the coastal areas particularly in the Niger Delta has been on for more than four decades. In view of the big volume of fluid withdrawal from the young sedimentary rocks, it is believed that the Nigerian coastal area could be undergoing gradual subsidence. However, no conclusive study has been undertaken to ascertain the contribution of fluid extraction to coastal subsidence. The only available figure revealed subsidence rate of about 2.5 cm/yr at a location in the Niger Delta (Ibe 1988).

6.6 SEA LEVEL RISE

An accelerating rise of sea level in response to the green house effect is of great concern worldwide. A rise in sea level would result in increased flooding, erosion, loss of coastal land and sea water intrusion. Although value predicted for sea level rise may seem small, the effects show that a sea level rise of 0.3 m could cause shoreline recessions of more than 35m. In Nigeria, an estimated one-meter sea level rise would flood 18,000 km2 of coastal land (Awosika 1992).

6.7 POLLUTION

Major sites of serious pollution problems are Lagos, Port Harcourt, Escravos, Bonny, Warri, Brass, Calabar and Ibeno-Eket. Pollution types along the coastal zone can be categorised into : industrial, municipal, agricultural and aquatic macropytes.

6.7.1. Industrial Pollution

This includes oil exploration and exploitation, gas flaring, gaseous emissions and other industrial wastes e.g. radio active wastes.

6.7.1.1 Oil Exploration/Exploitation

Intensive oil and gas exploration and exploitation activities has been recognised as a major source of pollution in the Niger Delta. During exploration for crude oil, explosive charges are used in seismic surveys to obtain the configuration of the subsurface sediments. These have been reported to result in vast destruction of the environment.

Seismic surveys are usually followed by drilling activities during which drilling muds, cuttings and other products are discharged directly into the swamp and water bodies. Accidental blow out during drilling operations are less frequent but when they occur, large areas are devastated e.g. Shell Bomu-II blow out located within the Bonny river basin and Texaco Funiya-5 blow out, 8 km offshore sangana estuary (Odu and Imevbore 1985, Powell 1986).

Oil spillages have been a common occurrence in Nigerian coastal area. These have been due to leakages from the oil pipelines or from marine tankers that lift crude oil and refined product. According to the official estimates of the NNPC, a total of approximately 2,300 m3 of oil is spilt in about 300 separate accidents annually (Appendix 12 and 13). The environmental impact of these spills has been quite devastating as it is responsible for mass fish mortalities, destruction of mangroves and contamination of underground water.

Powell (1986) reported that discharges of ballast water from marine oil tankers was responsible for the introduction of exotic macroinvertebrates into some estuaries in the Niger Delta. The Indopacific sea urchin, Temnopleurus toreumaticus was previously unknown in Atlantic waters and was probably introduced into the estuaries through oil tankers from Pacific ports, most likely as larvae in the ballast water. The sea urchins are now major pests to artisanal fisheries in the Bonny-New Calabar estuaries. The sea urchins remove bait from long-line hooks, consume fish caught in nets and entangles cast and set nets. Their abundance make shallow fishing operations such as beach seining very unproductive and unsafe. The spines wound the hands and feet of fishermen causing small sores. The overall effect on artisanal fisheries is reduced production.

6.7.1.2 Gas Flaring

A large proportion of the associated gas produced with crude oil is flared. 80% of natural gas production in Nigeria, most of which is associated gas, is flared. The disposal of associated gas has been a major problem in the Nigerian oil industry as the country has become the greatest gas flaring country in the world. Approximately 1000 standard cubic feet (scf) of gas is produced in Nigeria with every barrel of oil. Most of this associated gas is flared because of the lack of commercial gas out lets.

The impact of Nigeria's gas flares has been of national environmental concern. The low combustion efficiency of Nigerian flares (80%) results in a large portion of gas vented being methane - a gas that has a high global warming potential. Gas flaring causes elevated temperature, noise, and acidification of soils, corrosion of metal roofs, crop damage and impacts on human health.

The Nigerian Government and the oil industry are presently trying to develop new markets for the natural gas through the LNG and NGL projects.

6.7.1.3 Other Gaseous Emissions

These include urban auto and industrial emissions from production plants. In urban areas, emissions are dominantly from vehicle exhausts, generators etc, exhaust emissions contain lead, carbon-monoxide, carbon dioxide, oxides of nitrogen and sulphur based compounds. Many of these are green house gases that increase global warming resulting in sea level rise. Many of these gases are also hazardous to human health.

6.7.1.4 Other Industrial Wastes

This includes various radio active wastes. Oil exploration and exploitation activities had led to the development of associated industries such as refineries, petrochemical and fertilizer plants. Untreated effluents are dumped directly into the creeks, Bonny and Warri rivers and the ocean.

6.7.2 Municipal Wastes

6.7.2.1 Sewage (Liquid)

There is high concentration of population and industries along the Nigerian coastal area. Lagos with a population of about 6.0 million is the largest and most industrialised town in Nigeria. Other industrialised towns located in the coastal zone include, Port Harcourt, Warri, Escravos, Forcados, Brass, Bonny and Calabar. Most of these towns have poor sanitation and water supply facilities. Domestic wastes are disposed directly into the lagoons, creeks and rivers. Direct disposal of sewage leads to increased biological

oxygen demand and therefore a reduction in the amount of dissolved oxygen available to aquatic life.

6.7.2.2. Solid (Garbage)

In most of the urban centres including these coastal cities of Lagos, Warri, Port Harcourt and Calabar, the solid wastes disposal system is not adequate. As a result solid wastes are dumped into the lagoon, creeks and along the river courses.

6.7.3. Agricultural Wastes

6.7.3.1 Pesticide Residues

Some large scale hydromorphic farmers make use of pesticides and herbicides to get rid of weeds, pests and insects that invade their farms and reduce their yield.

Most of the residues are toxic and they go back to water drainage system causing a lot of damage to the aquatic resources.

6.7.3.2 Fertilizer Residues

Fertilizers are used to enrich the soils and accelerate growth of plants and animals. Fertilizers are also used to boost fish production. However, fertilizers contain heavy metals which if not controlled can do a lot of damage to aquatic plants and animals. Fertilizers also encourage eutrophication resulting in the prolific growth of aquatic weeds which disturbs navigation.

6.8 INTRODUCTION OF EXOTIC SPECIES

Water hyacinth (Eichhornia crassipes) is an aquatic macrophyte that is believed to have entered Nigeria through Porto Novo creeks (Benin Republic). The Porto Novo creeks flow into the Badagry creek which is in turn linked to the Lagos and Lekki lagoons.

Eutrophication of the lagoons due to nutrient enrichment by unprocessed fertilizer effluent is believed to be responsible for the prolific growth of the weeds. The water hyacinth forms a mat covering the water surface thus making fishing and navigation almost impossible. The mats of weed has extended to a distance of more than 300 km along the southwestern coast of Nigeria - Lagos, Ogun, Ondo and Delta States.

The Nypa palm (Nypa fructicans) is another exotic plant introduced into the Nigerian coastal waters. This palm is spreading fast in the eastern Niger Delta and is replacing the mangrove forests.

The Indopacific Sea urchin, Temnopleurus toreumaticus was previously unknown in Atlantic waters. The sea urchin was introduced into Nigerian coastal water through oil tankers from pacific ports, most likely as larvae in the ballast waters of these marine

tankers. As previouly neutured, they are now major pests to artisanal fishermen fishing in the estuaries on the eastern flank of the Niger Delta.

6.9 COASTAL RESOURCES DEPLETION

The Nigerian coastal area is very rich in biodiversity especially plants, vertebrate, primate, fish, bird, invertebrate and insect species.

Human activities such as deforestation, habitat degradation, hunting, over-fishing, introduction of exotic species and poaching has resulted in biodiversity depletion of the living resources in Nigerian coastal zone.

The depletion of fisheries resources as a result of over fishing is a major problem in the Nigerian Coastal Zone. The Sea Fisheries Decree of 1992 stipulates that trawlers shall not use a cod-end with stretch mesh size of less than 76mm (3 inches) when trawling for fish in the inshore waters or less than 44 mm (1 3/4 inches) when trawling for shrimps in areas approved for shrimping. This statutory minimum cod-end size of fishing nets is not strictly enforced consequently juvenile fish are caught indiscriminately.

Another cause of over fishing is the increase in the number of licensed fishing vessels from 218 in 1985 to 586 in 1994 (Federal Department of Fisheries 1995). This has led to a decrease in catch per effort by as much as 60%.

The 1992 Sea Fisheries Decree also stipulates that no motorized fishing boat except canoes shall fish within the first five nautical miles of the waters of the Nigerian Continental shelf. Trawlers however, frequently fish in the no-trawl zone resulting in over fishing in the shallow near shore area.

Fish and shell fish breeding and nursery grounds are also lost due to mangrove destruction, while animals such as hippopotamus, buffalo, elephants, chimpanzee and colobus monkeys have become endangered due to hunting and poaching.

The list of endangered species as contained in Decree No. 11 of 1995 is presented in Appendix 14.

Major forest reserves are quite few within the zone, however, the Federal Government has proposed a network of forest reserves within the Coastal Area for biodiversity conservation.

6.10 REMEDIATION FOR ENVIRONMENTAL PROBLEMS

Suggested remediation measures for environmental problems are listed in Table 11.

Table 11: Environmental Problems in the NCZ and Remediation

PROBLEMS	CAUSES	REMEDIATION

1. Coastal land degradation 1.1 Coastal erosion 1.2 Subsidence 1.3 Flooding	- Improper construction of coastal infrastructure - Oil industry activities e.g.seismic, drilling fluids - Wave induced erosion - Sea level rise - Sand mining - Canalization and construction of dams	- Evaluate development projects - Identify hazard zones - Promote restoration projects to - Management of extraction of c - Control sand mining
2. Resource depletion 2.1 Fish stock depletion 2.2 Swamp shrimp depletion 2.3 Forest/Mangrove depletion 2.4 Wild life depletion 2.5 Biodiversity depletion	- Habitat loss from mangrove loss - Uncontrolled over fishing - Obnoxious fishing methods - Deforestation - Uncontrolled hunting of animals - Lack of conversation - Lack of protection of endangered species	- Conservation of valuable habi - Management of fish and shell - Provide scientific information - Establish forest reserves for bi - Regulate fishing nets mesh siz - Eradication of bush meat - Prevent illegal logging - Educate the citizenry on coast
3. Pollution 3.1 Air pollution 3.2 Water Pollution 3.3 Soil pollution	- Gas flaring, vehicle emission and industrial fumes - Pollution from oil and gas production and refinery activities - Invasion of exotic species e.g. water hyacinth and other aquatic weeds - Industrial pollution, effluent discharges and raw sewage discharges - Lack of industrial waste treatment systems and inadequate technology	- Implement environmental imp - Utilization of gas - Establish effective measures to - Control water hyacinth using i option - Review existing legislation an - Adopt and enforce pollution re

7. Institutional framework and relevant legislation

7.1. INSTITUTIONAL FRAME WORK

Three tiers of Government exist in Nigeria under the constitution of 1979 and amended in 1984 with a strong Federal System. These are: Federal, State and Local Governments.

In Nigeria, many Ministries, Agencies of the Federal Government, State and Local Government Councils, Research Institutes, Universities, Private organisations and NGO's have been actively involved in different areas of coastal zone management.

7.2. GOVERNMENT ORGANIZATION

7.2.1 Federal Environmental Protection Agency

The Federal Environmental Protection Agency (FEPA) was created by Decree No. 58 of 1988 as a parastatal under the Federal Ministry of Works and Housing. In 1992, the Agency's authority was strengthened through Decree 59 by transfer to the Presidency. The functions of the Agency include;

- Advise the Federal Government of Nigeria on national environmental policies and priorities and on scientific and technological activities affecting the environment.
- Prepare periodic master plans for the development of environmental science and technology and advise the Federal Government on the financial requirements for the implementation of the plans.
- Promote cooperation in environmental science and technology with similar bodies in other countries and with international bodies connected with the protection of the environment.
- Cooperate with other Federal Agencies, State Ministries, Local Government Councils, Statutory bodies, Research Institutes and Universities on matters and facilities relating to environmental protection.
- Protection of Nigeria's biodiversity and the conservation and sustainable use of natural resources.
- Enforcement of environmental regulations and setting emission standards for air, water and noise pollution.

With regards to the coastal zone, FEPA's priority areas include : coastal erosion and flood control, abatement of pollution by industrial effluents, global warming and

protection of ozone layer and environmental impact assessment of large scale projects. FEPA's goals in the coastal zone are to maintain and improve the quality of the environmental resources and its physical characteristics, to prepare of ecological master plans to guide the use of coastal areas for diverse and often conflicting economic and social activities.

7.2.2 Oil Mineral Producing Areas Development Commission (OMPADEC)

OMPADEC was established by Decree No.23 of 1992 and amended by Decree No. 7 of 1996 primarily to tackle effectively the ecological problems arising from the exploration and exploitation of oil minerals using 13% of the Government revenue accruing from the crude oil. The administration of the fund rests with the management of the Commission.

7.2.3 Federal Ministries

7.2.3.1 Federal Department of Fisheries/Federal Department of Forestry (Federal Ministry of Agriculture and Natural Resources)

The Department of fisheries is under the Federal Ministry of Agriculture and Natural Resources. It has responsibility to control, regulate and protect fisheries and other aquatic life in the Nigerian coastal zone and the Exclusive Economic Zone.

The Department works very closely with the Nigerian Navy, Marine Police and Nigerian Customs.

The Department of Forestry in the Ministry of Agriculture is vested with powers to conserve and manage Nigerian forest resources. The Department is also responsible for the establishment of forest and game reserves.

7.2.3.2 Department of Meteorology (Ministry of Aviation)

The Federal Department of Meteorology has sole responsibility for the collection of meteorological data and weather forecasting. The Department presently operates in Lagos one of the two ozone monitoring stations in Africa.

7.2.3.3 The Nigerian Navy (Ministry of Defence)

The Nigerian Navy has responsibilities to protect and defend the Nigerian Territorial waters and the EEZ. The policing activities of the Nigerian Navy involves the enforcement of the Sea Fisheries Decree of 1992. This include:

- Enforcement of the statutory cod-end mesh size of fishing nets;
- Arrest of poachers;
- Arrest of fishing vessels using explosive substances or noxious or poisonous matter for fishing;

- Arrest of fishing/shrimping trawlers involved in illegal transhipment of catches at sea;
- Arrest of trawlers fishing within the no-trawling zone;
- Arrest of marine vessels involved in polluting the marine environment by dumping chemical and nuclear wastes.

7.2.3.4 Ministry of Petroleum Resources

This Ministry, through its Department of Petroleum Resources has responsibilities for the development, conservation and management of Nigeria's Petroleum resources. It also has the mandate to enforce strict environmental pollution controls in areas of oil exploration and exploitation.

7.2.3.5 Ministry of Solid Minerals

This Ministry is responsible for the formulation and implementation of National Mining policy on solid minerals, quarries, geological surveys, mineral investigations and investment in mining activities.

The Ministry supervises sand mining activities in the Coastal zone.

7.2.3.6 National Maritime Authority, Nigerian Ports Plc (Ministry of Transportation)

The National Maritime Authority has mandate to manage marine transportation particularly the shipping industry, while the Nigerian Ports PLC Manages all the ports and facilities and maintains shipping routes.

7.2.3.7 Ministry of Water Resources

The Ministry has responsibilities for control of water resources, dams and irrigation; development of river basins, exploration and development of underground water; hydrological and hydro-geological investigations, water supply and control of soil erosion.

7.2.3.8 Federal Ministry of Works and Housing

This Ministry is responsible for preparing and executing land policies, as well as housing, town planning in the coastal zone, infrastructural development and also responsible for establishing set back lines along the coast from which development should be excluded, and also the protection of the coastline against erosion. The Department of Flood and Erosion Control of the Federal Ministry of Works and Housing is the implementing Agency for all coastal flood and erosion control measures in the Nigerian Coastal Zone.

7.2.4 Research Institutes

The Nigerian Institute for Oceanography and Marine Research (NIOMR), has responsibilities to conduct research into the living and non living resources and the physical characteristics of the Nigerian territorial waters and high seas beyond. NIOMR through its Divisions of Marine Geology/Geophysics, Fisheries resources and Physical/Chemical Oceanography is involved in the collection and analysis of data on coastal resources, environmental degradation, pollution, oceanographic parameters and sea level rise.

The Institute is also involved in the Global Sea Level Observing System (GLOSS) and operates the Gloss Station in Lagos. This station is equipped with analogue and acoustic tide gauges - Next Generation Water Level Measuring System (NGWLMS) developed by the National Oceanographic and Atmospheric Administration (NOAA) of the Unites States of America.

Another project is the SEAS-III (Shipboard Environmental Data Acquisition Systems), which is an International project under the sponsorship of NOAA. The objective of this project is to collect oceanographic/ meterological and environmental data from the South Atlantic (Route AX 14 - Lagos - Rio - Lagos).

7.2.5 Universities

Many Nigerian Universities are involved in research activities concerning various aspects of the coastal zone. These universities include:

- Universities of Lagos;
- Lagos State University;
- Obafemi Awolowo University (Institute of Ecology);
- University of Benin;
- Rivers State University of Science and Technology (IPS, IGST);
- University of Calabar (TOC).

7.3 STATE GOVERNMENT

Nine of the thirty-six States in Nigeria lie within the coastal zone. These include, Lagos, Ogun, Edo, Ondo, Delta, Bayelsa, Rivers, Akwa Ibom and Cross Rivers. Edo state which is land locked has the southern portion under brackish and marine influences.

The State and Local Governments in the coastal zone are closest to the communities and their responsibilities include :

- Liaison with Federal Agencies on environmental policies,
- Monitoring and enforcement of environmental quality standards and regulations,

- Regular assessment of environmental conditions and trends in rural areas and identification of programmes and actions needed to reduce or avoid further environmental degradation and pollution,
- Application of the national environmental assessment guidelines and procedures for all development projects likely to have adverse environmental impacts within the State and local Governments,
- Development of a State Environmental Management Plan with priorities for action to reverse environmental degradation, protect human health and the environment and accelerate progress towards environmental improvement and sustainable development,
- Development of contingency plans and capabilities to respond quickly and effectively to environmental emergencies such as natural disasters or major industrial accidents,
- Collection, storage and dissemination of data relevant to environmental impact assessments within the State,
- Sensitize the rural communities on the state of the environment.

7.3.1 State Environmental Protection Agency

All the above-mentioned states have EPA's whose functions are as stated in their respective mandates.

7.3.2 State Ministries

A number of states like Lagos, have specific Ministries for environment while others have Ministries whose activities relate to coastal zone management.

7.4 NON-GOVERNMENTAL ORGANIZATION

Some Non-Governmental organizations have programmes dealing with aspects of environmental protection in the Nigerian Coastal zone. Such NGO's include: Nigerian Conservation Foundation (NCF), Delta Environmental Network, Ecological Society of Nigeria (ECOSON), Fisheries Society of Nigeria (FISON), Forestry Association of Nigeria (FAN), Friends of the Environment (FOTE), Friends of the Niger Delta, Niger Delta Environmental Survey (NDES), Niger Delta Wetland Centres, Nigerian Environmental Society (NES), Nigerian Environmental Link (NEL), Nigerian Study Action Team (NEST), Nigerian Environmental Watch (NEW), etc.

Some of their activities include :

- The promotion of public awareness and action on environmental degradation in the coastal Zone,
- Promotion of public interest in conservation and the protection of biological diversity in the coastal zone,
- Provision of expertise and guidance on matters affecting the coastal environment,

- Assistance in the development and implementation of local conservation policies and support of local conservation activities on the sustainable use of resources in the coastal zone.

Apart from the NGOs, there are also Community Based Organizations (CBOS). These are village organizations and are present in most communities in the Nigerian Coastal Area. These organizations are involved in self-help projects such as provision of basic amenities e.g. electricity, portable water, roads, schools, primary health care clinics etc. CBOs tend to complement Government efforts.

7.5 INTERNATIONAL ORGANISATIONS

The country has enjoyed some form of bilateral and multilateral financial assistance on coastal environmental management from such agencies as UNDP, UNEP, IMO, RECTA, IOC of UNESCO, NOAA.

7.6 RELEVANT LEGISLATIONS

Nigeria has legislation that is directed towards the management of the coastal zone and the resources. There is also much environmental related legislation affecting the conservation and management of the Nigerian coastal zone. This legislation falls under : forestry, wildlife, fisheries, crude oil exploration and exploitation, Exclusive Economic Zone and Natural Resources conservation. It includes :

- Forestry Ordinance of 1937;
- Mineral Act of 1946 which affirms Ownership of all minerals as property of the Government;
- Petroleum Control Act 1968;
- Petroleum Drilling and Production Regulations 1969;
- Petroleum Act 1969 which established the right of Nigeria to exploit offshore petroleum and gas in Nigeria;
- Wild Animals Preservation Law 1972;
- Forestry Amendment Edict 1973;
- Exclusive Economic Zone Decree 1978, which established an EEZ of 200 nautical miles adjacent to the Territorial Sea;
- Crude Oil Transportation and Shipment Regulations 1984;
- The Endangered Species Decree 1985;
- Federal Environmental Protection Agency Act 1988 cap. 131;
- Associated Gas Re-injection Act cap. 20 1990;
- Harmful Waste Act cap 165 1990;

- Land Use Act Cap 202 1990;
- Natural Resources Conservation Agency Council Act Cap 286 1990;
- Oil in Navigable Waters Act Cap 1990;
- Sea Fisheries Decree 1992.

The Land Use Decree of 1978 stipulates that all land resides with the Federal Government of Nigeria. The Decree provides for granting of statutory rights of Occupancy over land and customary rights over rural land to developers, Institutions and Government. The Decree also empowers the Governor of each State to hold in trust and administer land for the use of all Nigerians. All coastal land areas are consequently under this Decree.

7.7 INTERNATIONAL AGREEMENTS

Relevant international environmental agreements ratified by Nigeria are :

- Geneva Conventions on Territorial Sea and Continental Shelf 1964,
-African Convention on the Conservation of Nature and Natural Resources 1968,
- International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1971,
- Convention on the Protection of the World Cultural and Natural Heritage 1972,
- Convention on the Prevention of Marine Pollution by the Dumping of Wastes 1972,
- Convention on International Trade in Endangered Species 1973,
- Convention on the Conservation of Migratory Species of Wild Animals 1979,
- Convention for Cooperation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region 1981,
- Convention of the United Nations Law of the Sea (UNCLOS III) 1982,
- 1989 Basel Convention on the Transboundary Movement of Hazardous Wastes and their Disposal.

The Legal framework for the management of the various legislations is hinged on the Federal enactments, with subsidiary instruments as well as State Laws since each State is autonomous within the sphere of its legislative competence.

- Planning,
- Design,
- Construction,
- Operation and Maintenance.

Planning is the first step to be considered in embarking on any project. There should be adequate planning for the successful implementation of a project to take place. Due consideration must also be given to physical, biological and socio-economic factors.

After planning, comes the design of the project. The main essence of design is to ensure a satisfactory project which is safe and economically viable. The data that will be required for design purposes should be stated. For instance, the rational design of drainage system requires extensive and reliable demographic, meterological and hydrological data. The next stage of the project is its construction. The types of materials to be employed must be specified. The mode of construction and calibre of workmanship to execute the construction must be stated.

The final stage is the operation/maintenance. After the project has been executed, the methods and ways of maintenance should be described.

8.5 DESCRIPTION OF ENVIRONMENT/BASELINE DATA

The project proponent shall provide detailed description of the existing environment of the project area. The description shall include, geographical location, climatic conditions and the ecological characteristics of the area. The proponent shall supply along with the description, the results of studies along with the description, the results of studies carried out on physical biological and the socio-economic characteristics of the project area. The vegetation distribution of the area shall be depicted. An assessment of the air quality and noise level existing in the environment shall be carried out.

The proponent shall acquire and supply baseline data and land use maps of the project area. Emphasis shall also be given to the description of areas of archaeological, historical and cultural values that exist in the project environment.

8.6 POTENTIAL ENVIRONMENTAL IMPACTS

Potential environmental impacts shall be quantified as much as possible and the impact prediction methods used must be stated. Some of the environmental impacts likely to be encountered in coastal development projects are impacts on : physical resources, biological resources, economic development/human uses and quality of life.

8.6.1 Physical Resources

- Surface Water : Coastal projects often result in significant alterations in the natural hydrological regimes, including re-routing of channels, paving and straightening of channels for flood control and construction of channel obstructions and barriers. These will not only alter the flow distributions during the year (both into and from the sea) but also can result in major changes in salinity patterns and water quality.
- Ground Water : The ground water resources in the project area are often developed and used for local water supply, and may be affected (both in quality and quantity) by the alterations in surface hydrology. Associated with excessive pumping of ground water is a serious hazard of salinity intrusion. Groundwater contamination can result from industrial activities.
- Air Resources : Smog and noise problems will of course result from any concentrations of industry and automotive traffic. Particulate generation can also occur.
- Beach and other Coastal Waters : The nearshore water quality will be affected by discharges from all various industrial and community wastes, especially from mining activities, while recreation and tourism impacts can be negative.
- Land Resources : Beach and other recreational assets may be encroached upon by roads, housing and other developments. Waste disposal is a major item.
- Land Alterations : Construction of break-waters and jetties may significantly alter normal ocean sediment deposition/transport patterns, resulting in gradual removal of existing beaches and creation of new ones.

8.6.2 Biological Resources

- Aquatic Resources : Fisheries and all other aquatic forms will likely be impacted negatively. The hazards are not only to fin-fish, but to shellfish, turtles, and other marine mammals and plants. The damages to fisheries which are generally the most serious involve alterations in their habitat and breeding grounds. For environmental analyses of proposed coastal projects, evaluation of the effects on aquatic life may be the most difficult aspect and may require much time and effort than for other impacts.
- Terrestrial Wildlife : Development projects in rural or remote coastal areas may sometimes have significant impacts on terrestrial wildlife including waterfowl and crocodiles.
- Forests : Coastal forests, especially mangroves, are likely to be seriously affected by most development projects. Forest loss could be due to clearing, dumping and industrial activities such as drilling and exploration.

8.6.3 Economic Development/Human Uses

Virtually all types of existing development projects will be impacted by proposed projects. Such projects include : transportation routes (highways, railways, navigation channels), community infrastructure (water supplies, drainage and flood control systems, sewage systems), housing, industries, ports/harbours, large scale aquaculture projects, recreational resorts etc.

Some of the problems usually encountered are :

- Pollution from community, industrial and mining sources,
- Increase in flooding problems due to alterations in topography or construction of obstruction,
- Interference with traffic patterns and transportation,
- Destruction of land resources resulting from erosion due to removal of surface vegetation.

8.6.4 Quality of Life

Coastal areas often include some of the most valuable areas in the region with respect to scenic and recreational values. Hazards to be evaluated include :

- Damage to natural scenery caused by highways or buildings,
- Encroachment upon and pollution of beaches and other recreational areas,
- Navigational activities from log transportation in coastal waters.

Another important subject area is the impact the project will have in local socio-economis terms, including effects on public health, on employment and income, on population and ethnic patterns, and needs for resettlement of families affected by the project. Coastal development projects can create ethnic differences and oppositions. It can also include piracy and pilfering.

8.7 MITIGATION MEASURES/ALTERNATIVES

The associated and potential environmental impacts can be mitigated or ameliorated. For instance, the industries that are sited in coastal regions, ought to get their waste-matters treated to a specified standard before they are discharged into the sea.

Various project alternatives should be considered before finally embarking on a particular project. There could be a possibility of having a no project option. Cost-benefit analysis should be encouraged in selecting alternatives.

The project proponent shall state the mitigation measures that shall be taken against adverse environmental impacts highlighted based on the EIA report. The EIA report should match the mitigation measures that shall be provided. A table showing the impacts and the corresponding mitigating measures shall be provided.

8.8 ENVIRONMENTAL MONITORING PLAN

In order to ensure compliance with the mitigation measures, the project proponent shall establish and submit information on environmental monitoring plans. These plans shall clearly establish the parameters to be monitored as well as the scope of monitoring. A monitoring schedule shall be stipulated based on the types and complexity of the mitigation measures.

8.9 REMEDIATION PLANS AFTER DE-COMMISSION/CLOSURE

The project proponent shall provide the necessary remediation plans that will be taken when the project is de-commissioned or temporarily or permanently closed. This shall take into consideration both the positive and negative changes that such plans may have on the environment.

The ways and means of restoring the project area back to its original status shall be fully exploited and firm implementation steps must be established in this section.

8.10 WEAKNESS OF EIA PROCESS

An Environmental Impact Assessment decree can be seen as a major break from the past in environmental protection. The negative impacts of development projects can now be avoided or mitigated with an efficient application of the decree. The extent of this change depends on various factors:

- The EIA process remain ineffective without a text of application to complement several aspects of the decree. It is important to put in place categories and conditions for applying EIA in the Coastal Zone, in order to mitigate the increasing rate of degradation as a result of developmental activities;
- EIA is multi-disciplinary, its effectiveness depends on professional capabilities of staff and objectivity in their opinions based on their scientific and technical expertise;
- Bureaucratic bottlenecks are responsible for slow administrative procedures. This could slow down development projects subject to an EIA process. The successful implementation of the EIA process therefore depends on the conscientiousness of the officials in the Agency charged with the issuing of permits and approvals;
- Incorporating predictions of environmental impacts as the basis for decision making and improved planning;
- Availability of data and expertise;
- Cost-benefit analysis is in-appropriate;
- Lack of Enforcement and acceptability;
- Lack of public participation and enlightenment.

There can be no doubt that problems continue to be encountered in conducting EIAs. As the EIA gains acceptance as a decision making tool, these problems will have to be addressed systematically and solutions sought. In conclusion the EIA Process is at its infancy in Nigeria with increasing activities in the coastal zone, measures should be adopted to facilitate the efficient functioning and implementation of the EIA Process.

9. Information management

9.1 INTRODUCTION

Information management is paramount to coastal Environmental Management. The Geographic Information System (GIS) will be adopted. GIS will be used for acquisition, inventory and storage of information and data on pollution, energy, biodiversity, coastal dynamics, infrastructural facilities, human activities on scales that will enhance coastal environmental management.

9.2 PROBLEMS AND PRIORITY NEEDS

Among the problems that will be encountered in adopting GIS are the institution which will coordinate, collaborate within and between institutions and department to reduce duplication of information available for sharing.

Other priority problems are:

- Non availability of digital and up to date maps;
- Financial constraints with respect to equipment and software;
- Lack of formulation and implementation of GIS;
- Lack of clear policy with regards to GIS and its application to coastal environmental management;
- Identification of national focal institution as well as subsidiary and zonal institutions from which information can be easily obtained;
- Manpower development.

9.3 ELEMENTS OF STRATEGIES

(a) Identification of a focal point;

(b) Creating awareness of the existence, function and responsibilities of the focal point;

(c) Formation of Technical Committee for collating and coordinating all available information and data capacity in GIS.

9.4 ELEMENTS OF AN ENABLING ENVIRONMENT FOR GIS

(a) Research ;

(b) Acquisition of computer with large storage capacity

(c) Acquisition of compatible software and technical support

(d) Accessing of the GIS by experts from different background to enhance ICAM's objectives;

(e) Integration of available information in varying formats e.g. Auto Cad, Arch info data etc.

9.5 TARGET FOR THE YEAR 2005, 2010 AND 2015

(a) Up to 2005 : capacity building;

(b) Up to 2010 : solution for the coastal environmental management problems should have been accomplished

(c) By 2015 GIS should have been well established. In order to be able to accomplish the target set above, ICAM should immediately produce an implementation strategy and structure for GIS programme at the national level.

10. Identified problems for effective ICAM in Nigeria

The Nigerian coastal zone is critical to the economic development of the Nation. Resources in the coastal zone are wide and varied and are presently exploited without efficient management. This has resulted in conflicting uses and degradation of the coastal zone. To ensure effective management and utilization of Nigerian coastal resources for sustained economic development, there is a need to overcome the following problem areas:

• Non enforcement of existing legislation and regulations that relate directly or indirectly to environmental degradation and pollution in the coastal zone;

• Non integration of environmental concerns into existing projects and economic activities in the coastal zone;

• Non clarification and harmonization of respective responsibilities and functions of the different Government Agencies among the Federal, State and Local Governments. There is need for a well articulated institutional arrangement to implement coastal zone policies. The relationship with the organised private sector and NGOs should be strengthened;

• Lack of coordination among the various Government Agencies with responsibilities covering the coast alone. The Federal Environmental Protection Agency which was established as a Central coordinating Agency has not been very effective;

• There is need to review and streamline existing legislation and regulations affecting the coastal zone in order to reduce overlaps and conflicts. There is also a need to update and bring the various legislations in line with current scientific knowledge;

• There is a need to increase the effectiveness of existing legislation. Priority areas should include Environmental Impact Assessment, habitat protection and conservation, pollution control and coastal set-back lines;

• Significant gaps exist in environmental data base for the Nigerian coastal zone. There is a need to strengthen environmental information gathering, technical capabilities and capacity building in all aspects of coastal zone management. An effective monitoring and assessment system also needs to be established;

• There is need to increase public enlightenment and participation in coastal zone management. Many coastal dwellers are unaware of the relationship that exists between human activities and the environment. This lack of knowledge leads to conflicting use of coastal resources. A change in communities attitude is very necessary before ICAM

can be successfully established. Educating the communities to enable them to control activities in the lagoons, creeks and beaches is very vital;

• Insufficient funding by Government in the implementation of policies that affect the coastal zone. The 1% (Federal Income) ecological funds earmarked as budgetary provisions for all ecological problems is rarely disbursed. Response measures to coastal problems such as erosion, storm-surges and flooding have been on a crisis management basis;

• The need to improve international cooperation on environmental protection with our immediate neighbours in the Gulf of Guinea. ICAM in Nigeria can not be effectively implemented without a regional approach and cooperation with neighbouring coastal countries because the region shares the same water body, similar oceanographic and meteorological conditions;

• There is great need to seek bilateral and multilateral assistance from International Agencies to cater for highly technical areas where there is a dearth of trained manpower;

• It was noted that infrastructural development in the coastal area was being threatened by a variety of physical problems peculiar to the coastal areas. There is therefore a need to rigorously implements Decree No. 88 of 1992 (the Nigerian Urban and Regional Planning Decree);

• There should be a strengthening of the existing population policy of the Nation and incentives should be given to Nigerians to control their population growth;

• There should be a mandatory and deliberate effort to enforce and monitor compliance with master plans and that these master plans should develop into subject plans. Also Environmental Impact Assessment should be carried out by State Environmental Protection Agencies to control, guide and monitor physical development;

• The drainage systems are completely blocked and this has been regularly identified as the most important factor causing flooding in our Nigerian cities : maintenance should therefore be pursued very seriously. There should be adequate primary, secondary and tertiary drainage systems, flood buffers should be constructed and mandatory enforcement of sanitation laws, waste disposal and waste treatment. The monitoring of compliance should include community based organisations, community development organisations ; Government should seriously consider the construction of central sewage systems. In the construction of our deep sea ports, the Environmental Impact Assessment process has not been fully considered : this is a serious lapse;

• In order to reduce rural-urban migration, rural area should be made more attractive through accelerated provision and maintenance of roads, telecommunications, water drainage and other infrastructural facilities comparable with those of the urban areas.

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Appendices