Original: English

UNIDO PROJECT NO.: EG/RAF/04/001 and Contract No.: 16001961 – Subcontract for Provision of services related to Restoration and the Conjunctive Sustainable Management of Native Mangroves and Nypa palms in Cross River Estuary of Nigeria

SECOND PROGRESS REPORT (Revised)

Prepared for the United Nations Industrial Development Organization (UNIDO)
By

Bioresources Development and Conservation Programme

April 2010

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List of abbreviations

AAS-Atomic Absorption Spectrophotometer
APHA-American Public Health Association
BDCP- Bioresources Development and Conservation Programme
BOD-Biochemical Oxygen Demand
COD-Chemical Oxygen Demand
DO-Dissolved Oxygen
FAO- Food and Agriculture Organization
GCLME- Guinea Current Large Marine Ecosystem
GIS- Geographic Information System
LGA- Local Government Area
NASRDA- National Space Research and Development Agency
NCF- Nigerian Conservation Foundation
OLNG- Olukola Liquefied Natural Gas
RSA- Rapid Site Assessment
SPDC-Shell Petroleum Development Company
SSM- Standard Survey Method
TDS-Total Dissolved Solids
THC-Total Hydrocarbon Content
TOR- Terms of Reference
TSS-Total Suspended Solid
UNEP- United Nations Environment Programme
UNICAL- University of Calabar
UNIDO- United Nations Industrial Development Organization
UTM- Universal Transverse Mercator

1.0 General Background Information

UNIDO is implementing various transboundary international waters projects covering mostly Large Marine Ecosystems and River Basins in several regions of the world. The Guinea Current Large Marine Ecosystem (GCLME) Project is one of UNIDO's portfolio of International Waters projects approved by GEF Council in November 2003 and the subsequent GEF CEO endorsement on 18 August 2004 of the full project proposal "Combating Living Resources depletion and Coastal Area Degradation in the Guinea Current Large Marine Ecosystem through Ecosystem-based Regional Actions" for the sixteen (16) countries of the GCLME.

The project has a primary focus on the priority problems and issues identified by the sixteen GCLME countries that have led to unsustainable fisheries and use of other marine resources, as well as the degradation of marine and coastal ecosystems by human activities. The priority action areas include reversing coastal area degradation and living resources depletion, relying heavily on regional capacity building. In addition, the project focuses on nine demonstration projects (6 National and 3 regional) designed to be replicable and intended to demonstrate how concrete actions can lead to dramatic improvements. Among the 6 National demonstration projects is the "Restoration of native mangroves and the conjunctive sustainable management of native mangroves and Nypa palms in the Cross River Estuary of Nigeria.

In accordance with the Terms of Reference stated in the Contract document No. 16001961 the Contractor BDCP, will assist the Government of Nigeria to implement the activities to restore native mangroves and to control the Nypa palm infestation through utilizing Nypa products as proposed in the technical report "Nypa palm control and mangrove restoration in South-East Nigeria and based on the technical report of the study tour to Asian Institute of Technology, Thailand" referred to as Annex I and 2 in the contract document. The purpose of the subcontract therefore is the "Restoration and Conjunctive Sustainable Management of Native Mangroves and Nypa Palms in the Cross River Estuary of Nigeria". Essentially, it deals with the re-forestation of native mangroves at selected sites in the Cross River Estuary in South-Eastern Nigeria and the demonstration of the utilization of Nypa palm as a measure to control the infestation.

2.0 Objectives

The specific objective is to develop and implement the restoration and conjunctive sustainable management of native mangroves and Nypa palms at selected sites in Oron, Akwa Ibom State in the Cross River Estuary of Nigeria which is to be sustained long after the project duration through carefully planned community buy-in, involvement and active participation. The participation of local communities is expected in the establishment of well tendered nurseries of preferred species of native mangroves (mainly *Rhizophora sp., Avicennia sp., and Laguncularia sp*), control of Nypa palms through sustainable utilization for food and non-food purposes, and the re-forestation of degraded mangrove ecosystem.

3.0 Implementation strategies

In order to achieve the set objectives specified in the Terms of Reference (TOR), BDCP commenced the implementation of the project with a multi-disciplinary team drawn from the Nigerian Conservation Foundation (NCF), the Institute for Oceanography (IOC) of the University of Calabar (UNICAL) and BDCP staff members with expertise in physical planning, reforestation/afforestation of mangroves, community based participatory management, development of management plans, and frameworks for the management of mangroves. The approved work plan, reproduced as Annex of this report, is a useful guide to the project implementation with details for activities, responsible parties, time frame and expected output for each of the twelve reporting stages outlined in the TOR and approved proposal. The second reporting period for this exercise focused on section 7.2 on pages 19-20 of the Proposal for activities as follow:

7.2 Project step 2: The Delimitation and quantification of the nature and extent of depletion of native mangroves and consequent infestation by Nypa palm

The mangrove forests of Nigeria are the largest in Africa and are the third largest in the world after India and Indonesia (UNEP 2007). Various sources have attributed conflicting quantities to the volume of mangrove in Nigeria. Figures quoted include 5,400 km² and 6000 km² (SECAL, in Sayer, Harcourt, and Collins, 1992); Adegbehin and Nwaigbo, 1990), 9900 km², 9980 km², 7422 km² and the highest being 11,134 km². Estimates on extent of mangrove indicate a decline and has reduced by 26 per cent since 1980.

Some authors however, put the commencement of the decline at 1970 with the advent of the oil boom (Ohimain in UNEP, 2007), a development associated among others with petroleum and gas exploration and production especially from the seventies. The rate of decline due to various physical alteration and destruction of habitats have been estimated (Table 1) but actual cover is at best estimated from aerial photographs, high resolution satellite imageries and thorough ground truthing based on surveys. The goal is to conduct as complete as possible a ground reconnaissance survey of coastal States in a "zig zag" pattern to determine highly degraded sites and infestation by Nypa palm along the Nigerian coast.

Table 1: Mangrove area estimates (UNEP, 2007)

Source Year	**1980**	**1990**	**1997**	**2000**	**2005**	**2006**
Area (km²)	9 990	9 980	11 134	9 970	9 970	7 386

7.2.1 Distribution of Mangrove vegetation in Nigeria:

Mangroves are found to some extent in all the nine coastal States of Nigeria (Lagos, Ogun, Ondo, Edo, Delta, Bayelsa, Rivers, Akwa Ibom and Cross River). The major concentrations however are in the key Niger Delta States of Delta, Bayelsa and Rivers. The widest reach of mangroves is in the edges of the arcuate Niger delta (Figure 1) and specifically Delta, Bayelsa and Rivers States. The Lekki and Lagos lagoons have the

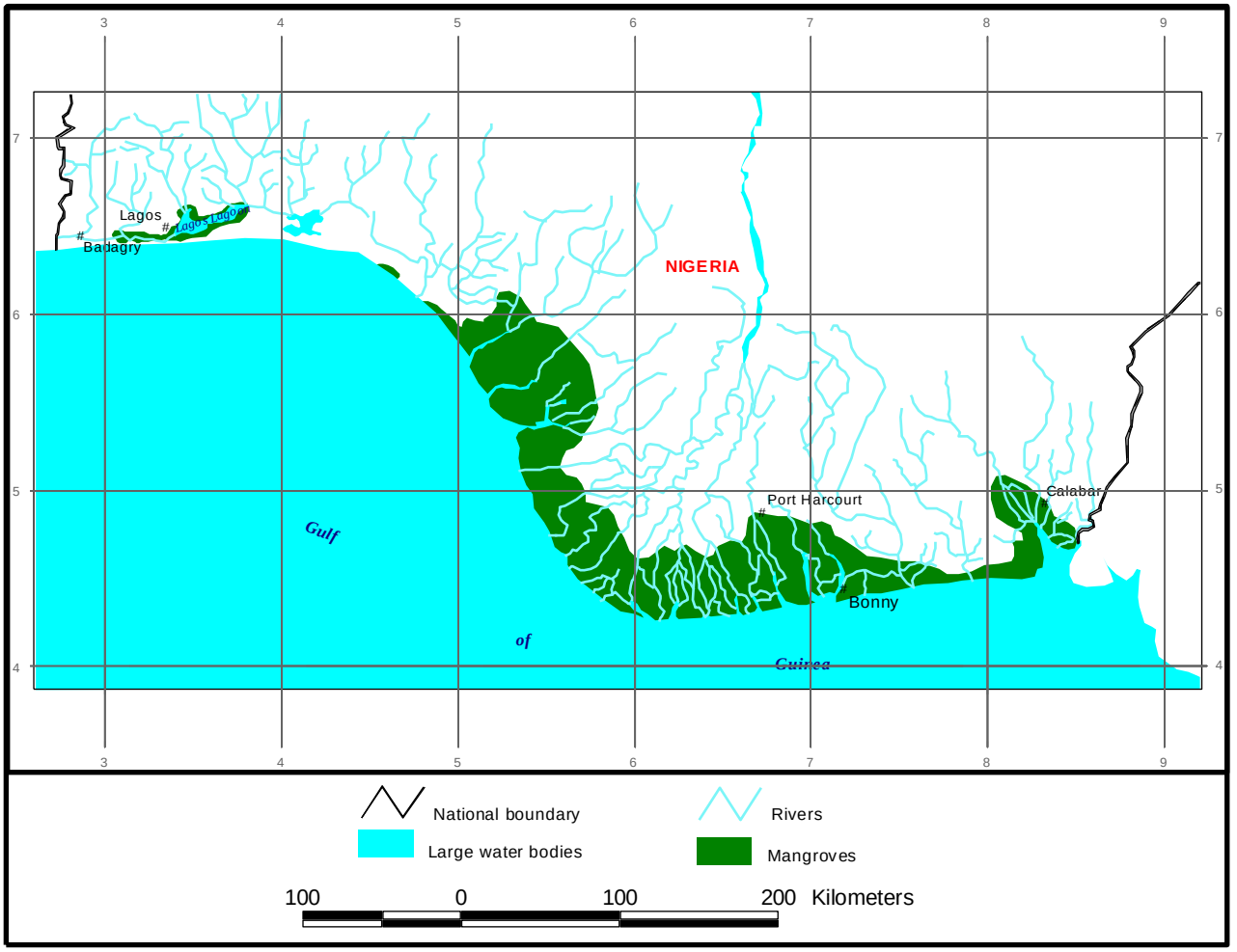

Figure 1: Mangroves and associated plants forest in Nigeria (Uluocha, 2010)

largest component of mangroves in the western axis. The Cross River has a secondary delta associated with the branching of the river into an estuary. This reaches 7-8 km in width and stretches inland into the estuary for about 26 kilometers (FAO, 2005). Edo State though not on the Atlantic coast has a tiny mangrove section along the Gwato creek. A further amount is along the boundary line with Delta State as the Ossiomo enters the Benin River.

The mangrove ecosystems are exposed to threats of destruction arising from urban development (e.g. dredging and sand filling for swamp reclamation, urban settlements, road construction, industrial development in coastal areas, coastal resorts, etc) coastal erosion, oil pollution, gas flaring, and subsidence of the coastal geosynclines aggravated by fluid withdrawal (oil and gas) from porous reservoirs in subsurface Niger Delta. However, the replacement of the mangroves by the exotic palm, *Nypa fruticans*, has been identified by various experts as a major threat to the mangrove ecosystem and an ecological disaster deserving urgent attention.

The stemmed, prostrate palm was introduced into Nigeria between 1906 and 1912, possibly from the Singapore botanic garden and has spread from the Calabar-Oron area westward to Warri (Obot, 1992). The most heavily affected areas are the Imo River System, Cross Rivers, the Great Qua, the Bonny-Opobo channel and westward towards Port Harcourt. A very significant aspect of the distribution and spread of the palm is the near-complete absence of mangroves in places where the palm has established for a long time. The "unnamed Island" in Oron, which is the project site for this exercise, is called "Uko Ntense" by inhabitants of Idua Assang. The island is presently extensively covered by Nypa which has replaced the native mangrove species in the last 30 years, except for a few scattered stands of mature mangroves and juveniles at the river banks.

7.2.1.1 Methodology for the study:

Quantification and delimitation was undertaken by reconnaissance visits by the same team employed for the BDCP project in 2007, and desk study of satellite imageries where available followed by appropriate ground truthing. The specific communities visited are listed under each state report**.** Quantification and delimitation was made difficult especially from satellite imageries for the Cross River Estuary and most of Akwa Ibom State by unresolved differentiation of mangrove vegetation from Nypa palm. Visual comparison between raw satellite imagery and classification as well as looking at the mean spectral signatures of different classes is near impossible to ensure that the mangrove areas are distinguished from other vegetation types (Figures 2 - 4). Perhaps better resolution of Sat 1 imagery could provide reliable quantification. However, efforts made to obtain a higher resolution of the satellite imagery has not yielded immediate results.

On Figure 3 the dark island in the Cross River estuary is the project site, which is virtually a pure stands of Nypa. Therefore shades of coloration from red to black (or dark) will represent mangroves to colonies/stands of the ubiquitous Nypa palm. The

Nypa palm enjoys a competitive advantage in colonizing abandoned clearings in the mangrove swamps. It is negatively associated with other plant species, resulting in loss of biodiversity as it steadily displaces the native mangrove flora. The entire bank of the Cross River Estuary is therefore completely covered by Nypa up to the disputed Bakassi Island bordering the Republic of Cameroon in Southern Nigeria.

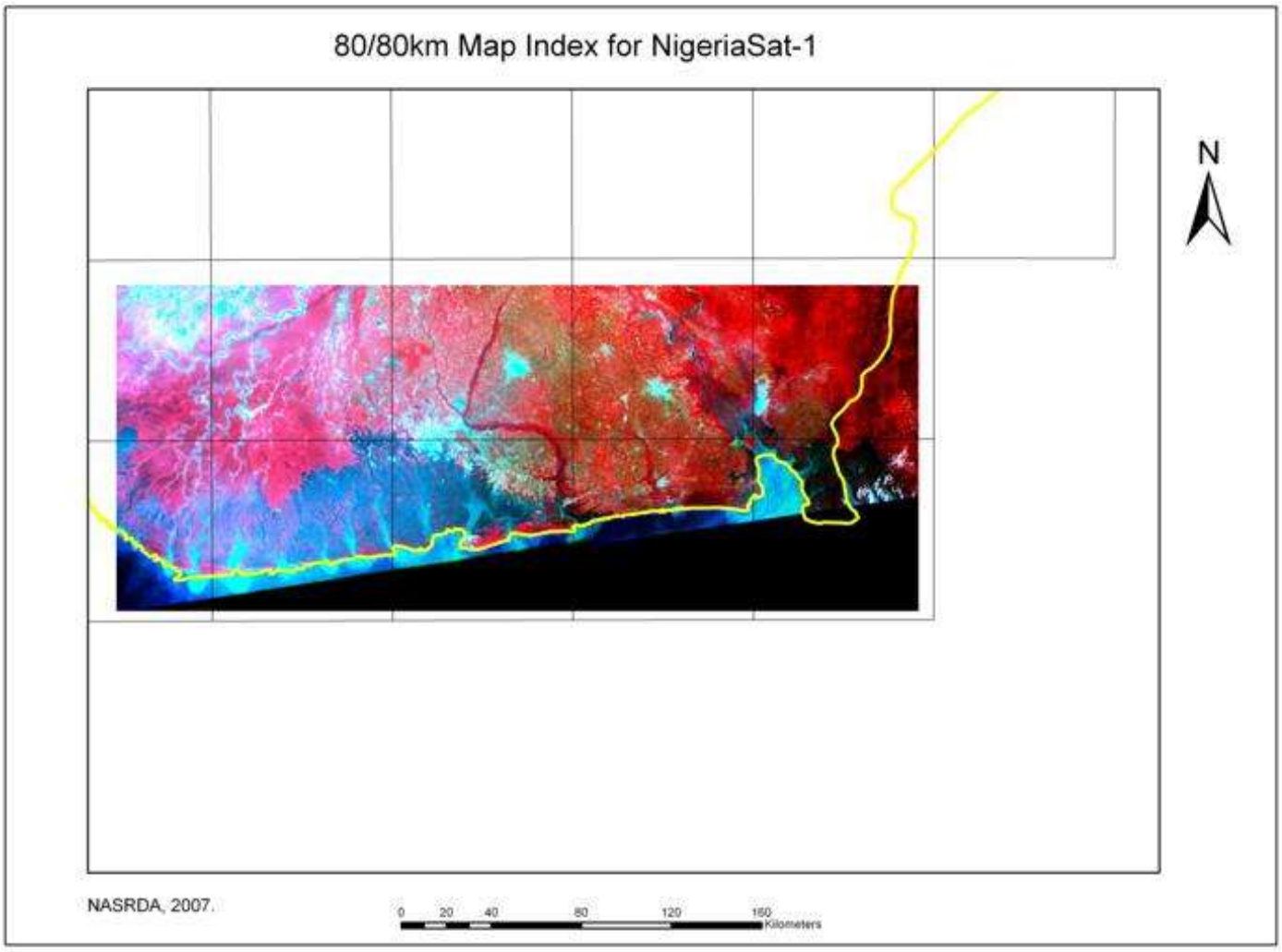

Figure 2: Nigeria Sat 1 view of Akwa Ibom and Cross River States in the Niger Delta (NASRDA, 2007).

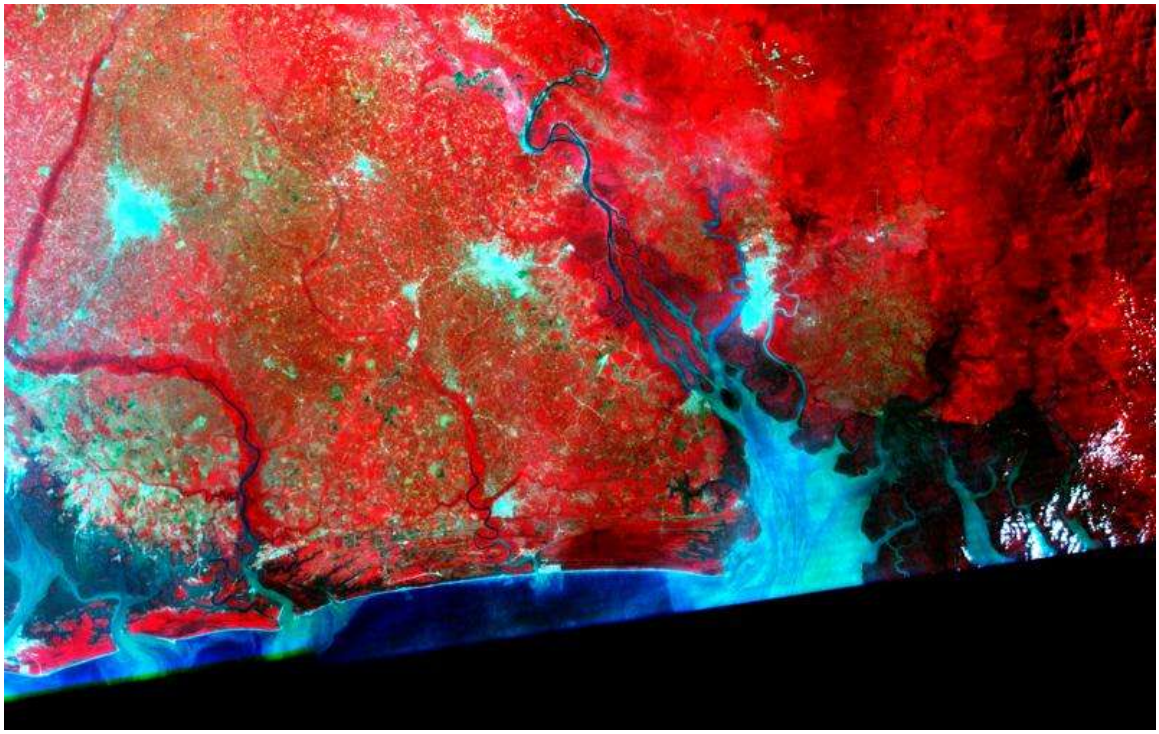

Figure 3: Details of the features in figure 2 could be observed in this imagery of the Cross River Estuary and surrounding Local Government Areas.

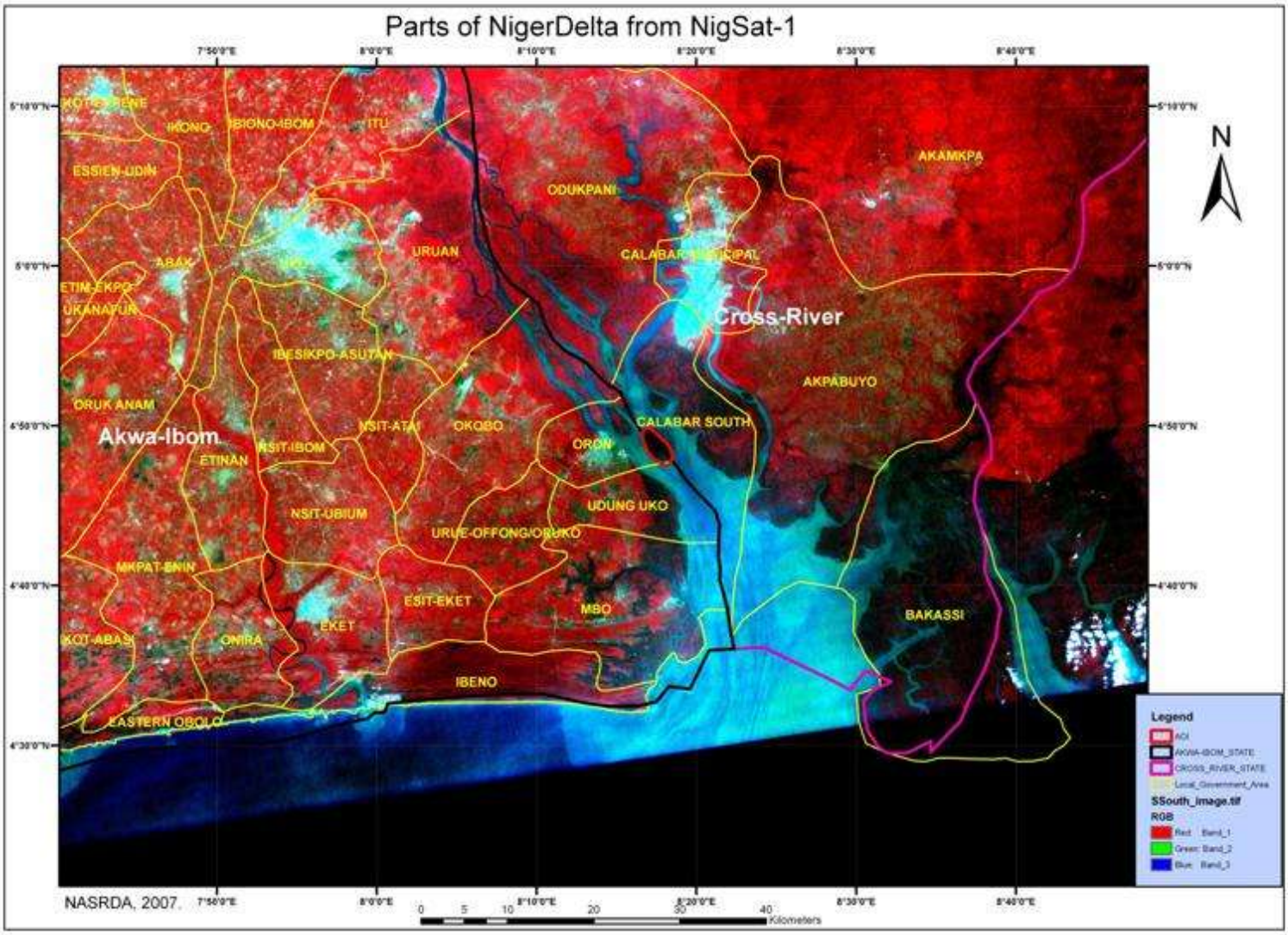

Figure 4: Satellite imagery (NASRDA 2007) showing most of Akwa Ibom and Cross River States – note “Uko Ntense” island, the project site next to Oron in Cross River Estuary.

7.2.1.2 Akwa Ibom State:

The confirmation for this observation is supported by ground truthing which has shown that the most Nypa infested sites are found in Oron, Udunguko, Mbo, and Ikot Abasi while luxurious stands of mangroves are found in Oron, Udunguko, Mbo, UrueEffiong/Oruko, Opobo, Uruan, Ikot Abasi, Essien Eket, Ibeno, Eastern Obollo, and Parrot Island. Apart from invasion by Nypa palm, impacts on native mangroves are generally linked to three causative factors, which are activities of the oil companies (exploration and exploitation in mangrove swamps), increasing rate of mangrove removal by Timber logging, and local usage of mangroves. There are clear distinctions for the degradation/depletion due to socio-economic conditions and anthropogenic /developmental pressures in anyone location. By far, onshore exploration in mangrove swamps accounts for the highest rate of degradation from the perception of local communities, followed by logging activities and communal usage of mangroves. An assessment of some communities revealed the following:

Mbo Local Government Area:

The mangroves of this area have been reduced to just sparse stands and found mainly within the Stubbs Creek section of the Local Government Area (LGA). This LGA is characterized by large settlements/villages whose members are essentially fishermen engaged in high fish and shrimp production most of which require drying for a booming fish and shellfish market. There is no alternative energy source available to the people, making over-exploitation of mangroves inevitable. Very large expanse of Nypa palm has replaced the original mangrove forests. *Rhizophora spp* are the main species in this area.

Oron

This LGA shares much in common with Mbo even as they are neighbouring LGAs. The mangroves in this area have been greatly depleted. This was one of the earliest locations where Nypa palm was introduced in the early 1900s; the mangrove forests have been replaced by Nypa forests. Public awareness of mangrove degradation is high, especially among local artisanal fishermen occupationally in contact with mangrove vegetation on fishing trips. Dependence is high in terms of local usage and impact is high in terms of removal of vegetation.

Ikot Abasi

The dominant mangrove species in this area is *Avicennia africana* (black mangrove).

Figure 5: Young mangroves at Uta Ewa, Ikot Abasi, Akwa Ibom State (BDCP, 2007)

Figure 6: Young mangroves at Uta Ewa, Ikot Abasi showing Nypa displacement (BDCP, 2007)

Udunguko

Mangroves in this area have been seriously depleted. Two main responsible factors are: oil producing activities and utilization. Even within the Stubbs Creek, Nypa palm is the dominant vegetation. Public awareness is high, dependence is high and human impact is high.

Eastern Obolo- Proposed Forest Reserve

This area is the richest in mangrove forests and thus is recommended for establishment of Forest Reserve and not as a site for reforestation. The abundance of mangroves here is only comparable to that in Bakassi area of Cross River State, with mangroves of about 40-60 m

height. Awareness of mangrove as a resource is high, but dependence is medium and impact is also medium.

The fishing tradition in this area is that most communities tend to market their fishery products fresh and thus require little or no mangrove for fish smoking. Another reason is that they engage in other socio-economic activities as alternative sources of income/livelihood. The mangrove species include *Avicennia africana* and *Rhizophora* spp. The mangroves of this area should urgently be constituted into a Mangrove Reserve.

7.2.1.3 Delta, Bayelsa and Rivers States:

These coastal States are often described as Niger Delta Special Area. They comprise a chain of about 20 barrier islands extending for about 500 km on the rim of the Niger Delta between the mouths of the Benin and Opobo Rivers. They vary in lengths and widths and are composed of sandy ridges and muddy hollows. They separate the mangrove swamps from the open ocean and are generally dissected by tidal passes (Ibe, 1988). These cover approximately 80 per cent of the Niger Delta.

Figure 7: Mangrove forest in Eastern Obolo, Akwa Ibom State (BDCP, 2007)

Bayelsa and Rivers States cover two-thirds of the Niger Delta. Around 75 per cent of the States is riverine and regularly inundated with water. In Delta State, the percentage of floodplain drops to about 50 per cent and the State includes another 15 to 20 per cent of the Niger Delta. Most of the country's oil and gas reserves and production are located in the Niger Delta. These three coastal States together produce about 75 per cent of Nigeria's petroleum. The oil companies have been implicated in the destruction of mangroves in their areas of operations. By the mid 90s the World Bank estimated that 1% of the mangroves of present Bayelsa and Rivers States had been destroyed by operations including seismic, exploration and transportation of oil and gas resources (World Bank 1995). Seismic activities are initiated in onshore exploration by cutting of seismic lines

which involves clearing of mangroves in mangrove forests. All equipment for such activities are hand carried by crews of up to 1200 men moving through not easily accessible pristine areas (van Dessel and Omokum 1994 in World Bank, 1995). Seismic lines only a few meters wide that were cut over a decade ago are still visible by air. Pipelines, flowlines and seismic lines fragment mangrove forests leaving them vulnerable to other destruction /degradation.

In Delta State, huge investments in oil industry infrastructure have been centered on the mangroves and associated land. Land take is therefore a very big issue. Table 2 illustrates the extent of land use from mangrove conversion by oil operations in Rivers State by Shell Petroleum (World Bank, 1995).

Table 2: Mangrove Conversion in Rivers State by Shell Petroleum (van Dessel and Omukum, 1994 in World Bank, 1995)

Seismic operations		56.6 km²
	56,400 km of seismic lines	
Drilling		4.5 km²
	349 drilling sites	
Production		10.5 km²
	700 km of flowlines,	
	400 km of pipelines,	
	22 flowstations,	
	1 terminal	
Total	1% of Mangroves in Rivers State	71.4 km²

Specifically, wells and fields are developed using processes that remove large tracts of mangrove. In Delta State, the following are recorded: Dibi, Olero, Opumami, Omadino oil facilities. In addition two aircraft receiving facilities for ease of movement of staff are in Delta State - the landing strip at Forcados for choppers and the Escravos hangar which can receive medium sized aircraft. These have been built on mangrove reclaimed swamps.

Dredging of river channels in Delta State seems to be a regular activity. This is focused on the Warri, Forcados, Escravos and Benin rivers. Dredging actively imperils the stability of the edge of river channels thereby weakening the base of mangroves which eventually fall into the channels of creeks and rivers. Fallen mangrove trees die and decay, thereby depleting the standing stock. When dredge spoils are piled on the sides of creeks and rivers, they alter the hydrology and smother mangrove plants. These fallen trees die-off eventually and decay in the water. Sand-miners eventually remove the

dredged materials and in the process disturb the process of re-colonization of the swamp by seedlings of mangrove species (BDCP, 2007).

Habitats of particular importance for the coastal and estuarine fishery are the mangroves. At the local level the cutting of mangroves for fuel wood, urban development and settlements, oil activities (exploration and exploitation) and canalization have destroyed or degraded mangroves to various degrees near most villages, towns, and cities. However, mangrove degradation arising from human impact is reported to be minimal in the Niger Delta (World Bank, 1995), only a small proportion of the total mangrove area is said to be substantially affected. A few reports have described the degradation as "moderate decline" (UNEP, 2007). A conservative estimate puts degradation arising from mangrove utilization alone at 5 – 10 per cent (World Bank, 1995). A government representative (Director, Forestry Department, Akwa Ibom State) confirmed that the most impacted sites in Rivers State are Bonny, Andoni and Opobo communities. The following sites were listed as having a good concentration of Mangrove: Bonny, Kala – Ibiama, Cawthorn Channel, Andoni, Ogu – bolo, Febiere, Opobo, Okirika and Finima.

Defined by regular salt water inundation, the mangroves form a vegetative band 15 to 45 km wide parallel to the coast (World Bank,1995). The numerous anatomizing creeks which are kept open by tidal incursion and flooding flow throughout the mangrove forests. It can be stated that degradation affects only the easily accessible mangrove areas. Large areas of high quality forests with high concentrations of biodiversity remain intact due to the inaccessible and inhospitable terrain. Other areas remain intact because of the high cost of extracting timber, developing plantations and clearing for agriculture or aquaculture. This is especially the case for the freshwater swamps which are now the most extensive forest zones in the country, with the severe deforestation of other forest zones in Nigeria.

Observations have conclusively shown that very little lowland rainforests remain and only a few of the forests left are significant in size or species diversity (e.g. proposed Lower Imo Forest Reserve, Ebubu forest, Ikwerre). No literature exists on the original forest. As an ecological zone, lowland rainforests used to cover some 7 400 km² of the Niger Delta. Much of the rainforests in Ogoni land has been converted to degraded bush and farmland (World Bank, 1995). The Barrier Island Forests is the smallest of the ecozones in the Delta, only about 1 140 km². The barrier island or beach ridge island forests are freshwater forests found between the coastal beaches and the estuarine mangroves. Areas in Andoni and Sangana still remain relatively untouched and have been considered in the past for delimitation as official forest reserves. These are found in the western coast of Delta State.

It has been reported that two ethnic groups in Delta State, the Itsekiri and Ijaw depend heavily on mangroves (BDCP, 2007). This dependence has gone into cultural and culinary levels with very indigenous technologies and traditional knowledge evolving to meet their requirements in this "wet desert." The different species provide goods and services as distinct as mangrove-salt, medicine, food, source of income, fish (shell and fin), bait and attractant for fish, building materials and materials for reclaiming land

("chikoko"). Thriving industries in the Warri-Sapele axis depend on mangroves for planks and furniture making.

In addition to official reserves, an unknown number of communities have forest shrines/sacred grooves and ancestral plots which is off-limit to all except their priests and is thus traditionally offered protection. A complete survey of such sacred sites has not been documented. It has been reported that inhabitants of the beach-ridge island in Sangana, allow outsiders to fell trees for timber in one of their forests but reserve other areas for village hunting (World Bank, 1995). The indigenes are allowed to cut down trees only when required for building canoes.

Figure 8: Mature mangroves left intact at Odogene creek, near Warri in Delta State and preserved for religious belief.

7.2.1.4 Cross River State:

The mangrove forests in Cross-River are found in the following communities: Akpabuyo, Calabar South, Odukpani, Bakassi, and Calabar Municipality. The most impacted sites are Calabar South, Bakassi and Akpabuyo. In Bakassi, the mangroves are not over-exploited. Most islands retain dense mangroves. The main genus is *Rhizophora*. Tall mangroves of 30-50m high are still abundant in this area. Several dead mangrove stands thought to have died of senescence were observed. However, areas of intensive mangrove exploitation were also found. Dense Nypa palm colonization was characteristic of areas where mangroves were fully extracted. The mangroves of the Calabar South LGA are being heavily exploited by the communities, essentially for commercial purposes such as salt production and fuel energy to satisfy their needs. In the Anantigha coastal area, and around Ine Udo fishing community (West of James Island), dense mangroves of approximately 40 m high were observed. The Cross River Government has included this area in the gazetted Mangrove Reserve. The main species at Odukpani are *Laguncularia racemosa* and *Rhizophora racemosa.*

7.2.1.5 Edo State:

The main mangrove ecosystem in Edo state consists of small stands on the Gwato creek and Ossiomo River at the Benin River. Edo State mangrove is at risk due to oil industry activities. Mangrove vegetation can be seen restricted to narrow strips of exposed mangrove stands along pipelines constructed to evacuate products from the littoral flank of Ovia North Local Government Area. A few other areas of negligible stands of mangrove vegetation occur along two canals dug to convey oil industry products from the Gelegele area. However, the mangrove stands improve as the salt water increases from the freshwater of the Ossiomo. BDCP (2007) survey reported that public awareness of the strategic role played by mangroves is very high among all strata of users and impact sources in Edo State. Even among oil industry operators, there is evidence of agreement that there is need to ameliorate mangrove depletion. Two oil companies, SPDC and Chevron as part of their corporate social responsibility have shown some level of commitment to mangrove replanting and reforestation project in sites impacted by their operations.

7.2.1.6 Ondo State:

The mangrove forests of the State are found in the oil producing areas of mostly Ilaje Local Government. There are also patches of mangroves in Ese-Odo LGA. Both the red and white mangroves are found in abundance. In addition, the Nypa palm is also found. These trees are known locally as "Egba"- red mangrove, "Sekele"- white mangrove, and "Opejaja"- Nypa palm. Ondo State can be said to have one of the richest mangrove forests in the country. The Ilaje land consists of 78 communities/towns. The communities in these mangrove areas make maximum use of the *Rhizophora racemosa* trees for their daily sustenance and well-being. Mangrove wood is an economic resource for housing (pillar, roofing and flooring), canoe building, and bridge construction over swamps, bait for fishing, and dye for fishing nets, fuel wood, and medicine for various local ailments, and handcrafts. This is in addition to spillage and sea incursion which makes it a top priority that action is taken soon to prevent the total loss of the mangrove.

Figure 9: Oil rigs overlooking the community at Ilaje in Ondo State (BDCP, 2007)

Mangrove associated flora in these communities are regarded as eroded species or weeds because of the high dependence on indigenous mangroves for various uses. The mangrove is the basis for livelihood and housing, apart from its curative health value in treating endemic malaria.

Figure 10: An expanse of mangrove swamp land threatened by constant oil pollution and ocean storm surge at Ilaje in Ondo State.

7.2.1.7 Ogun State:

Over 75 percent of mangrove vegetation in Ogun State can be found in Ogun Water Side Local Government Area (LGA), but there are patches in the following areas-Ipokia LGA and banks of Ogun River. These are largely preserved due to inaccessibity of the riverine swamp areas. Mangroves are found in the Water Side LGA (Makun, Odeomi), Upokia LGA (Tony Island), and Ogun River (Baals). Some depletion arising from traditional uses could be seen at Ode-Omi, Makun-Omi, and Tongeji Island. Mangroves in these

communities are at risk of further depletion by the development of "Olukola Liquified Natural Gas" Project (OLNG) sited within the free trade zone of Ogun State. The red mangrove, Rhizophora racemosa is the predominant species in these communities.

7.2.1.8 Lagos-Lekki Barrier Islands:

The lagoons of Lagos and Lekki dominate the coastal systems in southwestern Nigeria. On this barrier island, both lagoons and a few smaller ones (Ologe lagoon) are fringed by mangroves and backed by swamp forests. Historical record for the city of Lagos (Figure 11) depicts the degradation of mangroves arising from urbanization, and industrialization over the last century. All the fringing mangroves in the diagram by Speeding (1896) have been lost to unregulated urban growth and expansion, sand filling of swamps and industrial pollution. However, outside the city and metropolis remnants of mangrove vegetation can be found at Ologe, Majidun, Ikorodu, and Epe lagoon. The predominant mangrove species in Lekki and Epe is the red mangrove "*Rhizophora racemosa*". The Nypa palm has not been reported in the Lagos area or on the barrier-island beach. However fruits of Nypa have been observed among debris on beaches.

Lagos State survey revealed that most mangrove forests are found within government reserves. Majidun-Awori reserve is the only gazetted forest reserve in Lagos State. The estimated total area of the Majidun Awori mangrove is 1,168 hectares. The predominant

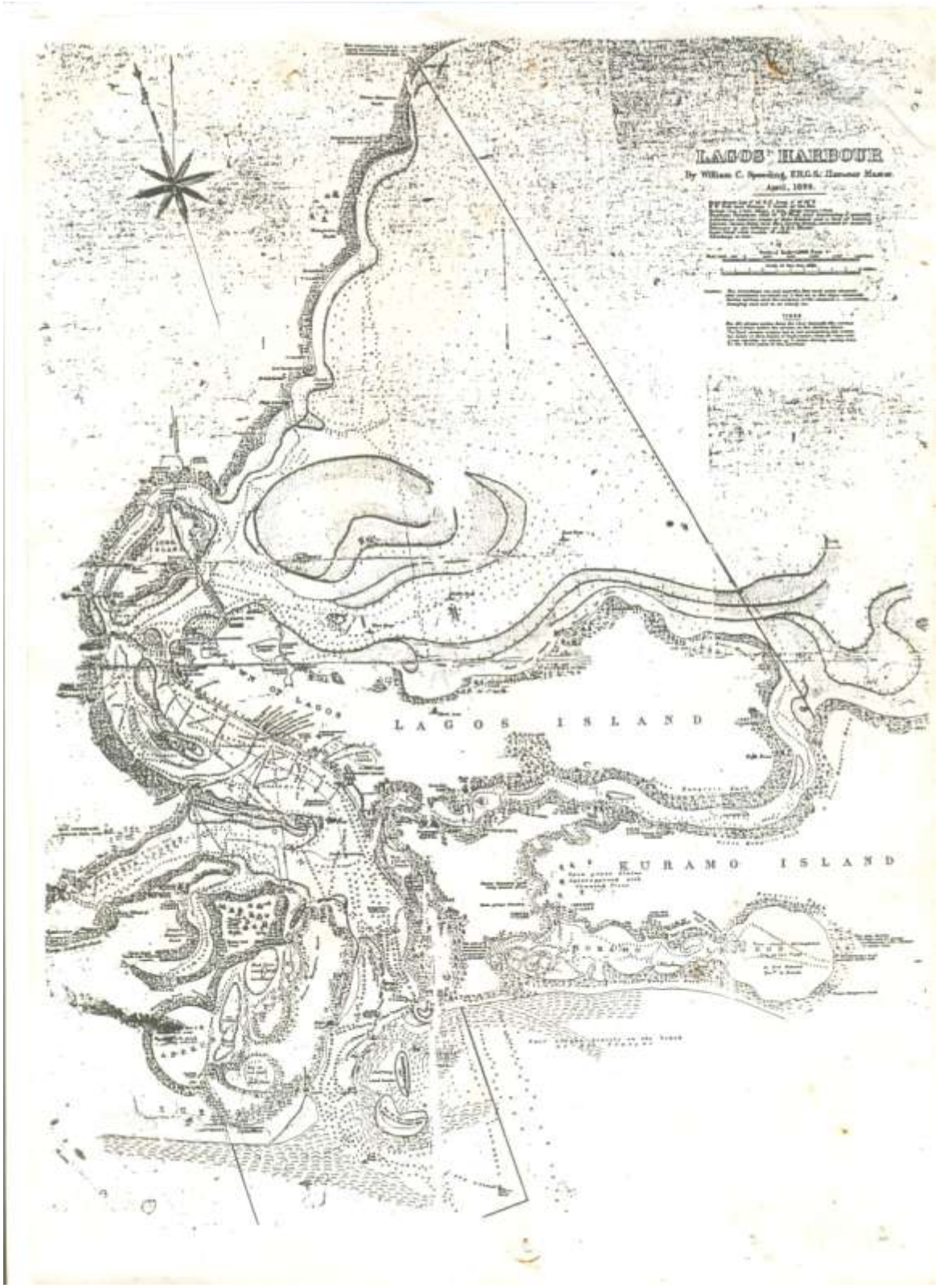

Figure 11: Lagos Harbour and environ showing tracts of mangroves surrounding the Islands (Speeding, 1896).

mangrove species found along Majidun River is the red mangrove, *Rhizophora racemosa* (known as "egba" in Yoruba land). The Majidun mangrove site (Figure 12) has been proposed for reforestation because of its richness in biodiversity, and the fact that it qualifies as a wetland of economic importance. The mangrove species are not under much pressure because the activities of the inhabitants there are minimal. The major activities are fishing and gathering of *Rhizophora* for firewood.

Figure 12: Majidun-Awori mangroves on Majidun River in Lagos State (BDCP, 2007)

7.2.1.9 Distribution of Mangroves and Nypa in Nigeria:

The distribution of mangrove forests and Nypa stands for the country are presented in Figures 13 and 14. The areal coverage can only be an estimate based on uncertainties encountered in the interpretation of satellite imageries and the limitations imposed by the inaccessible and inhospitable terrain in most of the Niger Delta. Aerial photos for detailed quantification and analysis of such remote areas are unfortunately not available presently. From Table 3 (BDCP, 2007) the coverage is estimated as 9,723.14 km² for mangroves. Ground truthing and visits to sites earlier quantified by BDCP however would suggest a slightly lower estimate by 5 – 20 per cent.

Table 3: Mangrove area in coastal States of Nigeria (BDCP, 2007)

State	Mangrove size km²	Mangrove forest in reserve
National	Circa 10 000 (973 000 ha)[a]	
Akwa Ibom	721.86 CRS and Akwa Ibom	
Bayelsa	Data not available	Data not available
Cross River	959	57.19 Cross River State and Akwa Ibom
Delta	3470.32	143.75 (Bendel)
Edo	Data not available	Data not available
Lagos	42.20	3.17
Ogun	12.18	
Ondo	40.62	Data not available
Rivers	5435.96	90.62
TOTAL	9723.14	304.69

[a] A slight volume may have been lost with the recent boundary adjustments in the Rio del Rey/Bakassi area.

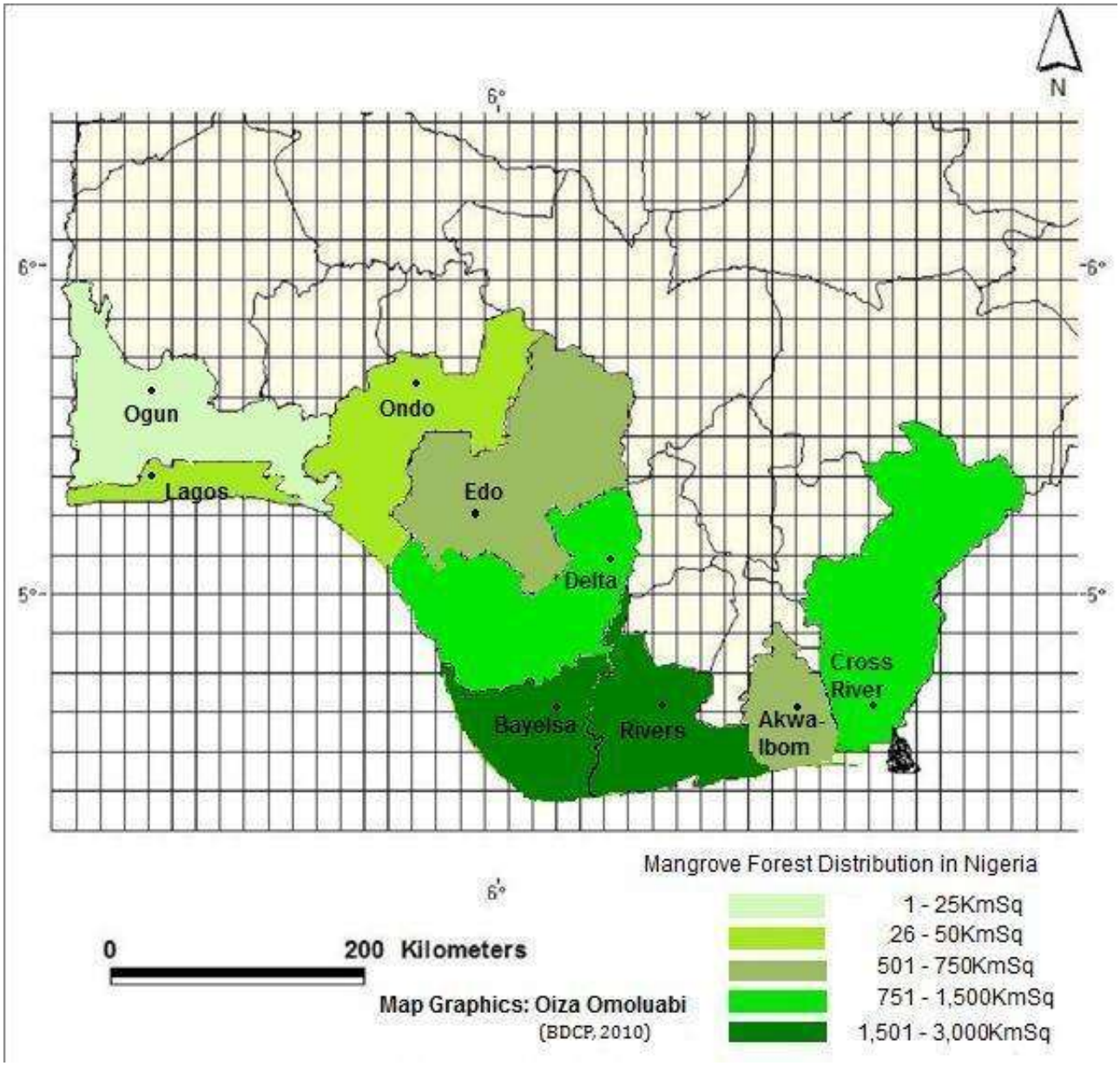

Figure 13: Mangrove Forest distribution in Nigeria

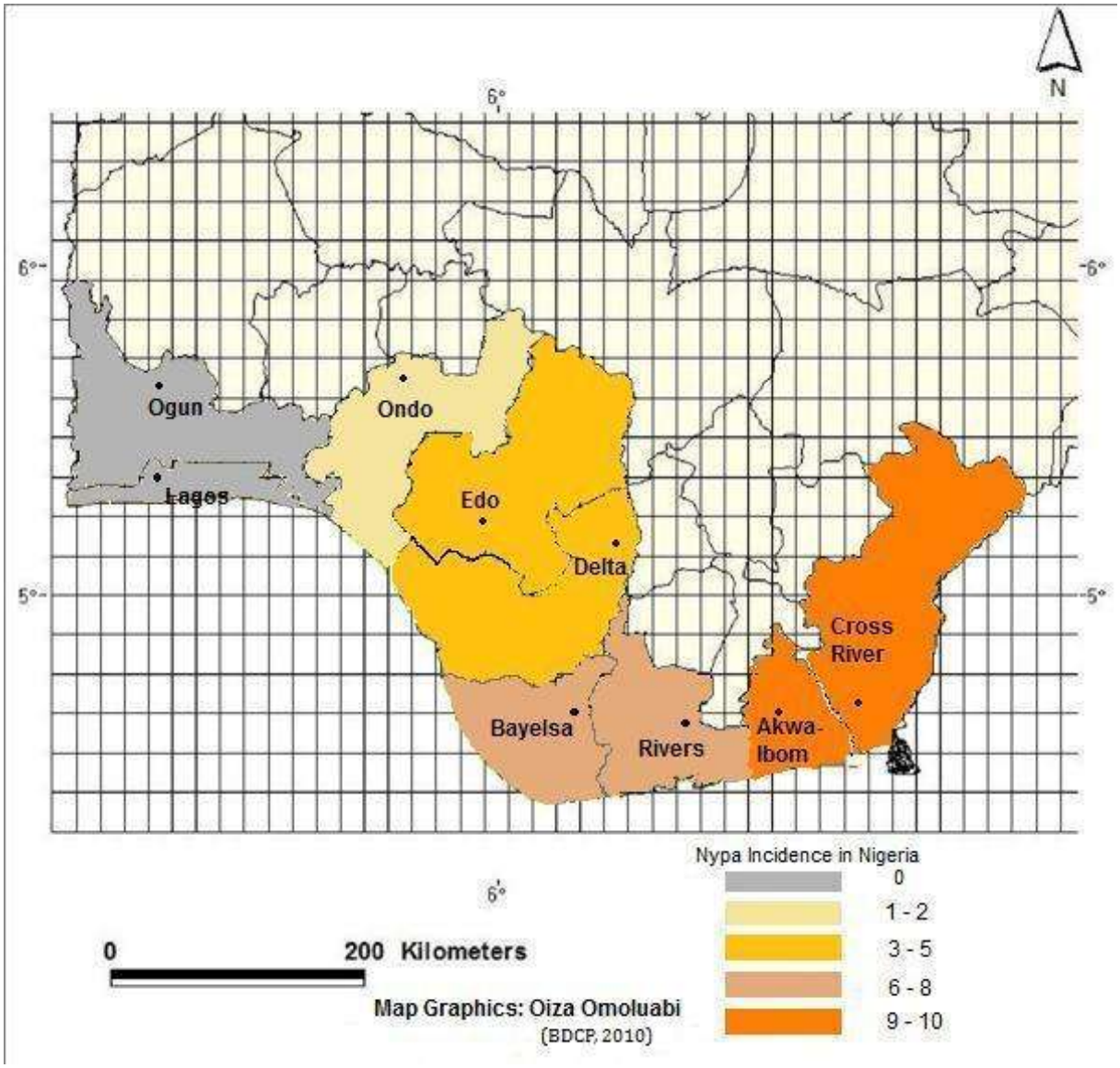

Figure 14: Nypa palm distribution in coastal Nigeria.

7.2.1.10 Extent of Mangrove Loss in Nigeria:

In Nigeria, the main drivers of change in mangrove status have been identified as follows:

A. Petroleum and gas exploration and production;

B. Deforestation – overharvesting / overexploitation near coastal settlements;

C. Urban development - sand filling of swamps for construction purposes;

D. Pollution arising from domestic and industrial wastes;

E. Mangrove conversion activities - plantations of oil palm, rice fields and agriculture/aquaculture ponds; salt production, etc

F. Dredging activities - Drainage and digging of canals (canalization)

The main sources of loss from our reconnaissance visits and earlier surveys by BDCP(2007) are urban growth, industrial development and oil activities. Decline of the mangrove resource is associated with the rapid population growth and expansion of settlements, high poverty, low development indices, poor governance in rural areas and open access of coastal resources.

Generally four drivers of mangrove change/loss have been identified in West African mangrove. These are population growth, socio-economic and political trends, climate change, and changes in upstream habitats. The decline has generally been described as moderate for West African mangroves with 21-50 percent change in mangrove cover (UNEP, 2007).

7.2.2 Biological Assessment, Monitoring Tools and Approaches

Biological monitoring represents a system of repeated investigation of defined biological processes to detect change over time. It is regarded as an essential element needed to assess the health and enhance the protection of the coastal and marine environment. The tools used for biological assessment include density of major taxa, species composition, abundance, biomass and diversity.

All of the eight mangrove species found in West Africa are recorded in Nigeria (UNEP, 2007). These are: *Acrostichum aureum, Avicennia germinans, Conocarpus erectus, Laguncularia recemosa, Rhizophora mangle, Rhizophora Harrisonii, Rhizophora racemosa, and Nypa fructicans.* The red mangrove, *R. racemosa*, which make up about 90 per cent of the vegetation of the mangrove ecosystem, is the pioneer at the edge of the alluvial salt swamp, *R. harrisonii* is dominant in the middle of the *Rhizophora* zone and *R. mangle* on the inner edge.

Other species, more often found in stunted and shrub form, are *Avicennia nitida* and *Laguncularia racemosa*. Associated with the main mangrove formation is strand vegetation with Conocarpus erectus and other woody species that grows at the edge of the swamps, mainly near the sea. *Hibiscus tiliaceus* (hibiscus*), Thespesia populnea, Drepanocarpus lanatus, Chrysobalnus spp, Pandanus candelabum* have also been recorded. Mangrove is a distinct sub-set of the Nigerian rainforest and estimated to cover about a

tenth of the forest and wooded area of 31.59 million hectares (Ibianga, 1985). It is found on the coast and stretch into the rivers and its complex lagoons in several places.

It is hoped that biological monitoring by the University of Calabar (UNICAL) and further studies in the future will provide basic information to be acquired over time on density of major taxa, species composition, abundance, biomass and species diversity for biological assessment of the mangrove vegetation in Nigeria. These would be employed by statistical methods to measure changes in assemblages/communities.

7.2.3 Standard Survey Methods (SSMs) for Mangrove Habitats

Survey methods vary depending on the aim of the survey and type of biotopes. The SSMs are predominantly based on the Rapid Site Assessment (RSA) or Permanent Monitoring / Quantitative Surveys.

Both RSA and Quantitative survey methods require collection of physical data (environmental, water and sediment characteristics) at the time of survey. The physical data collected can later be used with the biological data to assess and monitor the extent of infestation of the Nypa palm.

The sampling stations for water and sediments for the lower reaches of Cross River estuary are as shown in Fig. 15. Previous assessments of environmental conditions have used these sampling points. It would be useful to compare any new data with the previous records to observe trends and provide useful inferences on the prevailing conditions. Analysis of samples collected in February (dry season) is ongoing and would be reported later. The details on sampling methodology are described below:

Water Chemistry

In-situ Measurements

The following parameters were measured in the field:

(i) pH – This was measured using a portable pH-meter Corning m-90 checkmate deluxe field system)
(ii) Conductivity
(iii) Total Dissolved Solids (TDS)
(iv) Dissolved Oxygen (DO)

These parameters and those to be described below were determined as well for the borehole water samples in the laboratory.

Total alkalinity

Total alkalinity was measured by titrating 50ml of sample against 0.02N sulphuric acid solution using methyl orange indicator.

Chloride
The silver nitrate method (argentometric) was utilized to determine the chloride level in water. Water sample (50ml) was titrated against 0.1M silver nitrate solution using 0.5ml of potassium dichromate solution as indicator.

Sulphate
Sulphate was determined by the turbidimetric method. 50ml of water sample containing sulphate was reacted with 3mg of barium chloride in the presence of a conditioning agent of sodium chloride/hydrochloric acid and glycerol/ethyl alcohol. The absorbance of the resulting colloidal barium sulphate was measured in a colorimeter at a wavelength of 420nm.

Nitrate
Nitrate measurement was by brucine method (APHA 1975). It involves the reaction of nitrate with brucine at elevated temp (60°C) to produce a yellow precipitate. The absorbance was read off at 420nm wavelength on a spectrophotometer.

Total hydrocarbon (THC)
50ml of water sample and 50ml of Toluene were vigorously shaken for ten minutes in a 250ml Winchester bottle. The hydrocarbon extracted in the Toluene phase was determined by measuring the absorbance at 420nm wavelength in a spectrophotometer. The concentration of the hydrocarbon was calculated from a standard calibration curve.

The analytical protocols and appropriate references are given below:

Analytical protocols:**S/NO**	**PARAMETERS**	**METHODS/ TECHINIQUE**	**PROCEDURES**	**REFERENCES**
1.	pH	Digital pH meter	Direct measurement using glass electrode pH meter probe	APHA (1989) 17th ed. Pp. 4-86-4-90
2.	Conductivity	From the pH (sediment in water) suspension using probe	Direct measurement using conductivity probe	
3.	Total alkalinity	Titrimetric method	Known volume of filtered water samples was titrated with 0.1N sulphuric acid using phenolphthalein and methyl-orange indicators.	Vogel (1975)
4.	Dissolved Oxygen (DO)	Unmodified Winkler method	Titrating "fixed" samples with 0.025N sodium thiosulphate solution	Welch (1948)
5.	Biochemical Oxygen Demand (BOD)	Winkler method	Duplicate water samples were incubated in the dark at 25ºC for 5 days before the oxygen level is determined. This oxygen value obtained was subtracted from the value obtained from the samples fixed in the field.	
6.	Chemical Oxygen Demand (COD)	Dichromate reflux method	Refluxing a water sample in the presence of potassium dichromate and sulphuric acid. The quantity of potassium dichromate consumed is proportional to the COD.	
7.	Total Hardness	Titrimetric	The determination of calcium and magnesium ions in water samples using EDTA as a reagent.	ASTM – D1126-67
8.	Total Suspended Solid (TSS)	Gravimetric method	Filtration and weighing	
9.	Total Dissolved	Gravimetric	Evaporating a known volume	

	Solid (TDS)	method	of the sample to dryness and the residue obtained yields the weight of the dissolved solids.	
10.	NH_4^+-N	Colorimetric method	Nesslerization procedure	ASTM-D1426-53 British standard 2690: Part 7: 1968
11.	NO_3^- –N	Colorimetric method	Phenol – disulphonic acid used as colouring agent. Chloride ions interfere with this analysis and must be removed with glacial acetic acid and silver sulphate	ASTM DD992-52
12.	NO_2^- -N (nitrite-nitrogen)	Colorimetric method	Sulphanilic acid was used to develop the colour to be examined.	ASTM D1254-67
13.	Total Phosphorus (PO_4^{3-} -P)	Colorimetric method	Ascorbic acid procedure	
14.	Chloride (Cl^-)	Argentometric method	0.1N silver nitrate is used to quantify chloride ions in the samples.	
15.	Sulphate (SO_4^{2-})	Turbidimetric method	Gelatin-barium chloride reagent is used to precipitate and quantify sulphate spectrophotometrically at 420nm.	Tabataba
16.	Total hydrocarbon Content (THC)	Colorimetric method	n-Hexane will be used to extract total hydrocarbons in the samples and the values determined spectrophotometrically at 420nm	
17.	Cations (Ca, Mg, Na, K)	Na and K will be quantified with flame photometric technique, Ca mg with Atomic Absorption Spectrophotometric (AAS)	If the samples are cloudy, they will be filtered before being introduced into the instruments.	Perkin-Elmer Corp 91968)

		method.		
18.	Heavy metals (Mn, Pb, Cd, V, Ni, Hg, As and Cr)	AAS method	If the samples are cloudy, filtered samples will be used	Perkin-Elmer Corp (1968)
19.	Turbidity	Turbidometric analysis	A turbidometer was be used	-
20.	Taste and Colour	Visual method for colour and physically tasting the samples for taste.	-	-

Heavy metals
The heavy metals in both the water and sediment samples were analyzed using atomic absorption spectrophotometer.

7.2.4 Geographic locations of the mangroves in the Project Region obtained through site/field visits to obtain UTM coordinates applying GIS and Remote Sensing Technology (for acquisition of photographs and satellite imageries)

For the project site, "Uko Ntense", the following site bearing was recorded:

National Museum / NCF Office is on "Idua Assang" 32N0414662 Northern and 0533567 Eastern.

The Nypa palm Island is on 32N414652 to 32N0414758 Northern and 0534153 to 0534144 Eastern along the shoreline (measuring 100 m). Second reading Inland of 50 m is on a bearing of 32N414652 to 32N0714639 Northern and 0534153 to 0534223 Eastern. The mangrove nursery is located on a bearing of 32N0414592 N and 0533570 E at a 50 m by 30 m area plot (0.15 ha).

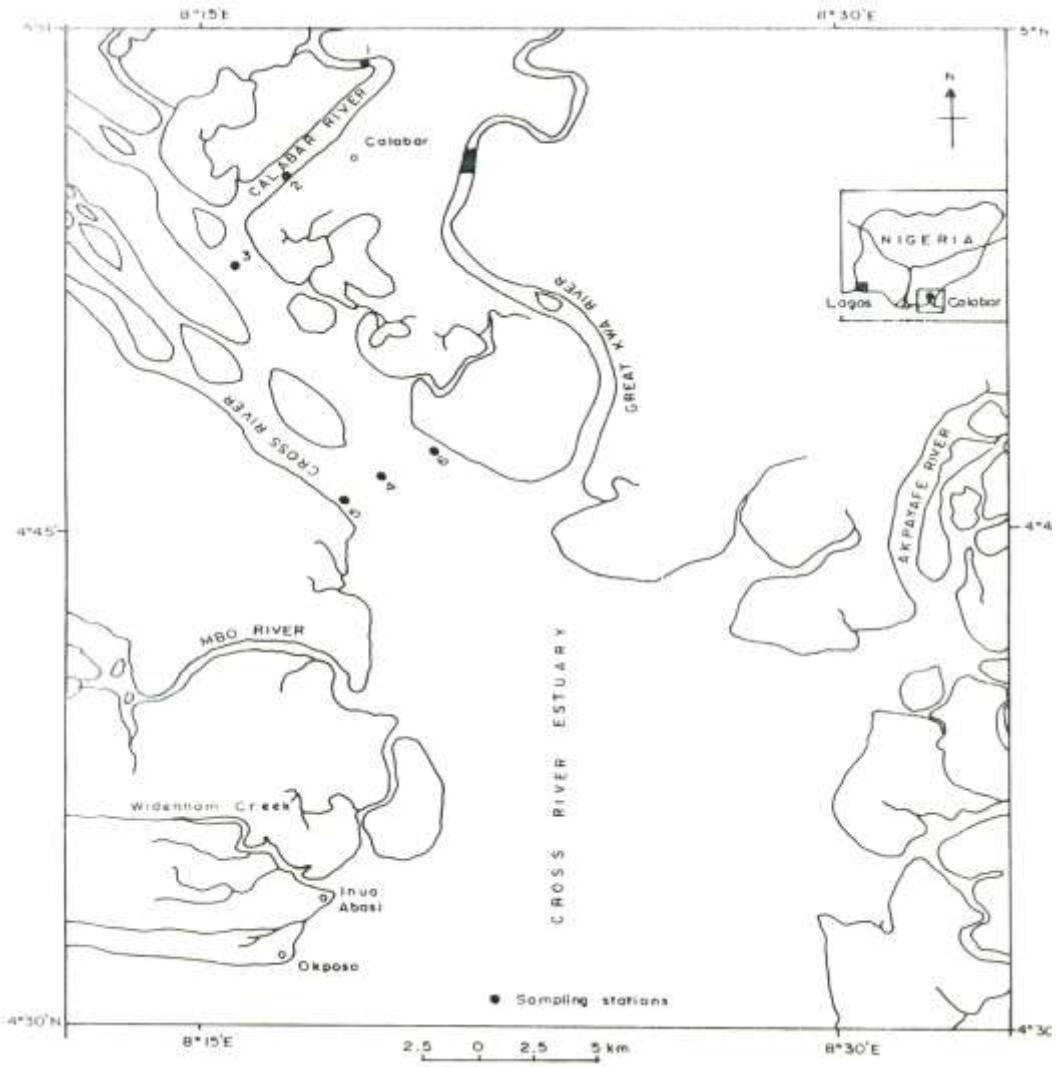

Figure 15: Location map of lower Cross River showing proposed the environmental, Water, and Sediment sampling stations.

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ANNEX WORK PLAN

PROJECT STEP	OBJECTIVE	SPECIFIC ACTIVITIES	RESPONSIBLE PARTIES	TIME DURATION	EXPECTED OUTPUT
The first step would be to IDENTIFY THE BEST POSSIBLE LOCATION FOR THE FOUR 0.5 HA MANAGEMENT SITES ON THE NAMELESS LARGE ISLAND OPPOSITE ORON	To identify the best location for four 0.5ha management sites. Establish communication channels with the Federal Ministry of Environment host communities, and all stakeholders.	Identify and hold consultative meetings to form networks with all stakeholders. Form Project Committees. Identify project site and elicit the support and cooperation of State Government and host communities. Carry out training sessions for ad-hoc staff to be involved in project work. Reconnaissance survey and acquisition of maps, photographs and satellite imageries of sites.	Bioresources Development and Conservation Programme (BDCP), Cross River State government, Federal Ministry of Environment, institutions NCF, IOC), NGO's, host community and CBO's	0.5 month	Effective communication channel at all levels are established Four 0.5ha management sites on the nameless island established. Project Committees constituted. Maps, baseline, coordinates and photographs acquired Deliver first progress report
The Second step will be to DEFINE THE NATURE, AND QUANTIFY THE EXTENT OF DEPLETION OF NATIVE MANGROVES AND INFESTATION BY NYPA PALMS ALONG THE NIGERIA COAST	Map out the most depleted sites from the survey photographs and satellite imageries.	Identify/map out Nypa infested areas. Delimit the extent of mangroves infestation by Nypa palm Identify most depleted sites.	Bioresources Development and Conservation Programme (BDCP), Federal Ministry of Environment and host communities	1 month	Nature, quantity and extent of Mangrove infestation and depletion delimited. Deliver a second progress report
The third step will be the ESTABLISHMENT OF A MANGROVE NURSERY WITH AN AREA OF CA.1.100 M^2 PLUS 200 M^2 WORK SPACE TO PRODUCE CA 30.000 MATURE PROPAGULES	Establish Mangrove nurseries of autochthon variety along the coast to supply seedlings and propagules for the re-forestation project.	Ascertain and map out sites to be used for the nurseries. Identify most thriving autochthon species of mangrove seeds and propagule to be used in nursery. Prepare soil and plant the seeds.	BDCP, Federal Ministry of Environment and the host communities	5 months	Project area mapped out to specification Native mangrove identified Mangrove nursery established.

PROJECT STEP	OBJECTIVE	SPECIFIC ACTIVITIES	RESPONSIBLE PARTIES	TIME DURATION	EXPECTED OUTPUT
					Deliver a third progress report
The fourth step will be to COMPLETELY UP-ROOT THE NYPA PALM JUNGLE (RHIZOMES, LEAVES AND FLOWER STALKS) ON A 0.5 HA AND PLANT AUTOCHTHON MANGROVE TREES (30.000/HA)	To completely replace a 0.5ha of Nypa palm jungle with mangrove seedlings and propagules.	Considering past disappointments of mechanical control, design a more effective method of up-rooting the palm and how the project will be carried out. Capacity building and knowledge transfer on the various uses of Nypa products	BDCP, host communities, and Federal Ministry of Environment.	7 months	Nypa palm jungle (0.5 ha) completely up-root and replaced by native mangrove demonstrate the use of up-rooted Nypa rhizomes as firewood and the leaves for different uses/ products Deliver a fourth progress report
The fifth step will be to CUT IN A NEIGHBORING PLOT OF 0.5 HA ONLY THE NYPA LEAVES AND FLOWER STALKS, PLANT AUTOCHTHON MANGROVES (30.000/HA) AND TEST USE OF THE NYPA LEAVES FOR THE DIFFERENT USES/ PRODUCTS	Cut Nypa palm leaves and flower stalks of the plant Plant native mangrove among cut Nypa palm. Experiment with Nypa leaves to produce different products.	Identification of community groups in each project state. Training of community groups for engaging in re-forestation.	BDCP, Federal Ministry of Environment, host communities and Project Committees.	7 months	Nypa leaves and flower cut Native mangrove species planted. Sample products produced from Nypa leaves Deliver a fifth progress report
The sixth stage is to INVOLVE LOCAL COMMUNITIES TO CONVERT A PLOT OF 0.5 HA OF NYPA JUNGLE NEIGHBORING TO THE MANGROVE PLANTATIONS INTO AN "EXPERIMENTAL NYPA	Establishment of a Nypa palm experimental plantation. Compare the quality and quantity of Nypa products in a	Selectively cut the Nypa palm leaves neighboring to the mangrove plantations. Set up Nypa palm experimental plantation to render	BDCP, host communities, Ministry of Environment and Project Committees	12 months	Nypa palm leaves selectively cut. Experimental Nypa palm plantation established

PROJECT STEP	OBJECTIVE	SPECIFIC ACTIVITIES	RESPONSIBLE PARTIES	TIME DURATION	EXPECTED OUTPUT
PLANTATION"	Nypa jungle (natural forest) and in this Nypa "plantation"	technical support and capacity building.			Quality and quantity of Nypa products compared Deliver a sixth and midterm progress report
The seventh stage is to INVOLVE LOCAL COMMUNITIES TO ESTABLISH A "REAL NYPA PLANTATION" ON AN AREA OF 0.5 HA NEIGHBORING TO THE MANGROVE PLANTATIONS IN ACCORDANCE WITH THE ASIAN EXAMPLES	Establish a real Nypa palm plantation in accordance with the Asian examples. Compare the quality and quantity of Nypa products the "real Nypa plantation" with the the " experimental Nypa plantation"	Establish a "real Nypa plantation" on an area of 0.5ha Utilize all rhizomes and leaves from the older plants of the Nypa jungle Compare the quality and quantity of the Nypa products in "real" and "experimental" plantations	BDCP, Federal Ministry of Environment, host communities and Project Committees.	12 months	A real Nypa palm plantation is established in accordance with the Asian examples. Products of "real Nypa plantation" and " experimental Nypa plantation" compared Deliver a seventh progress report
The eighth stage is to INVOLVE LOCAL COMMUNITIES IN LINE WITH THE THAILAND EXPERIENCE TO USE NYPA PALM TO PRODUCE FOOD PRODUCTS	Demonstrate food production, sap tapping and immature seedling sampling.	Demonstrate the production of sugar, alcohol, and vinegar. Demonstrate how tapping the sap and sampling the immature seedlings can reduce the reproduction power of Nypa palms	BDCP, State Governments, Stakeholders, Federal Ministry of Environment, host communities and Project Committees.	12 months	The production of sugar, alcohol, and vinegar is demonstrated. Possible use of unripe endosperms (fruits) as food products is demonstrated The impact of sap tapping and immature seedling tapping on production power of Nypa is demonstrated Deliver an eight progress report
The ninth and final stage is INVOLVE LOCAL COMMUNITIES TO HARVEST SEEDLINGS	Prevent Nypa seeds from penetrating into the experimental	To engage host communities in Nypa seedling harvesting and collecting.	BDCP and host communities	12 months	The spread of Nypa seedling into the experimental

PROJECT STEP	OBJECTIVE	SPECIFIC ACTIVITIES	RESPONSIBLE PARTIES	TIME DURATION	EXPECTED OUTPUT
FROM NYPA PALMS GROWING IN THE UNDISTURBED NYPA JUNGLE ADJACENT TO THE TEST PLOTS AND SAMPLE FLOATING SEEDLINGS	plantations and germinating there				plantations is prevented. Deliver a ninth progress report
The tenth stage is to DEMONSTRATE THE USE OF RIPE SEEDLINGS TO LOCAL COMMUNITIES AND GOVERNMENT STAKE HOLDERS AS HIGH QUALITY FIREWOOD	Sensitization of CBO's, host Community and NGO's on the the use of ripe Nypa seedling as high quality firewood.	Organize an exhibition/workshop to demonstrate the conversion /use of Nypa seedling for firewood.	BDCP, State Governments, Stakeholders, Federal Ministry of Environment, host communities and Project Committees.	12 months	Use of Nypa seedlings as firewood is demonstrated. Deliver a tenth progress report
The eleventh stage is TO CREATE AWARENESS AMONG THE FISHING COMMUNITIES IN THE CROSS RIVER AND AMONG GOVERNMENT STAKE HOLDERS ON THE NECESSITY AND LONG TERM BENEFITS OF ESTABLISHING A SUSTAINABLE MANGROVE HARVESTING PATTERN	To sensitize the coastal communities on the benefits of sustainable Mangrove utilization.	Carry out media promotion through state radio, television and print. Hold Rallies/Exhibitions and distribute flyers. Produce and distribute pamphlet and teaching aids that will be translated in local dialects.	BDCP, State Governments, Stakeholders, Federal Ministry of Environment, host communities and Project Committees.	12 months	Awareness already created. Public educated (formally and informally) on sustainable utilization of the Mangrove forest. Deliver an eleventh progress report.
The twelfth and final stage is TO DEVELOP A MANGROVE/NYPA MANAGEMENT PLAN, AND ESTABLISH USER RIGHTS AND SELF-MONITORING PROCESSES BY THE COMMUNITY AS WELL AS MONITORING PROCESS BY LOCAL GOVERNMENTS AND PROVIDE A **TWELFTH AND FINAL PROGRESS REPORT**	Develop a mangrove/Nypa management plan and establish governance processes To prepare a comprehensive final report.	Moderate the participatory process for the development of a mangrove/ Nypa management plan Preparation of a comprehensive final report on sustainable integration of Nypa/mangrove development.	BDCP, State Governments, Stakeholders, Federal Ministry of Environment, host communities and Project Committees.	6 months	Mangrove/Nypa resources governance plan developed. Deliver a twelfth and final progress report to UNIDO.

It is expected that there will be some overlaps in the timelines for the implementation of the activities as the activities will be carried out in parallel.