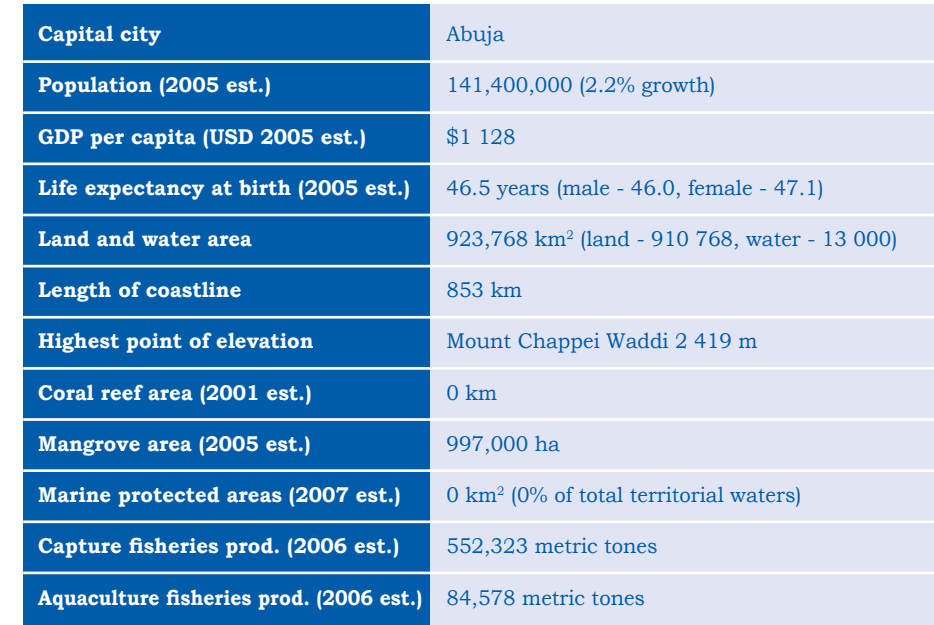


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total annual discharge has also been estimated to be about 300 x 10<sup>9</sup> cubic metres.

The south eastern river catchment basin is drained by Imo River, Calabar and several other smaller rivers which take their sources from the eastern highland south of the Benue River. These rivers empty into the ocean through estuaries.

**Coastal Climate:** The Nigerian coastal zone experiences a tropical climate consisting of a rainy season (April to October) and dry season (November to March). Temperatures are high reaching an annual mean of 28°C. Relative humidity is high throughout the year and rarely goes below 60%. The month of June receives the highest rainfall.

Total annual rainfall of between 1 500 mm and 3 000 mm is also experienced with a short dry break in August. The dry season, which lasts from November to March, is characterized by the northeast trade winds with speeds of up to 0 - 2 m per second. During this period, low visibility and relatively cold conditions are experienced at sea. Minimum wind gusts of 2.5 to 4.7 m per second are usually recorded during the months of November to February when mean wind direction ranges from 161 to about 190 degrees in direction.

**Coastal Geomorphology and Habitat:** The Nigerian coastal and marine area consists of a narrow coastal strip of land bordered by the Gulf of Guinea of the Central Eastern Atlantic. The coastal areas stretch inland for a distance of about 15 km in Lagos to about 150 km in the Niger Delta and about 25 km east of the Niger Delta. The Nigerian coastal area is divided into four main geomorphic zones (figure 1) namely:

- Barrier Lagoon Coast
- Mahin Mud Coast
- Niger Delta
- Strand Coastline

Each of these are described in the following section, as well as the continental shelf of Nigeria.

The *Barrier lagoon Coastal Complex* (Figure 1.) stretches from Badagry

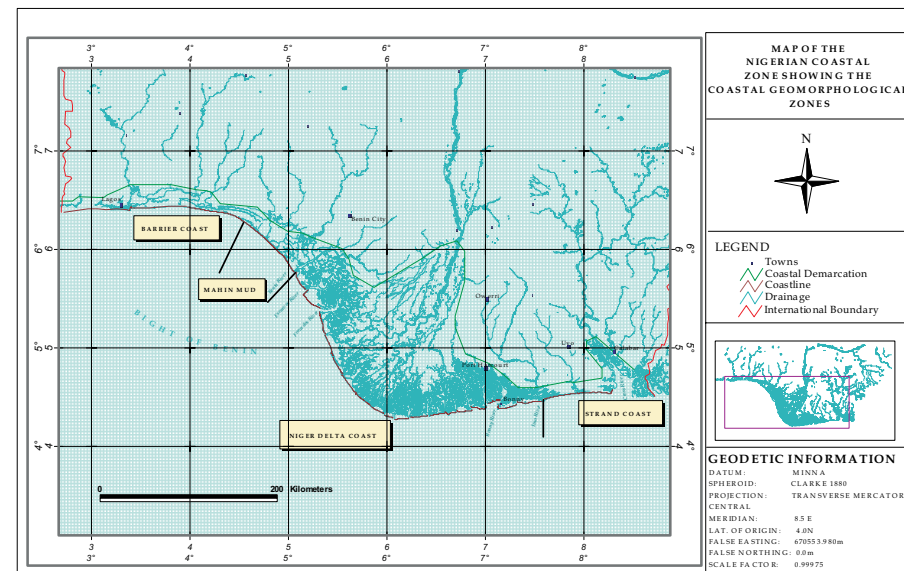


Figure 1. Map showing the Nigerian geomorphologic zones (Awosika et. al. 2000).

in the east to around Agerige village where the coastline starts a southward inflection. The barrier bar consists of beach ridges fronted by a very narrow beach with a foreshore gradient of about 1:50. Beach crest elevation is between 3 - 4 m above mean low water. The foreshore is backed by narrow and sandy beach ridges, which are aligned parallel with the modern coast. The beaches are subjected to high-energy waves, resulting in the formation of characteristically steep beach profiles. This coastal complex is very fragile as it is composed of narrow low lying sandy barrier bars backed by the Lagos, Lekki, and Yelwa lagoons, and linked together by many tortuous creeks. The coastal vegetation in the barrier lagoon complex is dominated by coconut trees, palms and other plants including sedges *Cyperus spp.*; herbs such as *Euphorbia hypossopifolia* and *Diiodia vaginalis* as well as climbers including species of *Ipomea*, *Vigna* and *Amaranthus*.

The *Mahin Mud Coast* is a muddy coastal complex which lies east of the barrier lagoon coast and stretches to the Benue River in the north-western flank of the Niger Delta. The Mahin mud coastline runs from the north-west to south-east between latitudes 5°52'00"N and 6°25'00"N. The coastline is so named because of the absence of sand



Figure 2. Deploying ADCP in the Lagos lagoon.

along the beach and the predominance of silt and clay size sediments. The coastal plain embodying this area stretches about 20 km inland. Relief ranges from sea level along the coast backed by a wide expanse of tidal flat, wide expanse of coastal plain with relief rising gently from 2 m to about 50 m above mean sea level. The coastal vegetation along the transgressive mud beach is dominated by mangrove, especially the red mangrove *Rhizophora racemosa* and the white mangrove *Avicennia spp.* Also present are the hardy grass *Paspalum vaginatum*, the fern *Acrostichum anreum*, the palm *Phoenix reclinata* and various climbers and shrubs.

The *Niger Delta* extends over an area of about 75,000 km<sup>2</sup> and accounts for 7.5% of Nigeria's land mass covering a coastline of 560 km, about two-thirds of the entire coast line of Nigeria. The Niger delta is rimmed by a chain of sandy barrier islands approximately twenty in number (Allen 1965). The Niger delta spreads over a number of ecological zones;

sandy coastal ridge barriers, brackish or saline mangroves, freshwater permanent and seasonal swamp and lowland forests. The mangroves and wetlands along the major estuaries between Benin river in the west and Cross River in the east have a total brackish area of 2 520.79 km<sup>2</sup> (Ndaguba, 1983). Most of the nation's fragile mangrove ecosystems are to be found in the Niger Delta area especially between the Benin and Cross-River. The mangrove vegetation in this zone occupies an area of about 7 500 km<sup>2</sup> in 30 - 40 km wide belt. The red mangroves -*Rhizophora racemosa* make up about 90% of the vegetation of the mangrove ecosystem. Other species are *R. harrisonii*, *R. mangle* and the white mangrove *Avicennia nitidae*.

The *Strand Coast* stretches from Imo River eastwards to the Cross River estuary along the Nigerian Cameroon boundary. The vegetation of the 85 km long strand coast comprises mangrove swamps with species composition similar to those of the Niger Delta zone. Some parts of the estuaries in this zone are populated by the palm: *Nypa fruticans* which is particularly dominant in the Kwa Iboe River area. The mangrove species *Rhizophora racemosa* are found along the Cross river estuary and in isolated pockets along the coast.

Nigeria has a narrow continental shelf, ranging from 15 km offshore off Lagos to about 75 km in front of the Niger delta, and about 85 km off Calabar, along the Strand coast. The shelf starts to break at an average depth of 90 m. The Nigerian continental shelf has three major canyons, namely: 1) Avon canyon just east of Lagos; 2) Mahin canyon off the Mahin mud coast, and 3) Calabar canyon off Calabar. There are other smaller gullies especially off the Niger delta while the outer shelf with depths between 80 - 90 m are characterized by dead Holocene coral banks. Some of the coral banks stick out from the bottom of the ocean and reach heights of 7 m above the sea bed (Awosika, 1990). The near shore area of the Nigerian shelf is composed of coarse to fine sand except off the Mahin mud coast, which is void of sand. Further out to sea, sediment grades vary from fine sand to silt, to mud at the outer shelf.

**Coastal Currents and Tides:** The Nigerian coast and marine areas are influenced by **tides, waves, long shore currents, and ocean currents**. They are described in the following sections:



**Tides** along the entire Nigerian coast are semi diurnal with two inequalities. The tides arrive in a south westerly direction. Tidal range varies from 1m at Lagos and increases progressively eastwards to about 3 m at Calabar. Intense tidal activities are more destructive along the Mahin coast during spring tides, during which tidal range reaches 1.5 m. Though the tidal range is relatively small, the effects of tides on the general morphology of the coastline are very significant.

Most of the areas along the Nigerian coastline experience moderate to high wave dynamics. The waves have a south westerly component driven by the south westerly winds. Waves are predominantly of the plunging and spilling types averaging about 1 to 2 m high along the Bar beach in Lagos. However, during the rainy months of June to September when storms are more frequent, waves of well over 3 to 4 m are common along most areas. While plunging breakers are more dominant along the Barrier-lagoon and the Niger delta coastline (Forcados), the Mahin coastline is normally subjected to spilling breakers with less intense wave action.

The currents affecting the Nigerian coastline consist predominantly of **long shore currents** generated by south-westerly breaking waves. The transport or drift, of beach sediments along a coastline, caused primarily by the action of waves and tidal currents, is a major factor in the long-term development of beaches. Long shore currents along the barrier lagoon coast in the west, have a west to east directional component. The Mahin mud coast has little or no long shore currents due to the fact that the south westerly waves arrive parallel to the coast. Long shore current along the north western Niger Delta is north westerly. The eastern Niger delta from Akassa Point to the Calabar estuary is characterized by a west to east flowing long shore current direction.

The West-East Guinea current is the dominant **ocean current** affecting the Nigerian continental margin. The Guinea current, which is an extension of the north Equatorial Counter current, attains speed of 0.3m per second with some reversals. The Guinea current runs above an undercurrent. This is thought to be a westward flowing extension of the northern branch of the Equatorial undercurrent, which splits into two branches after reaching upon the African continent at Sao Tome Island. Due to the fact that the Equatorial undercurrent carries cool,



*Figure 3. Lagos tide gauge house.*

highly saline water, the thermo cline beneath the Guinea current is particularly intense. The other important surface current in the Gulf of Guinea is the South Equatorial current (SEC).

**Coastal Observations:** Tide gauges are installed and operational at Lagos at the Nigerian Institute for Oceanography and Marine Research (NIOMR) Jetty Lagos. Meteorological stations exist at Eket, Brass and Forcados and Escravos. Salinity and water temperature measurements are also taken at the NIOMR jetty.

**Ports and Harbours:** Nigeria's major ports include Apapa and Tin Can in Lagos, Port Harcourt, Warri, Calabar and Koko ports.

**Coastal Economy:** Nigeria's petroleum industry is considered the back bone of the Nigerian economy. Nigeria is the largest oil producer in Africa, the eleventh largest producer of crude oil in the world, and a member of the Organization of Petroleum Exporting Countries (OPEC). Oil and gas operations concentrate traditionally on land, swamp, and shallows offshore in the Niger Delta area. Oil and gas provides 20% of

GDP, 95% of foreign exchange earnings, and about 65% of budgetary revenues. From the mid-nineties, major exploration activity in the deepwater offshore (500 - 1500 m) has expanded production. In 1997, Nigerian oil production reached a historic record of 2.3 million barrels per day, while in 2006 oil and gas production reached over 2.5 million barrels per day. In 2006, total Nigerian oil production, including lease condensates, natural gas liquids and refinery gain, averaged 2.45 million barrels per day (of which 2.28 million barrels per day was crude oil).

**Fisheries:** The inshore fish resources of the Nigerian waters (0-50 m) includes demersal, pelagic and shellfish resources. The potential yield from inshore waters is estimated at 201,000 metric tones per annum. Small-scale fisheries contribute between 50 - 70% of total domestic production. Tobor, (1965 and 1968 recorded about 157 species of fish belonging to 71 families in the Nigerian inshore waters. Demersal species are grouped according to their area of occurrence either above or below the thermocline at 30 - 40 m depth.

The pelagic fish resources are mainly the Clupeid family and the most exploited are; *Ethmalosa fimbriata*, *Sardinella maderensis*, *Sardinella aurita* and *Illisha africana*. Others such as anchovy and the scombrids are not the major targets of the small-scale fishery. Shellfish harvested by the artisans include white shrimps (*Nematoplaemon hastatus*, *Palaemon hastatus*), brackish prawn (*Macrobrachium macrobrachion*), river prawn (*Macrobrachium vollehovenii*), and juvenile pink shrimp *Penaeus notialis* and *Penaeus duorarum*. The industrial shellfish fisheries targets the adult pink shrimp *Penaeus notialis* and *Penaeus duorarum* taking considerable quantities of the guinea shrimp *Parapenaeopsis atlantica* in the process (Adetayo and Ajayi. 1982). Shrimp resources are abundant around river mouths and lagoon entrances. Important species occurring in Nigerian waters are the pink shrimp *Penaeus notialis*, dominant in 10 to 50 metres of water, the tiger shrimp *Penaeus kerathurus*, and the near shore shallow coastal shrimp *Parapenaeopsis atlanticat*.

**Mineral Resources:** Apart from petroleum, sand is one of the most important resources in the Nigerian coastal zone. Sand is mined along major estuaries, lagoons, near shore and along the beach. Much of the sand mined from lagoons, near shore areas are used for nourishment

of eroding beaches like the Bar beach in Lagos, sand filling swamps for development like in the Lekki area of Lagos, and construction of buildings and roads. Over 13.22 m<sup>2</sup> of sand was dredged from the Lagos lagoon between 1984 and 1989 to sand fill 552 hectares of the Lekki phase 1 residential area (Awosika et al., 1994). Local people usually mine beach sand for construction. Such activities are very prevalent among the rural dwellers in the Niger delta. Other non-renewable resources include heavy minerals, salt, gravel, and clay.

**Agricultural Products:** Subsistence agriculture is widely practised in the coastal areas. Food crops include maize, vegetable, yam, and cassava. Development of agriculture within the mangroves and swamps however is handicapped by poor drainage and high salinity of the soils, which are both difficult and expensive to control. Furthermore, draining the wetlands tends to increase soil acidity with adverse effects on plant growth (NEST, 1991). This is because the mangrove soils, usually characterized by large quantities of iron sulphides, are stable for as long as they remain submerged. Acidity increases progressively with oxidation of sulphides promoting the release of aluminium salts and other chemicals which are toxic to plant and animals.

## ADDRESSING KEY COASTAL ISSUES AND HOT SPOTS

The Nigerian coastal environment, which is richly blessed with a variety of both living and non-living resources, is responsible for almost 90% of its economic earnings. However, the coastal environment is presently subject to various issues, largely deriving from rapid expansion, particularly in industrial and agricultural areas. This is to meet the food, energy, goods and other needs of the large and growing population.

The Nigerian national report for the GEF MSP Project for Sub Sahara integrated problem analysis (Awosika et al., 2001) identified the hot spots and the following common problems at the national level:

- Modification of ecosystems from coastal erosion, flooding, deforestation
- Pollution from oil spills, solid wastes, sewage and industrial effluents
- Global climate change and sea level rise

## DEVELOPMENT AND ACHIEVEMENTS OF THE NODC

The Nigeria National Data Center (NODC) is presently located at the Institute for Oceanography and Marine Research (NIOMR) headquarters, in Victoria Island, Lagos.

The NODC provides products and services to the management, research, and academic community. This includes products for issues such as Integrated Coastal Area Management (ICAM), as well the archiving and dissemination of research and scientific documents and data in electronic format.

Several types of data are available at the NODC. These include:

- Coastal erosion data (beach profiles, littoral observation data)
- Bathymetric, Physio-chemical parameters of coastal waters
- Fisheries, Salinity, CTD, MBT, XBT

Two sets of water temperature data have been compiled for Lagos. The first set of data using the bucket system span from 1978 to 1999. The frequency of data gathering is weekly, with occasional data gaps of less than 10 days. The second set of data is compiled from the Next Generation tide gauge. This data set is based on 6-seconds intervals from 1992 to 1996.

### **ICAM products can be developed by the centre. Previous data that were compiled as part of the development of ICAM products include:**

- (i) Sediment grain size: Sediment grain size has been analyzed from 1986 to 1987 along the Nigerian coastal area, especially in Badagry, Brass, Ibeno Eket and along the estuaries of Bonny and Forcados. Each station has between 12 and 48 sub-sampling stations.
- (ii) Sediment organic content: Sediment organic content has been analyzed for Bonny, Escravos and Nana Creek estuaries in the

Niger delta. Data on the sediment organic content is available for Nana Creek and Escravos, while for Bonny data is available for only 1986.

- (iii) Collection and processing of historic data: A significant percentage of historical data on hydrodynamics, biological and socio-economics of fisheries data are available at the NODC.

## MARINE RELATED PROGRAMMES AND ORGANIZATIONS

The following organizations and contact work in collaboration with the NODC:

- Federal Department of Fisheries - 1 Wilmot Point Road, Victoria Island, Lagos
- University of Lagos -Marine Science Department, Akoka-Yaba
- University of Obafemi Awolowo - Department of Geology/ Geophysics, Ile Ife
- Lagos State University- Department of Fisheries, Ojo, Lagos
- University of Calabar- Department of Oceanography and Fisheries, Calabar
- Ministry of Environment - Integrated Coastal Zone Management, Abuja

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