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Marine ecosystems and the role of marine protected areas as sustainable development strategies

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MARINE ECOSYSTEMS AND THE ROLE OF MARINE PROTECTED AREAS AS SUSTAINABLE DEVELOPMENT STRATEGIES

By

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DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

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ABSTRACT

Title of Dissertation: Marine ecosystems and the role of marine protected areas as sustainable development strategies.

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The Marine ecosystems are used for a very wide range of human activities, from recreation to food and mineral production and transport. Each of these uses poses a serious threat to the ecosystems thereby affecting the productivity, ecosystem health, stability and biodiversity.

In this Dissertation, the threats to marine ecosystems are categorized as land-based and ocean-based. Land-based threats relate to habitat destruction and pollution including eutrophication, sewage, synthetic organic chemicals and heavy metals. Tourism and recreational activities, climate change and increased radiation belong to this group. The ocean-based threats on the other hand include the consequences of fishing and over-exploitation of fisheries, impacts of shipping activities including the introduction of harmful organisms from ship ballast water, anti fouling and associated pollution, seabed mining, and the impacts of marine scientific research.

Marine protected areas (MPAs) hold promise as one rational and practical way of managing ocean resources for sustainability and conservation of marine and coastal ecosystems and biodiversity. This Dissertation discusses the roles, legal framework or concepts and implementation issues of MPAs for the effective management of coastal and marine resources especially at national levels. The roles of MPAs as sustainable strategies are seen to include the maintenance of biodiversity; protection of endangered and threatened species; conservation of habitats; ecosystems and maintenance of ecological processes; enhancing fisheries (management); providing opportunities for education and research; conservation of cultural heritage; enhancing tourism and recreational potentials plus social and economic benefits.

The Dissertation focuses on Nigeria as a case study with the consideration of establishing an MPA for sustainable use of its coastal and marine resources. The coastal zone of Nigeria has numerous valuable ecosystems such as estuaries and mangroves. These ecosystems with their associated habitats play an important role in protecting biodiversity and in Nigeria's economy. The coastline is under pressure from human activities like shipping, oil exploration and exploitation, construction of ports, terminals and harbours and fishing. Integrated Coastal and Ocean Management (ICOM) or Coastal Zone Management (CZM) is outlined as an important regime and the establishment of MPAs may be an aspect of ICOM process or may serve as a triggering event that promote the designation of ICOM.

KEYWORDS: Marine, Ecosystems, Role, MPAs, Sustainable, Development

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LIST OF ABBREVIATIONS

ABP	Associated British Port
COA	Canada's Ocean Act
AOA	Australia's Ocean Policy
ATP	Adenisine Tri-Phosphate
BOD	Biochemical Oxygen De
CBD	Convention on Biological Diversity
CFCs	Chloroflurocarbons
CIESIN	Centre for International Earth Science Information Network
COP	Conference of Parties
CORDI	Coral Reef Degradation in the Indian Ocean
CRAN	Coral Reefs Network
CSD	Commission on Sustainable Development
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
ENS	Environmental News Service
ENSO	El-Nino Southern Oscillation
FAO	Food and Agricultural Organisation
FRN	Federal Republic of Nigeria
GBRMP	Great Barrier Reef Marine Park
GCRMN	Global Coral Reef Monitoring Network
GEF	Global Environment Facility
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
GIS	Geographic Information System
GPA	Global Programme of Action
ICES	International Council for the Exploration of the Sea
ICOM	Integrated Coastal and Ocean Management
ICRIN	International Coral Reef Information Network
ICRI	International Coral Reef Initiative
IMO	International Maritime Organisation

IOC	International Oceanographic Commission
ISA	International Seabed Authority
IUCN	World Conservation Union
MAB	Man and Biosphere
MARPOL	International Convention on the Prevention of Pollution from Ships
MPAs	Marine Protected Areas
MSY	Maximum Sustainable Yield
NFZ	No Fishing Zone
NGOs	Non-Governmental Organisations
NOAA	National Oceanic Atmospheric and Administration
NRC	National Research Council
PAHs	Policyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PSSAs	Particularly Sensitive Sea Areas
RAMSAR	Convention on Wetlands of International Importance
SPAs	Specially Protected Areas
SPAMI	Specially Protected Area of Mediterranean Importance
TBT	Tributyl Tin
UNCED	United Nations Conference on Environment and Development
UNCLOS	United Nations Convention on the Law of the Sea
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UVB	Ultra Violet Light
WWF	World Wide Fund for Nature

CHAPTER ONE
INTRODUCTION

> The measures taken under Part XII (on the protection and the preservation of the marine environment) "shall include those necessary to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered, species and other forms of marine life".
>
> (UNCLOS 1982, Articl194 (5))

1.1. Introduction

Historically, the marine ecosystems were seen to be impervious to harm from human activity. Today, the situation is quite different, it is universally well accepted that the oceans are vulnerable to the same threats experienced in the terrestrial ecosystems such as extinction and habitat loss (Robert and Hawkins, 1999). According to Snelgrove (1998), recent studies indicated that biodiversity is probably more abundant in the marine ecosystems than terrestrial.

The idea of coastal and Marine Protected Areas (MPAs) has been advanced as a possible solution to the conservation and sustainability of marine ecosystems and biodiversity (Salm, Clark & Siirila, 2000). In the case of terrestrial degradation, the establishment of protected areas, where human activities were restricted, restored the habitat and species diversity.

The United Nations Food and Agriculture Organisation (FAO) defines ecosystem as a functioning, interacting system composed of living organisms, and their environment. The concept according to FAO is applicable at any scale, from planet

as an ecosystem to a microscopic colony of organisms and its immediate surrounding (FAO, 1999a). Moreover, the 1992 Convention on Biological Diversity (CBD) defines an ecosystem as "a dynamic complex of plant, animals and micro-organism communities and their non-living environment interacting as a functional unit" (CBD, 1992, Article 2). In the words of Schramm &Hubert (1996)

> an ecosystem is a system formed by the interaction of a community of organisms with their environment. By this definition, an ecosystem may be a small array of microbes on the underside of a leaf on the bottom or as large as all of the interacting biotic and abiotic components in the Pacific Ocean (Schramm & Hubert, 1996, p. 6).

It is interesting to note that sometimes the definition of ecosystem is very dependent on the context, interest and the boundaries to be drawn from it.

In recent years, there has been so much concern and the recognition of the deteriorating situation of marine ecosystems that produces the world's living resources. Nevertheless, marine ecosystems are subjected to increasing stress or threats from pollution such as waste disposal, excessive nutrients from agricultural lands (eutrophication), habitat destruction, degradation and loss, over-fishing, introduction of invasive or harmful organisms to mention just a few (National Research Council (NRC), 2001). The main factor that is responsible for the numerous threats is an increased human population density (coastal urbanisation) in coastal areas leading to over utilization of coastal resources. The Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) currently estimate that 37-44% of the world population lives within 100-150 km of the coast (GESAMP, 2001).

The above threats are interlinked or interact with each other making effective management of resources a problem. For instance, in the establishment of a tourist resort, mangroves are cut down for the construction work. This will alter the coastline and can cause serious erosion. However, the tourist resort or hotel while carrying out their operational activities will generate wastes including sewage

discharge into the environment. The impacts will be extended to the destruction of coral reefs and finally loss of the resources.

Estuaries and lagoons, mangroves, coral reefs, wetlands and beaches are very important marine ecosystems. Each ecosystem has numerous functions in the marine environment. Estuaries are one of the richest biomass on the planet because of high carbon fixing rates and nutrients loading and transport of organic matter to the sea by tidal current. Coastal lagoons and estuaries are very productive habitat. They are nursery grounds for juvenile fish stocks, spawning and feeding grounds for most commercial species. Other benefits include recreation, aesthetics and harbour construction (Salm, Clark & Siirila, 2000).

Similarly, mangrove ecosystems protect the coast from erosion, storm surges, and strong winds such as tsunamis in volcanic active regions. They maintain water quality by trapping silt from rivers and filtering out pollutants (buffer zone). Mangroves are rich habitats for animals and plants species such as crustaceans, molluscs, fishes and birds. These organisms constitute part of the coastal resource. A very important ecological function of mangrove is the production of nutrients for sea life through their fallen leaf litter and detrital matter. This is often circulated around the sea by tidal currents. Mangroves also play the role of nurturing juvenile species from other habitats like estuaries and lagoons. Birds, mammals, monkeys, reptiles are prominently found in mangrove forest (Clark, 1997).

Coral reefs have a very high economic value in terms of income from tourist attraction and support the abundance of marine edible species of fish, and lobster. They are also valuable for scientific research and for harvest of ornamental products. Fishing using explosives still occurs and has a major impact especially on coral reefs where it is not properly protected. This activity destroys reef ecosystems sustaining both fish and other reef dependent species. In the Philippines, India, and other parts of South East Asia, use of dynamite, cyanide and fishing for aquarium industries create serious problems and threatens coral ecosystems. Coral serves as substratum for primary production and habitats for invertebrates including fishes and protecting

the coast from waves. The balance between accretion rates due to growth of corals, hydrocorals/coral lime algae and erosion resulting from mechanical activities/bio-erosion determines the development of reefs. Explosives also result in waste and by-catch. Fishing has direct impact on reef when gear trawls on the substratum. The effect can be indirect if the relationship between the invertebrate communities that are responsible for accretion and bio-erosion is altered (Michael et al, 2001).

Beaches and wetlands provide good opportunities for tourism developments and scientific research, species protection e.g. seals, birds, reptiles rest, breed and feed on beaches. Other important functions of wetland include the following:

1). Production (primary and secondary) that sustains plants and animals population living in the wetlands;

2). Wetlands act as a permanent sink for sediments, organic carbon and store water temporarily. This storage function is important in hydrological purpose of watersheds in terms of flood control, geomorphological processes e.g. control of coastal erosion, accumulation of organic carbon and maintaining genetic resources;

3). The bio-geochemical dynamics of wetlands is seen in filtering and cleaning water e.g. removal of toxic substances from water. This is an important function by providing tertiary treatment of sewage and reducing pollution from agricultural waste;

4). It serves as a link to others ecosystems. Water movement, nutrients and organic matter between wetlands and other ecosystems are necessary for the maintenance of food chains, migration routes and other linkages that support productivity, ecosystem health and resources that humans depend upon. It is the significance of these linkages that led to the protection of wetlands through the Convention on Wetlands of Importance especially as Waterfowl Habitat (RAMSAR Convention);

5). Wetlands provide buffering functions that protect life, property and economy of local coastal dwellers and nations. They regulate surface water flow and ground water recharge. Again, wetlands are seen to reduce the peaks of flooding water and controls flows in rivers and buffer the coast from storm surges and winds.

Despite these important functions of the coastal ecosystems and environment, the rate of destruction and degradation of marine ecosystems is still on the increase

especially in developing countries. The Nigerian marine ecosystem is not exempted from these coastal pressures. Activities such as shipping, industries for oil exploration and exploitation, ports/harbours constructions, fishing and other conflicting issues are directly damaging most valuable components of ecosystems.
The situation therefore requires a new management regime and also a means of protecting and restoring these unique ecosystems. One option is the establishment of MPAs at strategic locations of the coastal environment to reduce the stress on biodiversity and ensure sustainability of the system (Salm, Clark & Siirila, 2000; NRC, 2001). The current trend in protecting marine ecosystems is directed towards positive measures of conserving marine life and their habitats.

The 1992 United Nation Conference on Environment and Development (UNCED) in Rio de Janeiro focussed on the principle of sustainable development. The States defined sustainable development "as meeting the needs of the present generation without compromising the ability of future generation to meet theirs and introduced the concept of precautionary approach" (CSD, 1993). Agenda 21, the document produced by UNCED emphasized protection of marine ecosystems and the use of resources as being interlinked and requires integrated management and designation of protected areas for sustainable use of marine resources. It also identified the need to respond to threats to the environment from anthropogenic activities. This led to the United Nations Convention on Law of the Sea (UNCLOS), a framework Convention adopted in 1982. In this international instrument reference is made to the protection of ecosystem features. UNCLOS establishes framework conservational measures to protect and conserve rare and fragile ecosystems as well as their habitats from depletion.

The 1992 United Nations Convention on Biodiversity (CBD) is the overriding convention in this respect. The CBD and the Jakarta Ministerial Statement on the Implementation of CBD (Jakarta Mandate on Coastal and Marine Biodiversity) as adopted during the second meeting of the Conference of Parties to the CBD (COP), held in Jakarta in November 1995, involves the establishment of protected areas for the protection of ecosystems, threatened species and conservation of biodiversity by

Parties to the Convention (Jakarta Mandate on Coastal and Marine Biodiversity, 1995). It is also part of the International Maritime Organization's (IMO) work programme to initiate the establishment of protected areas for sustainable resources. IMO has adopted Resolution 927 (22) containing a set of Guidelines for the Designation of Special Area, and Identification of Particularly Sensitive Areas that require special protection from damage by shipping activities.

In order to fulfil to any international responsibilities States must enact their domestic legislation and policy implementing the obligation of international convention. Examples of countries national legislation include the Canada's Oceans Act (COA) and Australia's Ocean Policy (AOP). Canada's Oceans Act provides for the sustainability and integrated management of fisheries between users of the ecosystems. The establishment of marine protected areas is emphasized in Canada's Oceans Act (COA, 1996, Article 35). Australian Ocean Policy (AOP) also sets out a plan for sustainable and integrated management of marine ecosystems, environmental protection and biodiversity conservation. The Act requires permit from fishers to ensure ecological sustainability (AOP, 1998, Article 4). This initiative has strengthened the concept of MPA's and ecosystem 'health and integrity' (Sainbury & Sumaila, 2001).
This Dissertation examines these international instruments along side with regional and local actions and initiative to manage ecosystem through protected areas. It then examines whether MPAs could be used in Nigeria.

1.2. Research objectives and methodology

The objectives of this Dissertation include the following:
1). To provide an overview of the range of threats to the integrity of coastal and marine ecosystems.
2). To consider the role marine protected areas play as sustainable strategies for marine ecosystems and biological resources.
3). To examine the current legal and administrative framework for marine protected areas in terms of its effectiveness in preserving marine resources.

4). To examine the situation of Nigeria with respect to marine ecosystems and issues relating to the implementation of MPAs as conservation tool in Nigeria.

5). To recommend and suggest strategies or framework for national, and local authorities in Nigeria, which have to deal with planning and management of marine resources, to prevent extinction and maintaining ecological integrity and processes in the sea.

The methodology adopted in this dissertation is primarily library research of literature review, journals, periodicals, electronic and other academic publications plus personal experience in marine research. Moreover, exchange of views, discussions, interviews with experts and scholars through personal email was also adopted in acquiring information.

This Dissertation is presented in five (5) Chapters.

Chapter one is the present introductory. It introduces the complexities of the threats to marine ecosystems and importance of various ecosystems (habitats) to the economic, social and culture of the world and outlines the issues of each Chapter.

Chapter two provides an overview of threats to marine ecosystems and introduces the idea of Marine Protected Areas (MPAs) as important management option for sustainability and conservation of marine biological resources.

Chapter three explains the concept of Marine Protected Areas (MPAs) for effective implementation especially at national level independently. This Chapter also discusses the role of MPAs and issues relating to implementation.

Chapter four presents Nigeria as a case study and considers the need for the establishment of MPAs to conserve its biological resources to achieve sustainable development.

Finally, Chapter five, the conclusion, provides suggestions and recommendations for proper management of marine resources including preservation of marine ecosystems.

CHAPTER TWO
THREATS TO MARINE ECOSYSTEMS

2.1. Introduction

This Chapter reviews and analyses the threats to marine ecosystems from two main categories or sources. The first one is the land based threats to marine ecosystems e.g. habitat destruction while the second category is referred to as ocean based threats e.g. over-fishing. Both of these are presented in a more detailed form in Sections 2.2 and 2.3. It is important to note that these two categories overlap with each other thereby making it difficult to separate them. The distinction in this case is artificial and is made only for the purposes of this discussion. This implies that for proper management, there should be overall integration or regulation and institutional arrangements between land and ocean activities.

2.2. Land based threats to marine ecosystems

2.2.1. Introduction

The land-based threats to marine ecosystems are presented from five categories. Of these habitat destruction is the most serious threats where mangroves, estuaries, coral reefs and wetlands are being seriously destroyed through unsustainable practices. Other threats resulting from land-based activities are pollution including eutrophication, sewage, synthetic organic chemicals, heavy metals, radioactive waste and thermal pollution as well as oil and atmospheric deposition (air pollution) from onshore industries e.g. refineries. Tourism and recreational activities; climate change and increased radiation belong to this group.

To find a solution to these intensive problems for coastal systems, the Global Programme of Action for the protection of the marine environment from land based activities (GPA) and the Washington Declaration were adopted in 1995 by the European Union and 108 other countries (UNEP, 2002). The United Nation Environmental Programmes (UNEP) was designated as a coordinating body and secretariat. The secretariat promotes implementation of the GPA at national and regional level through the regional seas programmes and internationally. The various tasks of the GPA include amongst others assessment of programme activities, regional reviews and organisation of workshops.

2.2.2. Habitat destruction and degradation

The destruction and degradation of habitat is the most serious threat to marine ecosystems and their biological diversity. These impacts are seen in almost all the important ecosystems of the oceans such as coral reefs, mangroves and others.

2.2.2.1. Coral reefs

According to Bryant et al (1998) damage to coral reefs is due to careless coastal developmental activities through dredging and alteration of the coastline. For example siltation and sedimentation caused by soil erosion from inland deforestation and developments such as aquaculture are destroying the coral reef off St. Lucia (Sladek-Nowlis et al 1997). There are some destructive industrial practices such as mining of coral off Indonesian and Sri Lankan coasts and fishing using dynamite off Tanzania and South East Asia (Guard & Masaiganah, 1997). Similar damage is also occurring in the Caribbean.

Explosive fishing on coral reefs especially where it is not properly protected has major impacts on the ecosystems. This activity destroys the ecosystems of the reef sustaining both fish and other reef dependent species. In the Philippines, India and other parts of South East Asia, the use of dynamite, cyanide and fishing for aquarium industries has created serious problems and threatened coral ecosystems. Coral

serves as substratum for primary production and habitats for invertebrates including fishes and protects the coast from waves. The balance between accretion rates due to growth of corals, hydrocorals/coral lime algae and erosion resulting from mechanical activities and bio erosion determines the development of corals. Explosive fishing also results in waste and affect species other than the target species (by-catch). The effect of fishing on corals can be indirect if the relationship between the invertebrate communities that are responsible for accretion and bio erosion is altered (Michael et al., 2001).

In response to the degradation of this productive and diverse natural habitat and the recognition given to these natural resources at the UNCED or Earth Summit in 1992 a number of nations, international organisations and institutions, and non-governmental organisations (NGOs) have started an International Coral Reef Initiative (ICRI). ICRI attempts to support communications and projects focussing at improving the management of the systems through shared responsibilities and encourage other interested nations to join. The United States Agency for International Development, Department of Commerce- National Oceanic Atmospheric and Administration (NOAA) and the United States department of States were the first to launch an International Coral Reef Initiative (ICRI). ICRI is comprised of three operational units plus a regional unit.

1). Global Coral Reef Monitoring Network (GCRMN). This body is responsible for the coordination and assessment of the extent of use and damage to corals at various locations to assist management. The body is also in charge of raising awareness between stakeholders and providing ways of preventing the damage to coral reefs.

2). International Coral Reef Information Network (ICRIN). It is the duty of this particular unit to handle and circulate all necessary information with regards to status of corals for education and public awareness for proper conservation. The unit also maintains and creates concern among public for the health of coral reefs.

3). Coral Reefs Action Network (CRAN). This is made up of ICRI members, designed for implementation of ICRI framework for action. It has the responsibility to reverse the declining level of the world's corals. This unit is strongly supported by the United Nations Foundation (UNF).

4). Coral Reef Degradation in the Indian Ocean (CORDIO). This is a regional network. It is created to respond to coral reef degradation in the Indian Ocean especially the extensive coral bleaching event of 1998 (ICRI, 2002).

2.2.2.2. Mangrove forests

The destruction of mangrove is equally occurring at an alarming rate. This loss is caused by the conversion of mangrove habitats to fish and shrimp farms especially in South America e.g. Ecuador (GESAMP, 1996). The threat has had serious impact on fisheries. Mangroves are vital for breeding and as nurseries for fish juvenile, crustaceans, molluscs and a primary source of shrimp larva to stock the farms. Habitat loss reduces the availability of feeding grounds, productivity and growth at the juvenile stage plus reduction in the entire productive success. Other problems associated with the mangrove destruction are severe erosion along the coast and loss of coastline leading to severe coastal flooding. Loss of coral reefs and mangrove habitats are most significant with regards to loss of biodiversity.

2.2.2.3. Alteration of coastline and watersheds

Wetlands, estuaries, and sea grass beds are identified to be nursery grounds for coastal fisheries. Estuaries pose conflicting interest in terms of industrial development, harbour construction, shipping, fishing, tourism and the need for protection. The degree of habitat degradation needs to be assessed and monitored over space and time. These coastal developments involving dredging of river channels for ports or building of shore reception facilities for ship generated waste, sand mining, construction of jetties, beach improvement and resorts to attract tourists and coastal aquaculture will result in the destabilization and alteration of the coast and watershed due to erosion and sedimentation (GESAMP, 2001).

This threat is a global problem. Examples can be seen even in the developed world. Developments such as the plans by Associated British Port (ABP) to construct a container terminal on 240 hectares of open grazing marsh and mudflats area of

Dibden Bay will have a severe negative impact on the coast and watershed (Environmental News Service, 2000). To the environmentalists and Friends of the Earth, Dibden Bay is an international wildlife haven due to its diversity especially among birds. The proposed site is in close proximity to Southampton water, a designated Special Protected Area (SPA) of European importance (Bird Directives) due to wintering and migratory birds use of this habitat. Friends of the Earth summarized the impact of such project in the region to include among others total loss of the marshland area, mudflats, and biological communities. Others include dredging leading to coastal erosion and variation in tidal flow and distribution of sediments (Environmental News Service, 2000).

Dredging increases the turbidity of water thus reducing light penetration to the bottom of the sea. Photoplanktons and benthos will suffer losing light or being covered with silt. Coral reefs have been smothered in the Philippines, Sri Lanka and other countries in South East Asia by similar developments. Another important effect of dredging is siltation of rivers and lagoons. A typical example of lagoon silted up by sediment is Korlea lagoon in Ghana while Angalleli River, Wari in Nigeria are suffering from excessive sediment load.

Deltas are formed as a result of the deposition of sediments on the coast by rivers and its tributaries. Hinterland activities like construction of dams has changed and altered this sequence leading to retreating or receding coastline and alteration of watersheds. In Nigeria, two major dams had been constructed on the River Niger at Kainji and Jebba for hydroelectricity generation and irrigation of agricultural lands. These projects have starved the coastal areas of the required sediments and nutrients. The result is reflected on a very intensive erosion problem at various locations e.g. Brass, Forcados and Ibeno, all along the Nigerian coastline (Niger Delta). Dam construction or re-routing of river obstructs and blocks migration routes of fish species between fresh and salt water e.g. diadromous and salmon. This habitat disturbance will affect those species of fish that spawn in pure fresh water (Richardson, 2001). Attempt to conserve mangrove habitat, salt marshes and sea

grass beds are in progress in the regional seas programmes through Integrated Coastal and Ocean Management (ICOM) and the establishment of protected areas.

2.2.3. Pollution

Pollution is a serious problem in the marine environment and pollutants take a variety of forms. The different forms relating to land-based category are eutrophication, sewage, synthetic organic chemicals and heavy metals.

2.2.3.1. Eutrophication

This is land-based source of pollution threat to the marine ecosystems. It is defined as the process of nutrient enrichment that stimulates algal blooms, primary production and excessive growth of macrophites (Wu, 1999). The primary cause of the problem is excessive nutrients usually from agricultural run off and/ or sewage discharged into coastal waters. According to Wu, eutrophication is significantly expanding and it is occurring in almost every coastal state and there is a tendency for constant increase of this problem for to the following reasons (Wu, 1999).

1). There is a continuous input of nitrogen in coastal waters. This is because the sources which include the atmospheric fallout and discharge are significant, both are non point sources and not easy to control.

2). Agricultural activities and irrigation practices are increasing with the corresponding increase in run off of nutrients to the sea.

3). Aquaculture or mariculture activities are increasing in coastal areas especially in South America (Ecuador) and South East Asia. This will keep input of nutrients in the ecosystem high.

4). Increasing volume of untreated wastewater from the growing population and tourist resorts around the coastal areas (Wu, 1999).

The effects of eutrophication are many, starting from the alteration of species composition in the water including benthos communities. This may result in local changes in biodiversity. More severe consequences are experienced when the phytoplankton bloom decay. It causes hypoxia/anoxia (depletion of oxygen) in the

environment. This results in massive mortalities of marine organisms and sensitive fish species over large area of the ecosystem. For example, a great number of benthic organisms were lost or extinct due to oxygen depletion in the Gulf of Mexico at one time. The problem started when excess nutrients from the Mississippi River flushed into the Gulf of Mexico creating a large hypoxia zone of about 18000 km^2 (Rabalais et al, 1999; Resenberg, 2001). Some fast moving organisms were able to move away from the area while their homes were no longer available. The effect is that there will be reduction in production.

Phytoplankton blooms also minimize or prevent light from reaching the bottom of the sea. In this situation, light dependent ecosystems such as corals and seagrass beds will deteriorate or completely die away. Evidence of decrease in Seechi depth due to nutrient load and turbidity increases to coastal waters has been indicated for the Baltic Sea and the northern Gulf of Mexico (Rabalais et al, 1999; Elmgren & Lawson (2001). It further enhances the rapid growth of benthos species of seaweeds that overwhelm coral and ends up smothering them leading to species extinction (GESAMP, 2001). Other effects that have been linked to eutrophication are explosive bloom of toxic or harmful algae known as 'red tides' or 'brown tides' (Laroche et al, 19997; GESAMP, 2001; Rabalais, 2002). Whitledge et al (1999) believes that the bloom will increase the mortality of zooplankton and larval fish as well as posing a significant risk to human health through the food chain.

2.2.3.2. Sewage

Sewage discharge to coastal waters from tourist resort centres or ships increase nutrients in the ecosystem. The effect is that it destroys fisheries, recreation potential and tourism leading to economic loss. Where toxic algal biomass is high e.g. in sewage and nutrient enriched coastal areas, the risks of gastrointestinal disease like cholera and typhoid are high (GESAMP, 2001). The disease is often caused as a result of eating infected fish or bathing in the water. Bonsdorff et al (1999) observes that long-term increase in nutrient in the Baltic has caused a corresponding increase

in phytoplankton biomass, decrease in water transparency by large-scale changes in species diversity of both benthic and fish communities.

2.2.3.3. Chemical pollution

Synthetic organic chemicals such as chlorinated or brominated compounds (PCBs), organophoshates (PAHs) and organo metals including pesticides are persistent in the environment and have toxic effect on marine organisms. Polychlorinated Biphenyls (PCBs) and Polycyclic Aromatic Hydrocarbons (PAHs) cause birth defects, reproductive and chromosomal problems in marine organisms (Oceanlink, 2002). The sources of PCBs to the marine environment include old electrical equipment like transformers and hydraulic fluids. PAH on the other hand originates from oil spills, road runoff and burning wood and coal. For example, in the vicinity of the Sea Express oil spill in Wales (1996), the fish and shellfish fisheries were closed down. This was a precaution taken to prevent people from buying the contaminated fish for consumption. There was an intensive monitoring which reveals that fish and crustacean only absorbed a little concentration of PAHs while mollusc assimilated a large quantity of oil in them. This implies that filter feeders accumulate oil and the corresponding contaminants than other organisms with different type of feeding (Law et al., 1999). Pesticides like DDT increase respiration and decrease protein content in shrimp (Reyes et al, 1996). This chemical reaches the marine environment through surface run off from agricultural lands. Dioxins, another form of pesticide originates from the paper bleaching process and herbicides. It causes chromosonal aberrations in marine life (Oceanlink, 2002).

2.2.3.4. Pollution from onshore oil activities

These include oil spill from transfer points, pipelines from land-based exploitation or refineries waste and effluent. The pollutants will reach the marine environment through surface run-off or air deposition in the case of nitrogen and sulphur dioxide gases from the refineries.

2.2.3.5. Heavy metals:

These may occur naturally in the environment from weathering of rocks through which the water traversed or is introduced by anthropogenic activities or even volcanic activity. The impact can only cause much concern in the affected locality with high concentration. Shilts and Coker indicate that trout fishery in a remote area was closed down because of high concentration of mercury from natural sources i.e. geology of the place (Shilts & Coker, 1995). Copper, lead and Iron are required in living organisms at low concentrations to grow properly. Basically, they are for the manufacture of enzymes and protein that carries out critical metabolic functions e.g. chlorophyll contains magnesium while haemoglobin in the blood contains iron. Although copper is required in the least concentration, it is very toxic at high concentration. The metal interferes with the functioning of cell membranes. The interference is with the binding power and permeability of other important metals in the organism. Copper binds to the thiol (-SH) groups of enzymes thereby disrupting the conformation and proper functioning of the biomolecules. Moreover, the toxicity of copper can affect organelles by interfering with the mitochondral electron transport, ATP production, respiration and photosynthetic process in the chloroplasts. Copper also posed the same threats to both marine vertebrate and invertebrate species (Oceanlink, 2002).

Conversely, cadmium, lead and mercury are toxic at the least concentration and have no biological function (Shilts & Coker, 1995; Richardson, 2001). The toxicity of the metals varies from one organism to another. Planktons are especially susceptible to metal contamination. Toxic impacts on phytoplankton include the following:

1). Reduction in chlorophyll content of the plants;

2). There will be increase in cell permeability resulting in loss of certain ions like potassium;

3). There will also be cessation of growth and development of the plankton;

4). Photosynthetic activities will be inhibited (Oceanlink, 2002).

2.2.4. Tourism and recreational activities

Tourism and recreation activities will also stress coastal ecosystems. The most significant threats are those of habitat destruction and decline of water quality and sewage discharge. Sewage discharge creates serious human health problems as well as an impact on biota (Clark, 1998). Mangroves are cut down for the building of new tourist resort and settlements. This will lead to alteration of coastline, erosion and reduce the diverse communities inhabiting the forest. The resort during operation depending on the number of tourists may threaten coral reef due to sewage generation and trampling on coral.

2.2.5. Climate change and increased radiations

Sea level rise is the most documented effect of global climate change. This has great impact on the low-lying countries of Tuvalu and Kiribati in the Pacific and Bangladesh. Wetlands habitats in these areas are vulnerable to the threat, being reproductive site for marine organisms. Schutz-Baldes (2000) indicates that other consequences of atmospheric change to the oceans and coastal waters include higher water temperature (especially top layer), alteration of the deep sea circulation, shifting of ocean front and current, changes in sea water composition as a result of altered gas exchange with the atmosphere and changes in marine biosphere. Global warming of coastal oceans has caused a serious impact on corals. In 1998, there was an increase of 3-5^{o} C above the normal temperature of the Indian Ocean with massive bleaching and mortality of some corals (Wilkinson et. al, 1999). Similar incidents have been recorded in other areas of Sri Lanka and Kenya.

Between 1997 and 1998, El Nino Southern Oscillation (ENSO) recorded the highest occurrence of regional wide spread bleaching of corals. ENSO induced rise in water temperature may not have been responsible for the entire impact of bleaching (Anon, 1999, Wilkinson, 1998). This has significant negative impacts on tourism with potential depletion in fish stock and coastal erosion problems in the affected areas. Climate change may result in reduction of forage fish availability with corresponding

decrease in productivity of important commercial stock. A typical example is the reduction of herring and capelin stock in the Bering Sea (NRC, 1996). As remedial measures, an international instrument, the Framework Convention on Climate Change and the Kyoto Protocol has been adopted. These instruments govern the emission of greenhouse gases such as carbon dioxide, methane, and most importantly Chlorofluorocarbon (CFCs) from both developed and developing countries. It requires the reduction of the gas emissions by an average of 5% below 1990 levels during the period 2008-2012.

As a result of ozone depletion due to excessive greenhouse gases in the atmosphere, UV-B radiation (ultraviolet light) is increasing greatly especially at the poles (GESAMP, 2001). The effect of ultraviolet radiation is on the top few metres of the ocean. It is affecting phytoplankton in the surface water thereby reducing productivity and inhibiting the growth and reproductive process. Phytoplankton is a food source for fish fingerlings and fry. The eggs and larva of fishes are threatened. Photoplanktons are the primary producers of the open ocean. This means that they supply the energy for the higher animals in the oceanic food web. They also supply a large component of the earth's oxygen. There has also been concern about the impacts of UV-B radiation on production of algae (diatoms) in coastal waters, sandy beaches and mudflats. This aspect is calling for more research to ascertain the effects on ecosystems and organisms.

2.3. Ocean based threats to marine ecosystems

2.3.1. Introduction

The degradation of the marine ecosystem emanating from sea based activities include consequences of fishing and over-exploitation of fisheries; impact of shipping such as the introduction of invasive species from ship ballast water; anti fouling e.g. TBT, oil and air pollution, seabed and sand mining, impacts of marine scientific research, offshore oil and gas exploitation. A number of international organisations or agencies have been designated with the mandate to manage and monitor the activities

in the oceans. The primary agencies are International Maritime Organisation (IMO), Food and Agricultural Organisation of the United Nations (FAO), International Oceanographic Commission of UNESCO and International Seabed Authority (ISA).

The IMO has a mandate to regulate shipping, navigation and to protect the marine environment by developing standards and conventions to regulate the shipping activities and prevention of pollution from ships. FAO is the organisation in charge of nutrition, food and agriculture. FAO relates to the oceans in the sense that agriculture includes fisheries. The organisation is concerned with the capture fisheries and aquaculture i.e. living resources of the oceans. IOC of UNESCO is concerned with marine scientific research and capacity building for the proper management of the oceans. ISA is involved with monitoring and control of seabed beyond the limit of national jurisdiction. In other words, ISA is in charge of the management of the non-living resources of the seabed.

2.3.2. Consequences of fishing and over-exploitation of fisheries

The consequences of fishing and over-exploitation of fisheries remain a serious ocean based threat to marine ecosystems. Fishing has both direct and indirect impacts on marine ecosystems (FAO, 2001). Direct impacts of fishing on marine ecosystems include over-fishing, mortality on non-targeted species (by catch and discards) and physical impact of fishing operations and vessel movements on the seabed and benthic organisms. The indirect effects are mortality of marine organisms other than fish due to lost gear (ghost fishing), competition and predation, and the impact of dumping discards and organic detritus (FAO, 2001; Goni, 1998).

The effect of over-fishing on commercial targeted species changes the size distribution leading to loss of genetic diversity as well as having impact on the existing food chain within ecosystems (Goni, 1998; Kaiser & Jennings, 1998). FAO regards the world's fish resources as either, fished to capacity, over-fished or recovering from over-fishing (FAO, 1997 & 1999). This implies that the fishing level is not sustainable but rather depleting. In this case, the exploitation rate is

always greater than 50 percent of the standing stocks (target species) per year. The mortality is extremely high considering the fact that the rate of exploitation for Maximum Sustainable Yield (MSY) of some stock is 15-20 percent per year (Rosenberg, 2001). This is a global problem and needs serious attention for sustainable use of marine resources. For example in the Grand Banks of Eastern Canada, stocks of cod were declined to the extent that the fishery was closed down and many people lost their jobs (GESAMP, 2001). Goni has clearly indicated that changes in fish species composition will affect other species such as sea birds and mammals that are dependent on fish. The same author indicates that over-exploitation of fisheries, especially the slow growing species with low reproductive cycle can become completely extinct locally or regionally e.g. bottom-living fish like elasmobranch of the Northeast Atlantic (Goni, 1998).

Most fishing techniques or gears are not selective e.g. bottom trawling. These results in catches of non-targeted species are usually undersized of the species targeted. Such incidental catches by trawling cause serious mortality in fisheries, including birds and sea turtles. The increase in mortality of young fish species means decrease in commercially available fish in future. The harvest of a particular component in the ecosystem will directly affect another. Shrimp fishery in the United States impacted directly on the fishery for red snapper due to by-catch of the young ones during shrimping in the Gulf of Mexico (NOAA, 1999).

The physical impact of fishing on the sea floor and benthic organisms is a threat to the marine ecosystem. Trawling for benthic fish greatly affects the habitat and species other than the target fish. Trawling destroys the benthic life of molluscs and echinoderms especially on the soft ocean floor. Here, the ecological processes that maintain marine productivity and diversity are also disrupted. For instance, the worms living at the bottom mud of the sea have a critical role in mixing and filtering sediments thereby preventing the sediment forming rocks. This process is known as bio-perturbation (Agardy, 1997). The sediments re-suspension into the water column by the gear causes suffocation to filter feeding organisms like sea anemones, corals, tube worms and eliminates food web components from the ecosystem.

Michael et al (2001) observed that the re-suspension of the sediment due to bottom trawling will release nutrients, contaminants accumulated in the sediment, expose anoxic layers, increase turbidity and Biological Oxygen Demand (BOD) and smother feeding and respiratory organs of marine organisms. Sediment/water interface is an area of benthic primary production. According to Michael et al (2001), large areas of the Posidonia Oceanica meadows in the Mediterranean have been subjected to intensive trawling activities causing reduction in littoral primary production. This may reduce species abundancy or can even lead to extinction. However, because there is no area free from trawling in that vicinity, investigations cannot be conducted. Michael et al (2001) suggests that designation of trawl free zone where by comparison of the effects of trawling with trawled areas in the Mediterranean can be assessed.

By-catch is thrown back into the sea thus excluding fishing mortality of this nature from the landing estimates. This contributes to the waste of valuable resources (Goni, 1998; Rosenberg, 2001). There has been a serious effort made to reduce this problem by zoning practices and development of selective fishing gears. The main reason for such practices in commercial fisheries is because of market demand and regulations. Regulations are binding and prohibit undersized fishing. Each fisher has a quota and to avoid exceeding his or her quota, the fisher discards small ones to enable them to catch the target species. Market economics in fisheries also accounts for the worldwide discard practices.

The indirect effect of fishing caused by lost gear is referred to as ghost fishing. This accidental loss of gear, dumping or abandonment impact negatively on marine organisms by entangling fish, seabirds or mammals leading to death (Goni, 1998).

The effluent from aquaculture sector of fisheries is a source of pollution in the marine environment. The most frequently observed effects in the receiving water ranged from eutrophication to increased bacteria counts, lowered oxygen content of the water and increased algal bloom and turbidity (ICES, 1995).

2.3.3. Impacts of shipping

There are various types of harmful impacts to marine ecosystems emanating from shipping activities. These range from the introduction of invasive or harmful aquatic organisms from ballast water; anti-fouling e.g. TBT; oil (or Hazardous and Noxious Substances, HNS) and related air pollution.

2.3.3.1. Introduction of invasive or harmful aquatic organisms

The words harmful aquatic organisms are used internationally with alien species, exotic, nuisance, hitchhiker, invaders or non-indigenous species. The terms refer to species of organisms which normally are not harmful in their living habitat are established, cause destruction, significantly displace or change the ecology of the native habitat into which they are introduced (Kraiem, 2000; GESAMP, 2001). Examples are jellyfish, crabs, molluscs, toxic dinoflagelates, bacteria, plankton and fish. Coastal waters are prone to the deliberate introduction of alien species. This can be escaped species introduced for aquaculture or discharged into the system from ship ballast water. In many countries introduction of alien species internationally requires licensing but this is not checked properly. The primary focus concerning this problem is ship ballast water. Ballast is defined as "any solid or liquid placed in a ship to increase the depth of submergence of the vessel in the water (the draft), to change the trim, to regulate the stability or to maintain stress loads within accepted limits" (NRC, 1996; Kraeim, 2000, p.2).

Ballast water including sediment is taken in by seagoing vessels outside the port where cargo is discharged for stability of the vessel to withstand the perils of the sea. During this exercise the harmful organisms can be taken into the ship with the water. Regulation 13 in Annex 1 of the MARPOL Convention provides the minimum capacity and location of ballast tanks for tankers. This is for the purpose of safe operation and not to ballast in the cargo tanks contaminated with hydrocarbon products (IMO, 1997). Again before arriving at the loading port (may be in another region of the world), the vessel needs to empty its ballast in order to load the

assigned cargo. For example, Very Large Crude Carriers (VLCC) carry about 140,000 tonnes of ballast (i.e. 30 % of the ship deadweight). Sediments in the water may contain cysts of dinoflagellates or larva of some other organisms. Three thousand species have been the estimated figure of organisms transported daily from one coastal region to another. Most of them are harmful to the native species, disturb nutrient balance, spread pathogens and severely disrupt the entire ecosystem (Gollasch, 1997; GESAMP, 2001).

GESAMP (1997a) indicates that *Ctenophore Mnemiopsis Leidyi* (jellyfish) that was introduced from North America to the Black Sea has the most damaging effect of such transfer to marine ecosystems. The species alter trophic web and cause high reduction in commercial fisheries stock in the area. According to Ambrosa (1999), the Round Goby (*Neogobius Melanostomus*) was introduced to the Great Lakes from the Black and Caspian Seas. Round Goby feeds on the native species of mussels. This fish is said to be very aggressive. It damages eggs, juvenile fishes and perch in the ecosystem (IMO, 1999a). Another example can be seen in Northern Africa, where more than 250 species were introduced to the Mediterranean from the Red Sea due to the opening of the Suez Canal. The jellyfish species from the Red Sea successfully displaced the native fish of commercial important, reduced catch per unit effort, clogged water intake pipes of coastal power plants and finally reduced the tourism potential of the Mediterranean (Agardy, 1997).

Ballast water species transfer is a global problem and therefore requires an international approach to address this crisis. IMO has adopted Resolution A 868 (20), Guidelines for the control and management of ships ballast water to reduce the transfer of harmful aquatic organisms and pathogens. An industry organisation, Intertanko has developed a Model Ballast Water Management Plan to complement the IMO resolution. Other international agreements that address the management and control of alien species include UNCLOS (Article 196) and the International Council for the Exploration of the Sea Code of Practice on the introduction and transfer of marine organisms. Few specific measures and obligations to harness harmful aquatic organisms problems have also been articulated in regional and global agreements on protected areas. To prevent the introduction of alien species, IMO

recommend exchange of ballast water at open sea and developing a convention to control the introduction of harmful organisms. However, IMO in collaboration with UNDP and GEF has embarked on the Globallast programme to assist developing countries to minimize the transfer of harmful organisms.

2.3.3.2. Anti fouling

Organic chemicals are known to interfere with female oestrogen hormones and endocrine disruption e.g. Tributyl Tin (TBT), herbicide in ships anti-fouling paints. Anti-fouling system is defined as "a coating, paint, surface treatment, surface, or device that are used on the ship to control or prevent attachment of unwanted organisms (IMO, 2001, Article 3 (2)). The convention on Anti-Fouling Paints as a control measure prohibits ship from applying or re-applying organotin compounds on their hulls or external parts, surfaces or even to bear coating that forms a bridge to such compounds (IMO, 2001, Article 5 of annex 1). This chemical induces imposex in snails thereby terminating reproduction in marine gastropods. Imposex has been reported in gastropods in areas with high marine transportation and activities.

The chemicals, in addition to terminating reproduction also cause decrease and species extinction (Cadee et al, 1995; Wu, 1999). In the words of Trans et al (1996), there is potential risk of mortality in fish and zooplankton. This problem was observed during and after a clean up operation around marinas. The impact of TBT also relates to reduction in the immune efficiency response in fish. Grinwis et al exposes flounder to the same maximum concentration of TBT found in nature. He observes that the organisms were dead between 7-12 days. The mortalities according to the author was related to gill lesion, reduced immune function and lower volume of thymus (Grinwis et al., 1998). Reduction in the immune efficiency has also been verified in shellfish through exposure of the organism to TBT. Again, exposure increased the susceptibility of oysters to a parasite pathogen called *perkinsus marinus* compared to organisms not being exposed to TBT (Fisher et al., 1999).

2.3.3.3. Oil pollution

The sources of oil pollution are many. These include accidental oil (and HNS) and operational discharges from ships during loading and discharging operations. However, oil spills also result from offshore flow stations. Collisions and groundings of large oil tankers at sea have been a major source too. Major oil spills in the world such as Exxon Valdez (1989), Sea Express (1996) and Amoco Cadiz have had tremendous effects on the marine ecosystems. Impacts of oil are dependent on the quantity of oil spill, type and its properties (e.g. viscosity and solubility) oceanographic conditions such as currents, waves, winds, temperature and geomorphology of the coast (IMO, 2001).

Oil on the surface of the water contaminates birds, mammals, sea turtles and other swimming organisms on the surface of the water. Marine organisms are dependent on quality of primary production from phytoplankton for food. During a spill incident, plankton communities are seriously destroyed thereby reducing primary productivity and this will change growth rate and reproduction rate in many species. The extent of destruction is determined by the type and concentration of oil dissolved in water. Some of the spill oil may sink to the sea bottom depending on the specific gravity. The impact in this case will be on benthic organisms and spawning grounds for herring and other habitats.

The degree and persistence of oil in the intertidal zone is subject to geomorphology of the coast, sediment type and the residence time of oil in the sediment. Steep, rocky profiles have the capacity of deflecting waves and keep the floating oil away from shore. The same profile (i.e. steep) with gravel or coarse grain sandy sediments tends to accumulate and retain pollutants longer than fine grain and low profile beaches (IMO, 2001). In the latter case, the compact nature of the beach retards the penetration of spilled oil. It therefore means that the oil will remain on the surface and can be cleaned up naturally by waves and tidal currents with minimum impacts to the ecology. In the former situation of gravel, coarse sandy grain profiles, the

pollutants may penetrate the sediments and have longer residence time causing more damage to marine life.

Oil tends to persist in the ecological zones of sheltered lagoons and tidal flats, salt marshes and mangrove swamps. Biota are contaminated and smothered especially at the initial stage of an oil spill. Mangrove ecosystems will experience defoliation, death of seedlings and mortalities of invertebrate communities and fish inhabiting the ecosystem. Mangrove roots retain massive sediments and if the roots decompose due to oil impact, the sediments will be released. The threat will be covering corals and other creatures that are intolerant to siltation.

2.3.3.4. Air pollution

The pH of rainwater under normal conditions will not fall below 5.5. When the pH drops below 5.5, the precipitation becomes acidic. These have serious negative impacts on ecosystems including damage to mangrove forest and other living resources such as fish (USEPA, 2002). The United States Environmental Protection Agency (USEPA) provides that scientist has confirmed acid precipitation to be caused by the release of acidic gases like SO_2, NO_2 and Hcl into the atmosphere. In general, the sources of these gases include fossil fuel combustion by ships, air craft to mention just a few (USEPA, 2002). Incineration at sea from ships is another important source of air pollution. As the means of controlling the emission of the gases, special sulphur oxide emission coastal areas are established with more stringent rules to reduce air pollution from ships in that particular area (MARPOL 73/78, Annex vi). This means that the fuel quality used in this area must not have SO_2 above 1.5 percent m/m compared to the global maximum limit of 4.5 percent m/m. The Baltic Sea area is an example of the area designated as a SO_x emission coastal area in the protocol (IMO, 2000).

2.3.4. Seabed mining

This is another ocean-based threat to marine ecosystems. The sediments and seeps of the seabed are being seriously threatened by mining activities. The hydrothermal vent is a typical example of such seeps. These are underwater hot springs associated with volcanic or tectonically active portions of the deep seabed whose fluid is a mixture of seawater, dissolved minerals and chemicals e.g. hydrogen sulphide (Broad, 1997). The fluids later result in the formation of massive polymetallic sulphide deposits that vary from several thousand to about 100 million tones. Polymetallic sulphide deposits contain gold, copper and other base metals (Halfar & Fujita, 2002).

Mining for these metals poses serious threats to hydrothermal vent ecosystems and biological communities of the area. Direct impacts may include physical damage and destruction of the communities inhabiting the area while indirect adverse effects will be sedimentation and disruption of water circulation systems (Glowka, 2001). Halfar & Fujita (2002) have indicated that Manus Basin of Bismarck sea in the north of Papua New Guinea to be the first location other than the Mid- Ocean regions where hydrothermal chimmy deposits are found.

The environmental impact of mining depends on the technique used. ISA believes that strip and open cast mining will be the technology for the mining of polymetallic sulphide deposits (ISA, 2000). In that case, effects will include the killing of the surface and subsurface organisms directly. If mining tailing is being disposed at sea, there will be mortality of fishes, zooplankton and deep-diving mammals due to sediment plume and metallic substances. Depletion of oxygen due to bacterial growth, dissolved heavy metals and incorporation of these into the food chain will results (Halfar & Fujita, 2002).

According to Halfar & Fujita (2002) if the mining activity is carried out in the EEZ of a state (near coast or land) like the case of Manus Basin, the activity will pose higher environmental risks than in the international waters that is far away from land. The possibility will be that the sediment plume of mine tailing discharged into the

shallow water will move towards the shelf area. The effect on shelf and the near-shore habitats and environment may be greater (Halfar & Fujita, 2002). On the other hand, deep-sea mining will be more mobile with corresponding widespread effects than terrestrial mining operations. The reason is that in the terrestrial case, no infrastructure is left at the end of the operation (Jones, 1998).

Again, deep-sea mining will involve lifting ore and deep-water bodies by hydraulic pumps to surface ships. The deeper waters have a high nutrient content and thus can result in local or regional increase in primary productivity on the surface water paving way for local or regional eutrophication and changes in community structure. This is prominent in oligotrophic oceans with more sensitivity to nutrient inputs (Halfar & Fujita, 2002). Mining for offshore and beach sand for construction projects or buildings has been quite frequent activity in certain countries. The effect of such activities include erosion and damage to benthic organisms and their habitats plus increased turbidity leading to reduction in productivity (Clark, 1998)

2.3.5. Impacts of marine scientific research

Marine scientific research is another ocean-based threat to hydrothermal vents and their biological communities. The research just like any other natural resource use should be sustainable. The Convention on Biological Diversity defines sustainable use as "the use of components of biodiversity in a way and at the rate that does not lead to the long term decline of biodiversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations" (CBD, 1992, Article 2, p.2). This definition acknowledges the fact that biodiversity must be conserved along side with the sustainable use of its components such as the population of species, genomes and the ecosystems. According to Glowka (2001) one of the threats from scientific research is due to the shift in research priorities from exploration and discovery to the emphasis on temporal processes. This results in certain incompatibility in the concentration of sampling, observation and instrumentation at hydrothermal sites. This author indicates that the outstanding conflict is between observational monitoring activities that rely on an undisturbed

state and the ones involving manipulating or collecting biological or geological samples from a site (Glowka, 2001).

The primary objective of marine research activities is sampling of macro and micro-organisms. This is a significant pressure on hydrothermal biological communities with adverse effects. The sampling such as the one involving invertebrate may not be sustainable. The effect may be direct in the case of over collecting samples with limited population or endangered or rare species. Introduction of exotic species or pathogens from one site to another habitat by scientists is also a serious threat. Moreover, the use of inappropriate collection techniques may result in collateral damage to habitats or biota other than the species targeted. The particular concern here is on the fragile ecosystems and environment where destructive collecting techniques such as trawling are used.

CHAPTER THREE

MARINE PROTECTED AREAS

3.1. Introduction

This chapter discusses the concept of Marine Protected Areas (MPAs) that has been advanced at international, regional and national levels as a strategy to respond to the damage activities outlined in Chapter 2. Implementation concerns, strategies and the roles of marine protected areas are also discussed in this chapter.

3.2. Definitions and categories of marine protected areas

The definition of (MPAs) and management options are becoming increasingly flexible. MPAs have variable meaning from one country to another depending on the country's national legislation and international agreements. The most widely adopted definition is that put forward by World Conservation Union (IUCN) and other international and national organisations. IUCN defines an MPAs as " any area of inter-tidal or sub-tidal terrain together with its overlying water and associated flora, fauna and historical and cultural features which has been reserved by law or effective means to protect part or all of the enclosed environment" (IUCN, 1994 Study (as cited in Green & Paine, 1997, p. 2); WWF, 1998, p.6; NRC, 2001, p.237). The above definition is broad. It covers areas established for conservation purposes including fisheries management as well as protected areas by effective means. The establishing legislation in the case of effective means includes voluntary agreement or customary tenure.

MPAs are managed for various purposes or objectives. These management objectives in practice include the following: scientific research, wilderness protection,

preservation of species and genetic diversity, maintenance of environmental services, protection of specific natural and culture features, tourism and recreation, education, sustainable use of resources from natural ecosystems and finally the maintenance of cultural and traditional attributes (Green & Paine, 1997; NRC, 2001). The different objectives or purposes of marine protected areas led IUCN to classify marine and terrestrial protected areas into six main categories ranging from strict nature reserve to multiple use areas management mainly for sustainable use of resources. The six main categories are listed and defined in Table 1 below (IUCN 1994 Study (as cited in Green & Paine, 1997). Table 2 charts the corresponding objectives for each of the categories.

The basis of categorization is the primary management objectives of the protected areas. This provides uniform international regime, facilitates communication and sharing of information, comparison, analysis and the basis for planning protected areas at national level (WWF, 1998). There is a close relationship between the six categories of protected areas and the management objectives as indicated by IUCN. This relationship is shown in Table 2 set out below.

From Table 2, it is observed that one or more management objective(s) may be encompassed within a single category of protected area. However, there is gradation of human interference ranging from none in category 1a and 1b to a high level in category V. According to Green and Paine, category VI was included in the categorization system in the 1994 revision and as such does not match exactly into the pattern. It falls between category III and IV. Furthermore, it is important to note that all categories are of the same importance in terms of the conservation of biodiversity (Green & Paine, 1997).

Table 1: Definitions of the IUCN protected area management categories

CATEGORY I	**Strict Nature Reserve / Wilderness Area: protected area managed mainly for science or wilderness protection**
CATEGORY Ia	**Strict Nature Reserve: protected area managed mainly for science**
Definition:	Area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring.
CATEGORY Ib	**Wilderness Area: protected area managed mainly for wilderness protection**
Definition:	Large area of unmodified or slightly modified land, and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition.
CATEGORY II	**National Park: protected area managed mainly for ecosystem protection and recreation**
Definition:	Natural area of land and/or sea, designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations, (b) exclude exploitation or occupation inimical to the purposes of designation of the area and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.
CATEGORY III	**Natural Monument: protected area managed mainly for conservation of specific natural features**
Definition:	Area containing one, or more, specific natural or natural/cultural feature which is of outstanding or unique value because of its inherent rarity, representative or aesthetic qualities or cultural significance.
CATEGORY IV	**Habitat/Species Management Area: protected area managed mainly for conservation through management intervention**
Definition:	Area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.
CATEGORY V	**Protected Landscape/Seascape: protected area managed mainly for landscape/seascape conservation and recreation**
Definition:	Area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.
CATEGORY VI	**Managed Resource Protected Area: protected area managed mainly for the sustainable use of natural ecosystems**
Definition:	Area containing predominantly unmodified natural systems, managed to ensure long term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.

Source: IUCN 1994 (as cited in Green & Paine, 1997, p. 2)

Table 2: Protected area categories and management objectives

Management objective	1a	1b	II	III	IV	V	V1
Scientific research	1	3	2	2		2	3
Wilderness protection	2	1	2	3	3	-	2
Species/genetic diversity	1	2	1	1	1	2	1
Environmental services	2	1	1	-	1	2	1
Natural/cultural features	-	-	2	1	3	1	3
Tourism/recreation	-	2	1	1	3	1	3
Education	-	-	2	2	2	2	3
Sustainable use	-	3	3	-	2	2	1
Cultural attributes	-	-	-	-	-	1	2

Key: 1= primary objective, 2 = secondary objective, 3 = potentially not applicable or not applicable.

(Source: IUCN, 1994 (as cited in Green & Paine, 1997, p. 3)

3.3. Concepts of marine protected areas

This section outlines the provisions of selected international, regional and national instruments that support the established protected areas in the marine environment. It is important to note that in response to any international agreements or conventions, national legislation and policies must have been in place to incorporate ecosystem considerations into national legislation setting out ocean management regimes.

3.3.1. United Nations Convention on the Law of the Sea (UNCLOS 1982)

UNCLOS was opened for signature in 1982 and entered into force in 1994. It deals with all matters concerning oceans and seas. UNCLOS provides rules for regulating activities (uses) of oceans and seas. It establishes a framework for development of conservation and management measures relating to marine resources and scientific research by nations within national and international areas. Part 12 outlines provisions regarding State responsibility to protect and conserve marine ecosystems.

States are obliged to undertake measures to protect the marine environment and to control, reduce and manage pollution of the sea (UNCLOS, 1982, Article 192 & 194).

Article 194 (5) provides that "states shall include those measures necessary to protect and preserve rare or fragile ecosystems as well as habitat of depleted, threatened or endangered species and other forms of marine life". This Article provided the legal basis to establish MPAs both within and beyond national jurisdiction. The Convention also contains a provision in which part of the sea bottom could be placed in off- limit for extraction of minerals where there is threat (UNCLOS, 1982, Article 194).

Article 211 permits coastal states to identify sites, establish an area and prescribe laws for the prevention of pollution from vessels in its EEZ, implementing such international rules and standards or navigational practices as made applicable through IMO for Special Areas (SA). The same Article also provides for additional national measures to be adopted by the coastal state provided that the measurement does not lay down design, construction, and manning or equipment standards for foreign ships. The additional standard must be approved by IMO and follow the general rules of the convention regarding enforcement in EEZ by a Coastal State (UNCLOS, 1982, Article 211).

3.3.2. United Nations Conference on Environment and Development (UNCED) – Agenda 21 (1992)

Agenda 21, the global blue print for sustainable development was adopted during the UN Conference on Environment and Development, Rio de Janeiro in 1992. The Conference defined sustainable development as the ability to "meet the needs of the present generation without compromising the ability of future generation to meet their own needs" (Commission on Sustainable Development, 1997). Chapter 17 of Agenda 21 is captioned "Protection of the oceans, all kinds of seas, including enclosed, semi-enclosed seas, and coastal areas and the protection of rational use and

development of their living resources". The chapter focuses on the following important areas:

1). Integrated management and sustainable development of coastal areas, including exclusive economic zones;

2). Marine environmental protection;

3). Sustainable use and conservation of marine living resources of the high seas;

4). Sustainable use and conservation of marine living resources under national jurisdiction;

5). Addressing critical uncertainties for the management of the marine environment and climate change;

6). Strengthening international, including regional, cooperation and coordination;

7). Sustainable development of small inlands (UNEP, 2000).

Under the Programme Area D, of Chapter 17 relating to the sustainable use and conservation of marine living resources under national jurisdiction, the designation of protected areas is required for protection of resources as a management tool. It provides that "states should identify marine ecosystems exhibiting high levels of biodiversity and productivity and other critical habitat areas and provide necessary limitation on use of these areas, through *inter alia*, designation of protected areas" (Agenda 21, 17 (86), 1992; Warner, 2002, p.157).

This instrument is not binding but States have agreed to the recommendations for sustainable development.

3.3.3. UNESCO man and biosphere programme (1976)

In the early 1970s, the United Nations Educational, Scientific and Cultural Organisation (UNESCO) pioneered the programme and established Man and Biosphere (MAB) Reserve. Biosphere reserve is defined as "area of terrestrial and coastal marine ecosystems which are internationally recognised for promoting and demonstrating a balance relationship between people and nature" (UNESCO, 2002; Kelleher, 1999, p.5). The reserve functions mainly in three aspects as indicated below:

1). Local, regional and international basis for research, education and information exchange which seeks to promote sustainable development

2). Conservation of biosphere resources including landscapes and ecosystems

3). Foster and improve global relation of humans with natural environments (UNESCO, 2002; Kelleher; 1999)

The Convention on World Heritage is directly linked to UNESCO's Biosphere and Man Programme. It creates an international forum for conservation of significant cultural sites. Parties are obliged to identify, protect and conserve for future generation unique cultural and natural areas. The programme is funded by a central control organisation (World Heritage Fund). Most of the heritage sites are terrestrial with few marine protected areas such as Great Barrier Reef Marine Park (GBRMP). The programme is based on the creation and management of a biogeographical network of reserves. It is often done through multiple use zoning and integrated to protect sensitive habitat and critical ecological processes in the core zone. The core zone is legally established with a minimum human interference and must be large enough to fulfil the conservation objective. The buffer zone is where, for example research, education and tourism can be carried out. These activities need to be regulated for the purpose of the buffer zone. There are zones called transition areas. Here the responsible parties such as the conservation and cultural groups agree to work in cooperation for the development of the areas to achieve sustainability of resources (Agardy, 1997).

It is the responsibility of different countries to nominate sites for inclusion in UNESCO's Biosphere network. There exist statutory guidelines governing the functioning of the networks. However, there is no legal obligation to do so (Kelleher, 1999). A good example of MPA that qualifies for Biosphere Reserve is the Great Barrier Reef Marine Park in Australia. The park consists of about 120 core zones (area of 16398 km^2) connected by buffer and transition zones totalling 350, 000 km^2 (Kelleher, 1999)

3.3.3. Convention on Biodiversity and the Jakarta Mandate

The Convention on Biological Diversity (CBD) was signed in June 1992 in Rio de Janeiro, Brazil and entered into force in December 1993. It provides an international framework for conservation, ecologically sustainable use of biodiversity and sharing of benefits from genetic resources equitably. CBD listed *inter alia* measures for conservation of biodiversity. These include both in-situ and ex-situ measures. However, these measures require developing national policies, strategies and programmes to reflect the principles in the Convention (CBD, 1992, Article. 6 (a)). Article 6 (b) of the convention urges governments to integrate the strategies and policies of conservation with cross-sectoral plan.

For in-situ conservation, the key points on measures include *inter alia* protected areas, ecosystems and habitats. The convention imposes certain obligations on parties concerning protected areas and ecosystems. These obligations are indicated below:

1). Parties should establish a system of protected areas for conservation of biodiversity and guidelines for the selection, establishment and development of the protected areas.

2). Parties should regulate and maintain important biological resources within the areas and in ex-situ. States should also promote sustainability of resources in adjacent areas to the protected zone to complements the zone resources.

3). Degraded ecosystems and habitats should be rehabilitated and restored, *inter lia* through the development and implementation of management plans and strategies. In-situ protection of ecosystems, natural habitats and maintenance of variable species should be promoted by parties. Alien species should be eradicated, prevented and controlled to avoid danger and harm to native habitats and species (CBD, 1992 art 8 (a-f), (h)). In addition, parties must develop and implement measures to control and manage risks associated with various activities in the zone Article 8 (g).

As complement to in-situ conservation measures, the Convention recommends that parties undertake ex-situ conservation measures as detailed in Article 9(a-e). The components of the ex-situ measure are as follows:

1). Parties should establish and maintain facilities for ex-situ conservation and conduct research into the origin of a particular biodiversity.

2). Parties should adopt measures to ensure recovery of threatened species and re-introduced them into their natural habitat with suitable condition.

3). Parties should regulate the collection of biological resources from habitats to avoid the collapse of the population and ecosystem.

4). Parties should cooperate in providing financial assistance to especially developing countries for ex-situ conservation. (CBD, 1992 Article 9 (a-e))

The Jakarta Mandate on Coastal and Marine Biodiversity was issued during the second meeting of the Conference of Parties to the CBD (COP) held in Jakarta in November 1995. The mandate identifies five (5) critical actions or activities that parties can take to implement or apply the Convention to marine habitats. These include the following:

1). Integrated coastal zone management

2). Ecologically sustainable use of coastal and marine living resources

3). Implementing sustainable mariculture

4). Preventing the introduction of alien species and

5). Establishing marine and coastal protected areas (Slam, Clark & Siirila, 2000)

3.3.4. International Convention on prevention of pollution from ships MARPOL 73/78 (Entry into force 1983)

In considering the concept of marine protected areas, the work of International Maritime Organization (IMO) is also very important. In 1991, IMO adopted Resolution A 920 (17) Guidelines for Designation of Special Areas and Identification of Particularly Sensitive Sea Areas (PSSAs). Special Areas are areas for stricter measures under the MARPOL 73/78 Convention with regards to discharges of oil, noxious liquids substances and garbage through IMO. Particularly Sensitive Sea

Areas require special protection due to their significant recognition in terms of ecology, socio-economic and scientific research. These areas are very sensitive and subject to damage by shipping activities (Churchill & Lowe, 1999; Gjerde, 2002). It provides a legal basis for significant reduction of the risk of accidents through routeing measures, compulsory pilotage, mandatory position reporting, and vessel traffic management systems.

In November 2001, a new Guideline Resolution 927 (27) was adopted by IMO. It replaces the 1991 Guidelines for the Designation of Special Areas and Identification of Particularly Sensitive Sea Areas (IMO Resolution A 920(17) as modified by Resolution 885 (21). The new Guidelines set out a new update or approach on criteria, procedure, evidence and legal basis for designation of such areas. The proposed site must satisfy one of these conditions or criteria viz: ecological, socio-economic or scientific criteria. Concerning the ecological factor, the initial Guidelines (1991) emphasized uniqueness, representative, naturalness, productivity, integrity and sensitivity of the area in question. The new Guidelines favour and focus on the Convention of Biodiversity (1992), involving rare habitats/ecosystems and genetic diversity as part of unique and species diversity. Furthermore, the ecological factors have been increased by three. These are protection of spawning/breeding areas, critical habitat and areas of biogeographic importance (IMO, 2001; Gjerde, 2002).

Other considerations for PSSAs in the new Guidelines include supplying information on vessel traffic characteristics such as type of vessel, cargo onboard and operational factors. Hydrographic (e.g. water depth), meteorological (e.g. weather, wind, visibility) and oceanographic conditions (e.g. current, waves) should also be supplied. This information will assist in the assessment of risks for proper management measures to be taken (IMO, 2001).

According to Gjerde (2002), designation of such areas has the following functions:

1). It will remind mariners to be more precautious in manoeuvring through such areas;

2). It will serve as a tool for the affected coastal states to control shipping provided the guidelines are supported by their domestic legislation. This will protect sensitive areas like coral reefs, and breeding grounds outside the territorial sea;
3). It will also stimulate good management practices of human activities and other threats to the system at both local and national levels.

The new Guidelines will increase the number of PSSA. "An increase in the number of PSSAs should simultaneously stimulate demand for electronic chats, vessel traffic services, automatic vessel identification systems and other technologies that can minimize shipping impacts on the sensitive marine areas and species" (Gjerde, 2002, p.40). The Great Barrier Reef of Australia and Cuba's Sabana Camaguey Archipelago are the two PSSA currently recognised by IMO.
Applications or proposals are required to be submitted to IMO for approval and must contain among others components with the following descriptions:

- description of the objectives, location and reasons for the required protection.
- use of charts, maps for description of the area with particular reference to PSSA criteria, the degree of sensitivity to shipping and its importance
- description of how the proposed measures will solve the problem and enhance safety of navigation
- non-member state having trans-boundary ecosystem, which can submit, coordinated application with member states to IMO.

3.3.5. UNEP Regional Seas programme

These international treaties create multilateral cooperation on a regional basis to manage coastal and ocean areas. The protocol on Mediterranean Specially Protected Areas was the first of its kind adopted in 1982 (Agardy, 1997). It is applicable to the territorial seas as well as wetlands designated by States according to Article 2 of the Convention. Article 3 empowers states to establish to the "extent possible" marine protected areas to conserve habitats significance in terms of ecology, genetic diversity, breeding grounds, control of the entire ecosystem and their processes. Parties can do this by adopting good planning and management practices e.g.

prohibiting pollution and controlling other activities such as fisheries, seabed exploration and navigation or adopt any other possible measures to protect negative biological processes in the areas. Parties should endeavour to recognise the traditional activities in the area and control their conduct for the protection of the ecosystem and its living resources (Churchill & Lowe, 1999).

The Barcelona Convention of 1995 on Specially Protected Areas and Biological Diversity in the Mediterranean will soon replace the Protocol discussed above. The distinguishing feature between the two is that more guidance on a management plan is provided in the new Convention (1995) and the programme is referred to as the establishment of Specially Protected Areas of the Mediterranean Importance (SPAMI). Such sites include habitats of endangered species, reproduction, biodiversity, scientific research, education and aesthetics or of cultural interest. The application here extends beyond national jurisdiction (Churchill & Lowe, 1999). There are other important examples of regional cooperation. Denmark, Germany and the Netherlands have for many years worked together for the conservation of the Wadden Sea with the participation of NGOs such as Greenpeace (Kelleher, 1999).
A provision similar to those of the Mediterranean also exists in the Carribbian, East Africa and South East Pacific Regional Seas Programme. It is of importance to note that the conservation of endangered species of fauna, flora and habitats in East Africa and the Caribbean extends even outside the protected areas (Churchill & Lowe, 1999).

3.3.6. National Marine Protected Areas

MPAs have been established by many national governments to conserve and protect their marine resources for future generations. Two good examples discussed in this dissertation include Australia and Canada.

The most diverse ecosystem and largest marine protected area in the world is Great Barrier Reef Marine Park in Australia. The Park spread over a distance greater than 2,000km along Australia's northeast coast. It consists of 29,000 coral reefs, large

inter-reef habitats and 900-1,000 islands (Clark, 1998; Salm, Clark & Siirila, 2000). It has been designated as PSSA by IMO. Traditionally, the reef area has been subjected to use by indigenous peoples for their living, culture and lifestyle. The Reef supports sustainable tourism, recreation, fisheries, shipping and employment in the area. In the 1960s, the intensity of the above activities including a proposal to drill oil and limestone mining was increasing. Deforestation and other developments also negative impact on the coast (Salm, Clark & Siirila, 2000).

To address the above problems, the Federal Parliament of Australia decided to establish Great Barrier Reef Marine Park (GBRMP) in 1975. The Act establishing the park area banned oil drilling and mining of limestone in the area. The GBRMP has special characteristics, which distinguish it from other MPAs in the world. These features are the provision for multiple use consistent with a conservation regime of the entire reef and the designation of an independent statutory authority (GBRMPA) to manage the entire park (Clark, 1998; Salm, Clark & Siirila, 2000). This is very effective and a factor to the success of the GBRMP. Zoning of the Marine Park provides a basic framework for effective management. The goals include:

1). Designation of "representative areas" for protection like flora and fauna refuges and scientific research sites;

2). Conservation of vulnerable habitats and species from damaging impacts e.g. eliminating trawling from coral reef fishing;

3). Conservation of biodiversity especially threatened and vulnerable species (Salm, Clark & Siirila, 2000). The Authority on inception was focussing its attention on establishment and management issues. This focus was later turned to resolving critical issues such as water quality problem from agricultural run-off, consequences of fishing, impact and management of tourism and conservation of biodiversity especially threatened or vulnerable species (Clark, 1998).

Another example of national legislation is from Canada. Canada is another good example with national legislation in place for the establishment of MPAs. Canada has the longest coastline in the world with the associated marine resources and ecosystems. This prompted a proper management of the ocean and its resources by

the Canadian national government. Canada's Oceans Act of 1996 provides the Department of Fisheries and Oceans, the authority to develop and coordinate federal marine protected areas programmes as one of the strategies for ocean management (Canada's Oceans Act, 1996, Article 35). The national government under various agencies has established some protected areas in its oceans in response to growing international and national concern. The established protected areas include marine parks, national wildlife areas and whale sanctuaries and areas closed to fishing for conservation purpose. However, plans have reached an advanced stage for the establishment of an MPA at the Sable Gully on the East Coast (offshore). MPAs establishment is the responsibility of the three federal agencies. These agencies are Canadian Heritage (CH), Environment Canada (DOE) and Fisheries and Oceans Canada (DFO) (Oceans Canada Library, 2002).

DFO has the responsibility of establishing MPAs in Canadian waters for conservation purposes of the resources and habitats including marine areas of high biodiversity or products. A number of protected areas have already been recognised in Canada from the Oceans Act, 1996. Fathom Five (130 km^2) in Georgian Bay was the first to be established in 1987. The national marine conservation area programmes extended to other areas like Gwaii Haanas and St Lawrence. Gwaii Haanas has a protected area of 3050 km^2 and it is located on the Pacific coast (off the Queen Charlotte Islands of Bristish Columbia). St Lawrence, on the other hand, covers an area of 1,138 km^2, sited at the confluence of the Sagueney River and St Lawrence Estuary (Oceans Canada Library, 2002). There is another one in the Pacific Rim National Park. It covers 200 km^2 and represents the Vancouver Island Shelf National Region (Oceans Canada Library, 2002). This Section 3.3 has provided all the necessary legal framework or concepts for the designation of marine protected areas. The next section will be dealing with the role of MPAs and implementation issues.

3.4. The need for Marine Protected Areas

3.4.1. Introduction

The decline in productivity and biological diversity of marine ecosystems as a result of human activities discussed in Chapter two triggered the establishment of MPAs to conserve and restore biodiversity. Table 1 shows different types of protected areas that could be established. MPAs are established to perform multiple functions leading to an optimum, efficient and sustainable use of coastal and marine resources. A wide range of roles has been suggested. These include the maintenance of biodiversity; protecting endangered and threatened species; conservation of habitats, ecosystems and maintenance of ecological processes; enhancing fisheries (fishery management); providing opportunities for education and research; conservation of cultural heritage; enhancing recreation and tourism potentials; social and economic benefits (Cocklin et al., 1998; Salm, Clark & Siirila, 2000; NRC, 2001). This section discusses these roles, looks at the preliminary process and operational criteria of MPAs site selection.

3.4.2. Roles of Marine Protected Areas

3.4.2.1. Maintenance of biological diversity

For the purpose of this study, marine biodiversity is simply a variety of life forms including species, communities or populations in the sea. The 1992 United Nations Convention on Biological Diversity objectives (i.e. maintenance of biodiversity) may be achieved through MPAs. This goal is possible through MPAs provided they are selected in a way that ensures preservation of important types of habitats and interdependences (Gislason et al., 2000). Many fish species do provide important pharmaceutical ingredients or supporting life in one way or the other. The conservation of such important species is necessary to secure food, fiber, drugs and used for research purposes (Salm, Clark & Siirila, 2000).

3.4.2.2. Protecting of specific endangered and threatened species

The creation of marine sanctuaries near South Africa, Brazil and the Southern Ocean protects whales from extinction (Environmental News Service, 2000). MPAs serve in a similar capacity for most vulnerable fish species from being extinct due to trawling and long line fishing. Fish species at risk include giant totoaba (Totoaba macdonaldi) and barndoor skata. According to National Research Council (2001) totoaba was abundant in the Gulf of California and large quantities were landed, exported and partially used as fertilizer. The situation is near extinction now as a result of heavy fishing, loss of estuarine spawning grounds (e.g. diversion of river Colorado) and by catch of young ones by trawling for shrimp (Cisneros-Mata et al, 1997; NRC, 2001). The creation of MPAs is therefore a way to deal with ecological impacts that are costly and not reversible like species extinction and replacement of commercially important fish species (Sainsbury & Sumaila, 2001)

3.4.2.3. Enhancing fisheries (fisheries management)

MPAs are very important in controlling fish mortality especially sedentary species. This is mostly applicable where the techniques used in fishing are non selective. MPAs will help to reduce by-catch of non-target species. Non-mobile fishing gear is used in MPAs and this reduces the impact of trawling on the sea floor. The sea floor habitat and composition will in turn have a mature feature (Watling & Norse, 1998; Goni, 1998). Declaring Non-Fishing Zone (NFZ) within an MPA has numerous benefits to the fisheries and ecosystems. The benefits include increased abundance and particular fish size within the non-fishing zone; increased production of eggs and larvae that automatically is exported to adjacent fisheries. There is increased rate of success in fertilization as a result of density effect and the habitat is protected for spawning and settlement of eggs and larvae. Moreover, target species emigrate to adjacent fishing grounds and thus increase catch per unit effort (WWF, 1998).

According to WWF (1998) NFZ acts as insurance policy against other fisheries management failures. Any observed fishing in this zone is a clear evidence of breach

of regulation. However, due to increase in catches in the near vicinity (outside) the zone, the fishers may themselves enforce NFZ especially where an alternative source of income exists such as tourism. The above reasons may render NFZ easier and less expensive to enforce. NFZ can be designated as single protected area or zone within larger multiple use protected areas (WWF, 1998). Closed areas from fishing in a reserve are similar to NFZ, as they reduce the fishing rate by diverting fishing efforts to less abundance and vulnerable fishery zones instead of high density fish areas. Closed areas work well where the management option is that of limiting total catch or unregulated fisheries. An example is a large closed area on Georges Bank. This reduces fishing mortalities of cod and yellow tail (NRC, 2001).

3.4.2.4. Conserving habitats, ecosystems and maintaining ecological processes

MPAs are primary means of conserving habitats and by doing so preserving the ecosystems. This extends further to conserving species and genetic diversity. The maintenance of habitats such as estuaries, coral reefs and mangroves is essential for shelter and food supply to various stages of marine organisms and maintenance of ecological processes like nutrient cycling and biochemical processes. These processes are responsible for maintaining ecosystem integrity and productivity (Salm, Clark & Siirila, 2000; NRC, 2001). Marine protected locations in estuaries or coastal zones may exclude dredging, dock construction, pollution, ocean mining and other physical damages in coastal areas. The result is that such areas will develop a more robust stock that can be exported to areas outside the protected areas. There will be a general increase in forage species essential for fisheries. Marine mammals may grow faster and increase in biomass thereby supplementing the marine living resources as a food source (NRC, 2001).

3.4.2.5. Providing opportunities for education and scientific research

MPAs can also be used as reference sites or points for establishing sustainability indicators. The use of these areas is subject to indicators such as baseline data to be measured and the duration the area has been under protection (Dayton et al., 2000).

Others academic research opportunities of MPAs include applied research like resource management needs and biomedical applications of reef bio compounds or monitoring a particular activity such as coral bleaching. The specific merit for the use of protected areas as research sites is that it permits long term continuous on the same species or group of organisms and habitat with no disturbance (Salm, Clark & Siirila, 2000). MPAs can give an opportunity for training and research for scientists. Several MPAs have on-site interpretive centres or programmes for education. The programmes can be a guided tour such as walk through coastal wetlands. Educational materials are prepared at such centres for schools and recreational groups for lectures.

3.4.2.6. Conservation of cultural heritage

One of the main criteria in selecting a marine protected area is for the conservation of significance cultural sites. These are areas of distinct or unique features such as archaeological sites or areas with special history, sacred sites or places for traditional or cultural practices. For example, in 1862, the civil war vessel Monitor sank in the United States and for the purpose of protection the area was declared a national marine sanctuary (NRC, 2001).

3.4.2.7. Enhancing recreation and tourism potentials

"Protected areas are major attractions for tourists" (Anaya, 1998, p.335). The reason for the above statement is simply due to the fact that MPAs are very important and have naturally beautiful ecosystems and recreational resources such as beaches, coral reefs and sea going activities e. g. whale washing, swimming and fishing. For instance, the natural beauty, sand beach, reefs and rich history of Seychelles Island and Mauritius attract many Europeans to visit the island, relaxing in the sun at the water edge or going water sking (Salm, Clark & Siirila, 2000). There are enormous benefits derived from eco-tourism. These benefits include employment opportunities for the local people, revenue generation for the MPAs and encouragement of environmental education and conservation awareness for the public (Anaya, 1998).

3.5. Preliminary development of marine protected area

3.5.1. Introduction

There are numerous factors affecting the development of a marine protected area. These include the pre-implementation and the main implementation issues. The National Research Council (NRC) states that "as with any enterprise good design is fundamental for the success of marine protected areas" (NRC, 2001, p.97). The choice of the location for an MPA requires good ecological data and information as the basis for action. In most cases information that includes species distribution patterns, habitats and ecosystems over extensive sea regions is scanty or limited in purposes. However, the processes controlling or maintaining biodiversity (e.g. fish recruitment) and the ecological links with other areas is not sometimes fully understood. The solution to overcome the above setback is to carry out a biological survey including social and ecological information with focus on habitats. The area of surveys should be large enough to enable valid comparison for selection (Vanderklift & Ward, 2000).

There has been debate regarding the best size of MPAs. Some have the opinion that they should be as large as 70 % of the ocean habitat to prevent uncertainties (Lauck et al., 1998). Walters (1998) suggests that the sea should be treated as close to fishing as possible with few exceptions. This means a very limited fishing area should be considered at a time due to inability to provide accurate stock assessment. Further, Kenchington (1999), recommends that marine protected areas should cover completely or large part of the spawning or breeding areas of the target species for the purpose of protecting genetic diversity. The general suggestion for a global target is a marine protected area size of 20 % of the world's oceans (Schmidt, 1997).

The survey or data collection mentioned above should include oceanographic characteristics like bathymetry and hydrography. They are also critically important in the transport of organisms in and out of the protected area and should be considered during site selection for MPAs (NRC, 2001). The data so collected from

the survey should be statistically analysed (cluster or principle computer analysis), synthesized into an information base indicating where the resources are concentrated and their threat including anthropogenic activities and areas of conflicts. A system plan of the protected area should support strict protection of highly value ecosystems such as breeding grounds. The analysis of the data could be made simple by presentation of data on map overlays. Firstly, a base map is produced with suitable scale indicating seabed islands, coral reefs, fisheries ground and turtle beaches on transparencies. The transparencies are then overlaid to show resources concentration of resources in order to make an analysis using GIS systems (Salm, Clark & Siirila, 2000).

The traditional use of the proposed area for subsistence fishing should not be ignored during the choice of site for MPAs, because it will render the management plan unsuccessful. It therefore means that the factors for consideration should not be totally ecological but socio-economic aspects must be incorporated into the selection, design and management of MPAs for successful implementation (Kelleher, 1999; NRC, 2001). Furthermore, Beaumont (1997) noted that resources within protected areas are part of the economic, social and political system of the people in the area. Therefore, the involvement of the people directly affected in the establishment and management process is of paramount importance.

There is a great need to establish well-defined and clear objectives before the selection process begins (Vanderklift & Ward, 2000; NRC, 2001). This is due to the fact that marine protected areas aim at conservation of biodiversity as well as improvement of productivity. In this situation, the factors listed below for site selection has to be weighted or considered subject to which objective is applicable. For example, biodiversity being the objective will encourage the establishment of a marine protected area at site with no major threat because resources will be limited. This is different from the situation with productivity as the objective. Here, closing the most threatened area from fishing will be better than protecting an undisturbed area (Vanderklift & Ward, 2000).

Several strategies and tools are available to assist in the design and implementation of marine protected areas. These techniques can take into consideration uncertainties concerning biological processes or management implementation issues. The strategies include the Geographic Information System, remote sensing and others described in the following sections.

3.5.2. Geographic information System (GIS)

A GIS is a computer-based system capable of mapping, storing, retrieving and processing spatial geographical referenced data. It relates information from many sources. The source of information must be known and may be denoted as x, y and z coordinates of longitudes, latitudes, and elevation. GIS assists MPAs in the following ways:

1). To evaluate the condition of ecosystems by comparing data from previous years with recent data through map overlay. A case in point is overlaying maps of mangrove ecosystems for two different years can indicate the extent of destruction or growth rates;

2). The maps indicate land use activities, industrial effluent discharge points or pipes, navigational routes and fish species distribution;

3). It is an efficient tool for a coral reef ecosystem in developing environmental education programmes that emphasize the significance of coral ecosystems and the need for conservation;

4). It gives detailed characterization of marine fish habitats and predicts threats, develops management strategies for MPAs and finally supports long term monitoring and analysis of changes. The above input enables concrete conservation, management decisions and protection of marine protected areas (Salm, Clark & Siirila, 2000).

3.5.3. Remote Sensing

The need for important information concerning scale and location of habitats on the sea floor e.g. coral reef can be handled by the above sea floor mapping technique (remote sensing). This method uses a combination of remote-sensing techniques e.g. side- scan sonar and multi-beam echo sounding, direct sampling and visual observations through digital photography and image processing to characterize the sea floor and bathymetry (Todd et al., 1999). According to Schwab et al (1997), these techniques have the ability to provide rapid and very detailed view of the sea floor, major habitat types over large areas including the effects of human activities such as trawling or waste disposal. The equipment can also be used to monitor sustainable indicators e. g spatially distribution of major sea floor habitats (Gislason et al., 2000).

With enhanced resolution of multiple sonar sensors, higher data volume can be collected. This means that the resolution of sonar sensor is directly proportional to the volume of data. Further implication of this is the requirement for better and more efficient data processing and interpretation tools. The interpretation problem can be solved by the use of automatic processing techniques such as image processor and understanding the survey areas (Guillaudeux &Charlot, 2002). These statistically based analytical procedures assist data processors and scientists to process and interpret huge volumes of data from sonar imagery surveys faster. The new technique can also help in monitoring and controling fishing activities in and outside MPAs, e. g, advanced vessel monitoring systems used in the Great Barrier Reef, Hawaii and long fleet on Georges Bank (Anon, 2001).

3.5.4. Participatory Rural Assessment (PRA)

PRA is a “process of gathering and analysing from and about rural communities in a brief period (weeks)” (Salm, Clark & Siirila, 2000, p.102; Clark, 1998,p.60). It is sometimes referred to as Rapid Rural Approah. This is a forum of dialogue with the typical tradition of the coastal communities. The process should be activated in the

time period between the main survey and general interviews (Salm, Clark & Siirila, 2000). The interview can be done individually or in groups. The interview covers matters relating to social values, opinion, knowledge, socio-economic, cultural and ecological importance of the area. The relevance of these data is subject to the efficiency and judgement of the term in charge.

The term could be consultant (researchers) but it is adviceable to adopt a participatory approach for data collection. The later option is cost effective as sampling error and bias are reduced. There is also the merit of flexibility and close interaction with the people and thus a better understanding of their views and objectives. A participatory approach to mapping is very essential for PRA. Mapping should include the following social factors e.g. infrastructure, layout of the village, health and family size, population density; resources such as fisheries, land use activities and management of water-sheds. A feasibility study through transects either by the use of small boats or a walk to visit local fishing techniques should be conducted (Clark, 1998).

A similar approach is used under an IMO programme-PEMSEA or the Partnership in Environmental Management for the Sea of East Asia. GEF/UNEP/IMO regional programme having seen the complexity and the magnitude of environmental problem in the areas, decided to stimulate collective efforts, resource and skills inherent in the sector through partnerships involving the countries of the area. This enables the local governments to effectively manage coastal and marine resources and the environment through strengthening local capacity (GEF/UNEP/IMA, 2002).

3.5.5. Education and outreach

Public environmental awareness is very important in the conservation of resources in marine protected areas. The aim is getting information across to the public on the long-term benefits of conserving and sustainable use of resources. This can be done through the forum of environmental education of the public using public information systems such as television, video, radio, print media books and pamphlets, posters, print clothing, barges, entertainment e.g. drama, open meetings or environmental

education. Face to face interaction is the best at the beginning of the programmes (Clark, 1998; Salm, Clark & Siirila, 2000).

It is important to have feedback because this will enable the organisers of the programme to determine the effectiveness of the awareness programme. In addition, feedback is a good way of conveying the people's perception and understanding of or for the management. Environmental education has the objective of providing the local communities with detailed information on a conservation culture. This is to enable community members to make informed decision on sustainable use of marine resources. There is a need to use the language that is well understood by the audience, especially politicians and economists.

The programme design should start with capacity building to identify the main audience e.g. tourists, hotel owners, artisenal fishermen, and the politicians. Most politicians monitor and influence any activity in their constituencies. Furthermore, the programme should target changing attitudes and behaviours of the groups. For example, in the Philippines, the fishermen who had education on artificial reef construction and use increased their fish catches. They were able to solve or end the problem of dynamite fishing on corals (Salm, Clark & Siirila, 2000).

3.5.6. Scientific contributions

The scientist's role is important in the assessment of marine protected areas. They collect data and information through research and monitoring to enable them to advise on how relevant, reliable and cost effective MPAs are. Scientists also supply monitoring techniques to determine how changes and practices in the environment can attribute to protection measures in relation to other factors (Salm, Clark & Siirila, 2000). Kelleher (1998) indicates that scientists provide objective data to support the perceptions of resource depletion and degradation.

GESAMP (1996) identifies the main opportunities for scientific and technical input to the process of an MPA designation for effective implementation in marine

protection to include Environmental Impact Assessment (EIA), resource survey, simulation modelling, economic assessment and evaluation, legal institutional analyses, social and cultural analyses, management methodologies and public education materials. Scientists working with conservation programmes are advised to design their research by preparing concise statements of objectives for research and monitoring to clearly define parameters to be measured and reasons for such measurements, and to identify cost effective methods, facilities and personnel for success of the studies. It is encouraged for the scientists to work with conservationist and managers in formulating specific questions to be addressed by in scientific investigations (GESAMP, 1996). Baseline data and monitoring are required before commencement of marine protected area projects. This is to enable an assessment to be made and confirmation gathered on a project fulfilling its objectives. It is good to involve the community group in the research to avoid their denying the result (Kelleher, 1998).

3.5.7. Restoration

One of the goals of establishing marine protected areas is the restoration of the marine ecosystem. It is the responsibility of marine protected area planners or managers to identify degraded habitats within the MPA that are important for restoration. The cost or possibility of restoring degraded habitats is sometimes problematic. Some degraded habitats cannot be reversed or restored although habitats, like mangroves, can be replanted (Clark, 1998). Coral reefs that have been damaged by natural processes such as hurricanes, mining or anchorage will be difficult and expensive to restore. In this case the time of recovery will be long. Marine protected area managers should assign priorities and strategies for restoration of habitats where possible (Clark, 1998). Community involvement in the restoration programme will be very effective and cheaper than contract or consultant services. An example from the Philippines indicates that mangrove restoration by planting new seedlings by the community cost five times less compared to contract services. The actual figures were given to be US$ 80/hectares by community effort and US$ 400/hectares by contract service. The community service has added advantage in

terms of caring for the new plantation as their right and product of their labour (Clark, 1998; Salm, Clark & Siirila, 2000).

Similarly, sand budget approach can be used to restore degraded beaches or dunes. It involves similar dealing as with cash flow in the bank account. The banking terms in this connection include debits and credits plus cash reserves or savings. In the context of the sand budget approach debits refers to erosion while credits imply accretion. Erosion (debits) involves sand being transported away from the beaches or dunes. They include wind, longshore (down drift) current, mining, solution and abrasion. Accretion (credits) on the other hand, involves sand deposit on the beaches by river transport, onshore transport, biogeneous, hydrogeneous deposits and beach fill. Sand storage (reserves) is mainly accumulation of sand dunes, bars and offshore sinks (Clark, 1998; Salm, Clark & Siirila, 2000).

3.5.8. Coastal Zone Management (CZM) or Integrated Coastal and Ocean Management (ICOM)

CZM or ICOM programme is known to be critically important for success of MPAs. It addresses an interconnectivity form of marine ecosystems and uncoordinated jurisdiction between national agencies (GESAMP, 1996). Estuaries are very productive habitats but also present complex problems due to many developmental projects such as ports and jetties constructions there. MPAs at such locations cannot succeed independently and therefore should be integrated into CZM or ICOM programmes (Salm, Clark &Siirila, 2000).

Where MPAs are established in isolation there are many impacts from outside the boarders beyond the control of the authority in charge of the protected area. This will disrupt the programme success and effectiveness (Allison et al., 1998). In CZM or ICOM, there is zoning of influence next to the boarder of the protected area. This zone buffers the protected area from external impacts such as pollution. In Malaysia, increasing tourism development is causing sewage pollution and run-off from the areas used for golfing thus impacts a negative on protected areas. There has been an

effort by WWF, Malaysia to persuade federal and states management and islands associated with marine protected areas to be integrated into state parks (WWF, 1998). MPA process can serve as a project to trigger broader ICOM or CZM process or it can be an aspect of existing process.

3.6. Operational criteria for Marine Protected Area site selection

Having completed the preliminary work, the following guidelines, factors or criteria can be considered in the selection or determination of boundaries of MPAs. These include the following: biogeographic and ecological criteria; naturalness; economic, social and scientific importance; international or national significance; practicality or feasibility; duality or replication plus regional criteria (Agardy, 1997; Kelleker, 1999; Salm, Clark & Siirila, 2000; NRC, 2001).

3.6.1. Biogeographic criteria

This involves the selection of an area with the presence of rare biogeographic habitats "type" or types. However, the geological characteristics of the area should be unique or have unusual features or rare characteristics to qualify for selection (Kelleher, 1999)

3.6.2. Ecological importance

The value of an ecological site can be assessed in the following ways:

1). Positive impact of the area in maintaining ecological processes or life support systems. Such life support systems include larva or juvenile supply to the downstream vicinities.

2). Integrity of the area as an effective functional unit. In this case the area can be either ecologically self- sustaining or jointly with other protected areas as one ecosystem.

3). Productivity of the area as a nursery or juvenile grounds, spawning, feeding or rest areas for organisms like birds and containing diverse species. The area must also

contain a variety of habitats, rare or endangered species and the habitat must be unique and rare for species (Agardy, 1997; Kelleher, 1999;Salm, Clark, & Siirila, 2000).

3.6.3. Naturalness

The candidate site should meet the above criteria. In the case of naturalness, there should be no disturbance or degradation of the area by any anthropogenic activities. A high degree of an area's naturalness places the area on high priority for selection as protected site (Kelleher, 1999)

3.6.4. Economic factors and social importance

The economic factors can be evaluated in the following ways.

1). The extent to which protection will have an impact on the local economy. Tourism development, feeding and breeding areas of commercial fisheries or recreation areas or traditional use have positive effects and higher ranking for selection.

2). Estuaries, reefs or wetlands are critical breeding and nursery sites for many fish species. Such areas will be rated high and deserve selection for protection.

3). The traditional and subsistence use of the area by inhabitants may warrant the choice of such site for protection too (Agardy, 1997; Kelleher, 1999; NRC, 2001).

Social importance consists of both the social and cultural benefits of a particular area to local, national or international communities. The values can be derived from its heritage, cultural, aesthetics, education or recreational qualities including traditional historic values of the place. Aesthetics is considered in terms of seascape, landscape or any other area of natural beauty and should be given top priority. Such areas can have high value for recreation and tourism. Natural areas that have important cultural features such as religious, historic and artistic should be given high priority. It will be supported by the local people for the protection to maintain the integrity of

the adjacent ecosystems (Agardy, 1997; Kelleher, 1999; Salm, Clark &Siirila, 2000; NRC, 2001).

3.6.6. Scientific research and education

Areas that have many ecological features that can serve research, monitoring and educational purposes are good candidate sites for selection. There may be ongoing research projects or regular monitoring, surveys or even previous work in the area. The site should also be sufficiently large to serve the conservation and teaching purposes in terms of field studies or on-site studying centres for training and demonstrations (Kelleher, 1999; NRC, 2001).

3.6.7. International or national importance:

This is the potential of an area to be declared as Biosphere Reserve or World National Heritage or is a subject of national or international conservation agreement. Such areas have high priority for selection as marine protected areas (Kelleher, 1999).

3.6.7. Practicality/ feasibility factors

This involves social and political acceptance. This is very important because the success of the management of MPAs depends on the support and degree of acceptance by the local people. If there is an area already protected by the people's tradition, this should be reinforced and such areas will receive high ranking for official selection and protection. The official status is for the purpose of government (political) recognition of such area. For example, a sacred forest on Chale Island in Kenya was approved by the government for development of hotels, notwithstanding the protection status of the forest by the local people for hundreds of years (Salm, Clark & Siirila, 2000). Feasibility and ease of implementing existing management programmes effectively should be compatible with uses. It should also be accessible for education, tourism and recreation. The extent of prevention of the site from

threats, such as direct exploitation and development projects is very important when selecting a site (Kelleher, 1999; NRC, 2001).

3.6.8. Duality or Replication:

There can be more severe human impact or natural events (e.g. cyclones on coral reefs) on small size marine protected areas. This therefore calls for replication of such habitat or ecosystems in a marine protected area to qualify for selection (Kelleher, 1999).

3.6.9. Regional criteria

This is the degree of which an area has regional natural characteristics, an ecological process, cultural site or other shared resources. It can be in terms of contribution of nutrients, support of species such as migratory species within the region. Such areas are maintaining the species or ecosystems and should have high priority for selection under regional agreements (Salm, Clark & Siirila, 2000).

CHAPTER FOUR

NIGERIA: A CASE STUDY

4.1. Introduction

The coastal zone of Nigeria has numerous valuable ecosystems such as estuaries, mangroves, wetlands, and sand beaches. These ecosystems and their associated habitats play an important role in protecting biodiversity and in the nation's economy as in other parts of the world. The coastline is under unusual pressure and threatened by human activities such as shipping, oil exploration and exploitation, constructions of ports and harbours, fishing and natural processes e.g. coastal erosion enhanced by human activities.

For the purpose of achieving ecological, socio-economic, scientific, educational and cultural benefits, the objective of protecting biodiversity and promoting sustainable use of resources, there is a great need for the establishment of marine protected area (first of its kind) for effective management of the Nigerian coastal resources. This chapter briefly introduces the topography of the Nigerian coast, discusses the relevant management and maritime zones, coastal uses and interactions with examples of conflicting issues. This chapter and chapter five finally addresses the development of marine protected areas regime for Nigeria.

4.2. The Coast of Nigeria

Nigeria is located on the west coast of Africa and has a total land surface of approximately 923,768 sq km. The population was estimated at 95,223,521 at mid 1995 with a population density average of 105.2 per km ^{2} (Mabogunji, 2001). According to International Oceanographic Commission (1994), about 20 % of the national population live within the coastal zone while the industrial activities within the zone is about 50 % of the national industrial activities. The shoreline between the Republic of Benin and Cameroun Republic includes a total of 800 km of shore area that opens to the Atlantic Ocean. This coastline is adjacent to the Gulf of Guinea and lies between $4^o 10'$ and $6^o 20'$ North Latitudes and $2^o 43'$ and $8^o 32'$ East Longitudes. The major features of the Nigerian coastline include the following: extensive beach areas, barrier ridges, a major deltaic complex, estuaries, tidal inlets and flats, lagoon, wetlands and swamp vegetations

The River Niger is one of the main rivers in Nigeria. It is the third longest river in Africa and the ninth large drainage area in the world's river with 2.23 mill. km^2 (Rangeley, 1994; Moffat & Linden, 1995). River Niger originates from the Fouta Djallon mountain of Northern Sierra Leon. Another river is the Benue which rises from the Cameroun Mountain and flows in southwesterly direction into the Niger. The main tributaries of the Niger within Nigeria include Sokoto, Kaduna, and Anambra rivers. Other important rivers in Nigeria are Ogun, Oshun, Imo and the Cross river. All of them drain into the Niger delta which is one of the world's largest wetland, comprising 20,000 km^2 in southeastern Nigeria. Moreover, all the rivers are open to the Atlantic Ocean through lagoons systems. The rivers supply sediments into the Niger delta flood plain especially during flooding. On the other hand, erosion is constant along the coastline. The construction of dams upstream of the Niger decreases sediment supply to the delta leading to severe coastal erosion and lost of habitats. The dams later resulted in siltation of rivers with flooding as the result (Moffat & Linden, 1995).

The Nigerian coast has a low-lying topography. According to Nwilo and Onuoha (1993), the mud coast around Benin revealed the height of 0.8-1.8 m above the mean

sea level with 1.5 m tidal range. This area suffered from serious flooding during spring tide conditions (Nwilo & Onuoha, 1993). The Delta consists of 20 barrier islands and has a maximum of 2-4 m height above the mean sea level. This indicates that Victoria Island (Lagos), a reclaimed area, directly facing the Atlantic Ocean on 2.5-3,5 m above mean sea level will be flooded during storm surges (Nwilo & Onuoha, 1993).

There are four major ecological zones viz: fresh water flood plain, brackish water mangrove swamps and the marine backed beach barrier island and the lowland rainforest (Moffat & Linden, 1995). The physiographic setting and the distribution of ecological zones of the Nigerian coast are shown in Figure 1.

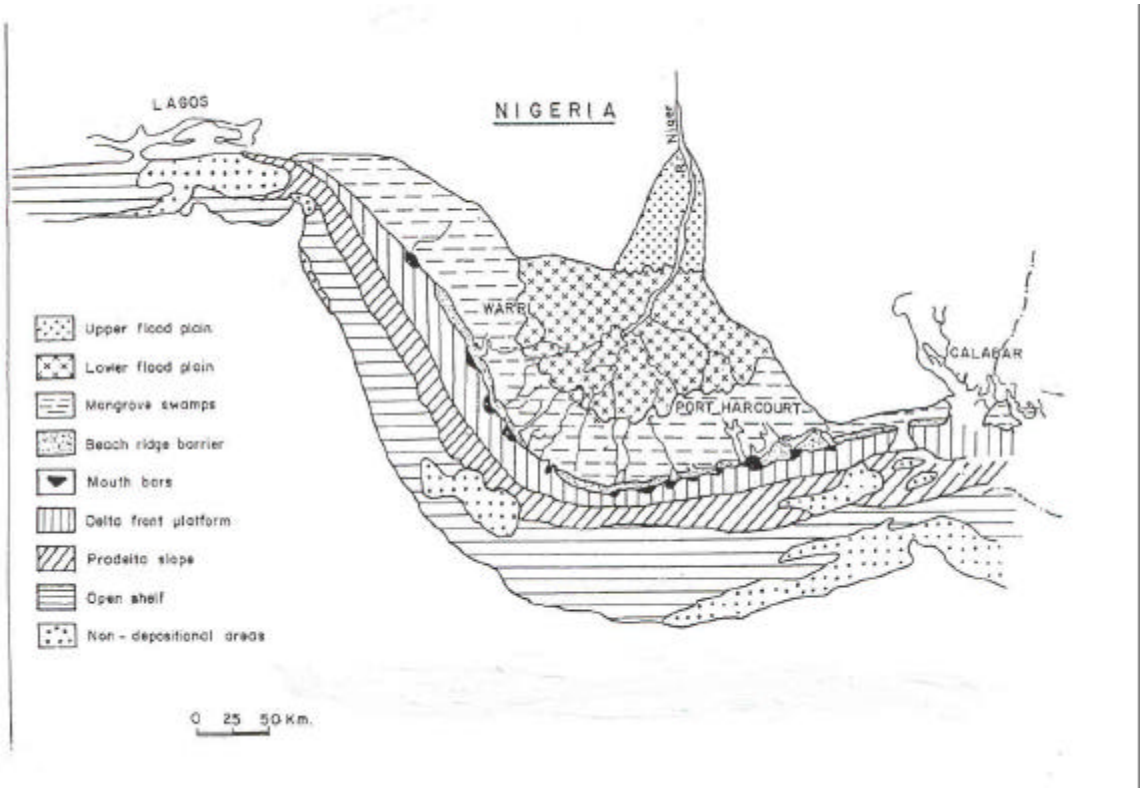

FIGURE 1: **PHYSIOGRAPHIC SETTING AND DISTRIBUTION OF ECOLOGICAL ZONES ALONG THE NIGERIAN COASTLINE**

Source: Antia & Nyong, 1985

The mangrove swamps are extensive and very pronounced around the eastern flank of the Niger Delta between Wari and Calabar. The mangrove ecosystem here is directly facing the sea especially around the Cross River Estuary, Calabar (Nyong & Antia, 1985). According to Moffat and Linden (1995), the mangrove forest of Nigeria is the third largest in the world and the largest in Africa. These authors state that fresh water swamp forests are equally large to the extent of 11,700 km^2. Futhermore, they indicated that degradation of the forest zone is mainly due to logging and agricultural practices. The ecology of the barrier islands in the delta area is the smallest and intact with high biodiversity (Moffat & Linden, 1995)

The climate of the Nigerian coastal region is mainly that of the equatorial hot and humid climatic conditions. The annual temperature is within the range of 26-36^o C. The highest is in the dry season, November-March (Nwilo & Onuoha, 1993). The peak of the rainy season is April-October. This is the time of the highest tropical storm frequency. Rainfall of 50 mm/hour is frequent in the months of July through August. The result of heavy rainfall is flooding and erosion in the area. This will also increase river discharge and surface runoff from agricultural lands and industrial areas to the seas thus increasing pollution. This calls for integrated management approach of the land-based activities with the ocean activities. The average rainfall is between 350-600 cm. The south west trade winds from the Atlantic Ocean brings rain to Nigeria and dorminate throughout the rainy season while the dusty north east dry winds from Sahara Desert brings harmatan and hazy weather condition to the coast (Ibe et al, 1985)

4.3. Nigerian maritime zones

Nigeria is a party to the United Nations Convention on Law of the Sea (UNCLOS), 1982. In order to comply with the Convention, Nigeria has established national legislation on maritime zones or boundaries in accordance with UNCLOS 82. Parties to UNCLOS have certain exclusive and jurisdictional rights within the Territorial Sea, Contiguous Zone, Exclusive Economic Zone and the Continental Shelf delineated by the members. The exclusive rights pertain to the control of

natural resources while jurisdictional rights concern the sovereign authority of the coastal state to regulate activities within those zones. The rights and obligations are clearly spelt out in the Convention. UNCLOS defines the internal waters as waters on the landward side of the baseline. There are two types of baselines. These include the normal baseline and straight baseline system. The normal baseline is applicable to Nigeria. UNCLOS Article 5 defines the normal baseline as "the low-water line along the coast as marked on large-scale charts officially recognised by the coastal State" (UNCLOS Article 5, 1982).

4.3.1. Territorial Sea

The Territorial Sea of Nigeria consists of a belt of water with the breadth up to a limit not exceeding 12 nautical miles measured from the based lines i.e. low water line along the coast. The 1998 Territorial Sea Decree amended the limit from thirty nautical miles in 1967 to twelve nautical miles (Territorial Water Amendment Decree, 1998). Nigeria exercises sovereignty over the adjacent belt of the territorial waters. This sovereignty extends to the air space, seabed and the subsoil of the territorial sea. It allows innocent passage to ships of all states whether coastal or land-lock over the territorial sea

4.3.2. Contiguous zone

The contiguous zone of Nigeria is a zone contiguous to the territorial sea over which Nigeria may exercise control necessary to prevent infringement of its customs, fiscal, immigration or sanitary laws and regulations within its territory or territorial sea. Nigeria can punish infringement of the above laws and regulations committed within its territory or territorial sea. The contiguous zone of Nigeria consists of the water bodies not extending beyond 24 nautical miles from the baseline from which the territorial waters are measured.

4.3.3. Exclusive Economic Zone (EEZ)

The Exclusive Economic Zone of Nigeria consists of an area of sea extending from the external limits of the territorial waters of Nigeria up to a distance of 200 nautical miles from the baseline from which the breadth of the territorial waters of Nigeria is measured (Exclusive Economic Zone Decree, 1978).

Nigeria exercises sovereign rights in terms of exploration and exploitation, conservation and management of both living and non-living resources of the waters superjacent to the seabed and of the seabed and its subsoil. These rights also include other activities for economic exploitation and exploration of the zone like production of energy from water, current and wind. In terms of the living resources, Nigeria determines the total allowable catch (TAC) of the living resources and ensure through proper conservation and management measures that living resources are not endangered by over exploitation. Where Nigeria cannot harvest the entire allowable catch, it is obliged to through agreement or arrangements give other states access to the surplus of the allowable catch to avoid waste. Provisions are made for developing countries of the region and especially land-locked states to be given preference to participate in the surplus of the allowable catch.

For the purpose of exploring, exploiting, conserving and managing the natural resources of the zone, Nigeria or appropriate authority designated on behalf of the Nigerian government has the jurisdictional right to regulate by law, establish or permit the establishment, operation or use by any person subject to certain conditions as the following:

1). Artificial island
2). Installations and structures
3). Marine scientific research and
4). Protection and preservation of the marine environment.

Ships are prohibited from entering such designated areas and installations subject to exceptions provided in the Gazette (Exclusive Economic Zone Decree, 1978). The master of any ship in violation of the above regulation is liable to a fine or

imprisonment or both unless proved otherwise e.g. having no knowledge of such provision by the master (Exclusive Economic Zone Decree Article 3 (3), 1978). Other rights and duties in the Nigerian Exclusive Economic Zone include those provided for under international law. For example the six traditional high seas freedoms including navigation, over-flight, the laying of submarine cables and pipelines are enjoyed by all states. Others are fishing, construction of artificial islands and installations and marine research mentioned previously.

4.3.4. Continental shelf

According to the Nigerian Petroleum Decree No. 51 of 1969, the continental shelf means the seabed and subsoil of submarine areas adjacent to the coast of Nigeria, the surface of which lies at a depth no greater than 200 metres (or where its natural resources are capable of exploration, at any depth) below the surface of the sea, excluding so much of those areas as lies below the territorial waters of Nigeria (Petroleum Decree, 1969).

The above definition clearly reflects the Geneva Convention on the Law of the Sea of 1958. There are two basic ways of determining the outer limits of the continental shelf. These are the depth criteria under the 1958 Convention, i.e., 200 m depth limits and exploitability criterion. It is important to note that in the depth criterion, there is no reference to baseline or seaward distance from the baseline (neither natural prolongation of land territory) as contained in UNCLOS. Furthermore, the exploitability criterion has no definite limits. This implies that coastal States can claim continental shelf up to any distance from its coast provided they have the capability to exploit the resources. There was a serious concern and reconsideration of the continental shelf definition at the third UNCLOS due to improved exploration and exploitation technology plus uncertainty in the former definition (Mukherjee, 2002).

4.4. Coastal uses in Nigeria

Coastal activities or uses in Nigeria have been increasing and include fishing and aquaculture, shipping, tourism, the laying of cables and pipelines and scientific research. Many up land activities have direct impact on the coast and linked to the above coastal activities. These are agriculture, river diversions and constructions such as roads and human settlements.

4.4.1. Oil industries

Most industrial activities along the Nigerian coast are oil related operations. Oil exploration and exploitation activities are undertaken both onshore and offshore in the territory of Nigeria. Currently, no less than five oil terminals are located along the 800 km coastline. These are Qua Iboe, Brass River, Pennington, Forcados and Escarvos oil terminals (Figure 2). Apart from the ecological instability caused by heavy mechanical installations and operations, there are dramatic impacts of oil spills on the coastline with reduction in recreation/tourism potentials and destruction of sensitive marine ecosystems.

According to Moffat and Linden (1995) the estimate of oil spills in Nigeria per year has been approximately 2300 m^3 in 300 separate incidents. The resultant impacts include death of sea birds, increased concentration of hydrocarbons in the water and bottom sediments that affect pelagic and other fauna and most importantly fishing grounds. The impact of oil spills was discussed in more detail in section 2.3 (under shipping activities) of this work. It is interesting to note that in Nigeria, sabotage is one of the main causes of oil spillage due to negligence of the communities by the oil companies and government. Another problem from the oil industries such as Shell Petroleum Company of Nigeria has been the destruction of mangrove ecosystems. It has been estimated that Shell has destroyed about one percent of the mangrove forest by seismic lines in the rivers and about similar percentage in Delta state (Moffat & Linden, 1995).

4.4.2. Fishing and aquaculture

Fishing has been a very important economic activity in the rural riverine communities of Nigeria. The greater percentage (about 80 %) of fish supply in the Niger delta area came from about 400,000 local fishermen. According to Moffat and Linden (1995) the Maximum Sustainable Yield (MSY) of fisheries in the country has been estimated to be about 240,000 tonnes and that MSY was exceeded since 1995. However, it is problematic to estimate MSY accurately due to the lack of accurate data on catch, effort and standing stock in Nigeria. Fish stock such as sardines, snappers, croakers and mackerels have declined with corresponding decreased in size of most commercial fishes in the Niger delta. The reasons for that decreasing tendency in fisheries include over exploitation of juveniles (Niger Delta Wetlands Centre, 1995).

Dams construction on the River Niger was also identified to be responsible for the reduced fish and shellfish stocks of the coastal water. The dams also reduced floods and nutrients thereby lowering the productivity of the systems, which are normally stocked by fish larva during flood seasons.

Aquaculture practice is increasing slowly in the Nigerian coastal environment. Almost all the oil companies (e.g. Shell) have established fish farms in their operational areas as community development projects or local benefits. Privately owned fish farms also exist around the Nigerian coastal zone. This results in the destruction of mangrove ecosystems and other associated problems discussed earlier in Section 4.4.2. However, deliberate introduction of alien species through aquaculture farms is an issue that need attention. The recent Cartagena protocol on Bio-safety should be ratified by Nigeria.

4.4.3. Shipping

The density of marine traffic especially oil tankers in the near shore of Nigerian waters is high. Operational discharge from tankers is another source of pollution in the Nigerian coastal environment. Despite the fact that many oil tankers are

transporting oil from Nigerian oil terminals and recently gas from the Bonny terminal in Port Harcourt, no accident has been reported in the area. The high rate shipping activities are mainly due to Nigerian port operations for importers and exporters at Apapa, Tinkan Island of Lagos; Onne, Okirika and Bonny in Port Harcourt and Calabar ports. Figure 2 shows the location of Nigerian ports and oil terminals along the coastline. Oil company's shipment of their materials and equipment, oil and gas lifting by large tankers, fishing vessels, municipal ferries and private speed boat services plus naval vessels are on constant operations in the area. There is no VTS to monitor and control shipping activities in the area to prevent collision and related incidents. All the environmental problems associated with shipping such as introduction of harmful aquatic organisms are applicable here.

4.4.4. Cables and pipelines

Cables and pipelines for telecommunications, movement of gas and crude oil also require space in the coastal zone. They are laid or embedded in coastal sediment to avoid damage. This piping systems transports crude oil, gas and telecommunication from the offshore sector of the companies to land stations, tank farms and refineries and have negative impacts on ecosystems.

4.4.5. Scientific research

Universities and research institutes are involved in various research activities in the coastal waters of Nigeria. This research is aimed at survey, analysis and monitoring of changes in the environments and the estimation of the effects of these changes. It may also involve the study of fluctuations and the status of the environment and human impacts. For example, marine research within the Nigeria coastal waters has been the focal point of the Institute of Oceanography, University of Calabar. Monitoring programmes on long-term basis include productivity and evaluation of toxic organic pollutants at strategic locations along the coast.

4.4.6. Tourism

Tourism and recreational activities are increasing especially around Badagry, Victoria and Ibeno beaches of Nigeria. The developments around these beaches are relatively low quality service with few infrastructures. Standards in the last few years due to rapid increase of revenues accruing from the sector have improved.

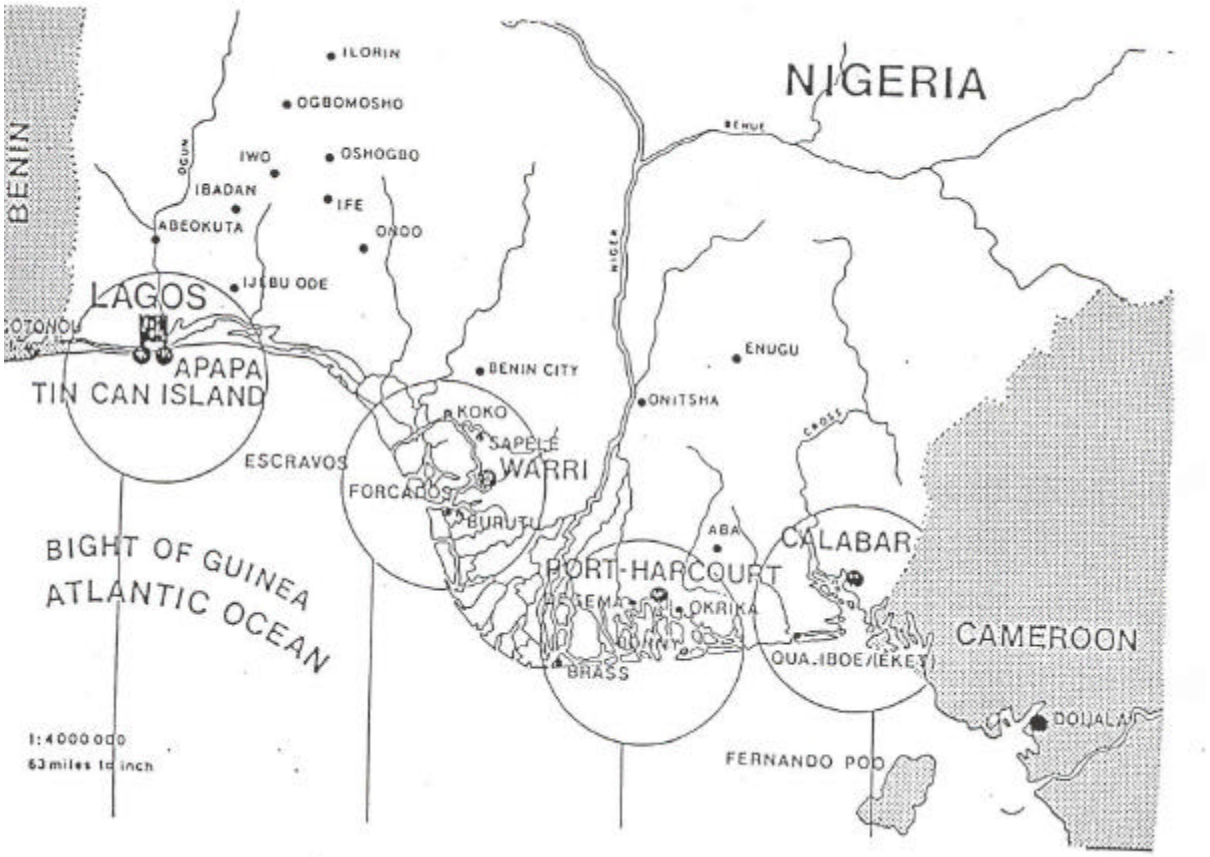

FIGURE 2: MAP OF NIGERIA SHOWING THE LOCATION OF PORTS AND OIL TERMINALS

Source: NPA Plc, Bilingual magazine (as cited in Maduka, 1995)

4.4.7. Mining activities

There are increasing activities of land and coastal mining for sand. Seabed sediments and coastal sand are important economic activities in the coastal area of

the country. These are used as materials for building, construction of roads, offshore and related structures such as jetties. These alter the coastline by changing the direction of wave and current patterns.

4.4.8. Conservation of nature

Nigeria does not have any marine protected area that could assist to address some of the marine environmental degradation problems. It is noteworthy that all the threats to marine ecosystems discussed in Chapter 2 of this dissertation are similar and applicable to the coastal and marine environment of Nigeria. This therefore calls for the establishment of marine protected areas similar to the terrestrial counterpart to conserve marine biological resources. The lowland forest of Nigeria is intact due to the fact that it is one of the world Biosphere Reserves. Omo Biosphere Reserve is a tropical humid forest (terrestrial) with a core zone of 800 hectares, a buffer zone of 14,200 and a transition zone of 145,600 hectares making a total area of 130,600 hectares (UNESCO, 2002).

4.5. Conflicts and interactions among coastal uses in Nigeria

The activities of the coastal users discussed in Section 4.4 affects each other and the environment. The impacts may be negative or positive and sometimes resulting in conflicts between users of the coastal zone or coastal resources. There have been serious conflicts concerning resource use rights and uses in the Niger delta area. The important and frequently occurring conflicts have been between the local communities and oil companies. Oil is the most valuable resource available in the Niger delta and the main stay of the nation's economy. This implies that Nigeria has virtually been sustained from crude oil exports. However, the benefit accruing to Nigeria from export resources from the Niger delta area is not clear to residents Moffat & Linden, 1995).

The oil exploration and exploitation activities both onshore and offshore are increasing rapidly so that the ecological and environmental degradation are linked to the oil companies by the communities. The impacts and degradation include decline

in fisheries and agricultural productivity. Although other factors such as dam construction might have been responsible for those impacts, the oil company's activities are often alarming. The companies are not accountable to local communities and sometimes there is no communication, coupled with insufficient compensation and social development activities, raise more tension and conflicts in the communities (Moffat & Linden, 1995).

The communities are angry with the oil companies due to the severe impact of their activities leading to damages to fisheries, crops and in the case of gas flaring causing damage to roof tops. This has resulted in clashes with oil companies, personnel and even police especially in the Ogoniland of Rivers state (Port Harcourt). The problem has extended over the entire Niger delta region, a way of expressing frustration of unfair distribution of oil income and costs of damage (Moffat & Linden, 1995). According to Cicin-Sain and Knecht (1998), petroleum production activities can affect fisheries in three ways resulting in conflicts. The effects according to these authors include reduction of fishing space, pollution and the disruption caused to the sea floor through debris. The impact of pollution and mining activities including sedimentation has been discussed earlier in this dissertation.

Shipping, harbour constructions, tourism, fisheries and aquaculture may conflict and interact with each other in various ways. Activities like space occupancy, noise and vibration from passing ships and speedboats through inshore waters may restrict the expansion of aquaculture. Harbour construction/expansion and dredging have significant negative impacts on fisheries and environmental quality. The result is reduction in nursery areas for important fish populations. The rapid expansion in harbours and increased number of marinas to meet the increasing need of tourist and recreational activities has taken over important ecological areas for fish stock recruitment or aquaculture development. Cicin-Sain & Knecht (1998) states that the navigational dredging and port expansion have severe negative impacts on other coastal uses especially fishing, aquaculture development and the general environmental quality leading to conflicts.

The discharge of ballast water from ships has been linked to the transfer of virus, bacteria, parasites and others toxic organisms that have impact negative on the native organism e g. fish. The potential impacts of some exotic species have been dealt with in Section 2.3.3 of this work. Common fouling organisms on ship hulls are transferred and distributed to other parts of the world including Nigeria. In the Nigerian coastlines, an exotic plant called Nipa palm is very conspicuous. It was first observed around Calabar in 1906 (Moffat & Linden, 1995). The source was not known at that time but recent studies have shown that such foreign species are often transported around the world through ballast water from ships especially oil tankers. The plant has naturalised itself and is spreading at a very rapid rate replacing mangroves in most the areas.

This invasive plant has undertaken the creek of Calabar further east. It is fast growing and has been gaining grounds around Port Harcourt and Ibeno. The Nipa palm is moving with such rapidity that unless its presence is documented and checked as an ecological hazard, just like the water hyacinth, Nigeria may lose all its mangrove vegetation within the next decades (Umana, 2000). Apart from degradation of mangrove vegetation, the plant also reduced fishing yields. It should be noted that in South East Asia, Nipa palm is considered a resource with multiple uses (Moffat & Linden, 1995). In Nigeria, there is no definite use that has been attached to Nipa palm except the use by small riverine fishing communities in constructing their thatched houses.

Tourism also presents significant environmental problems. Tourists often see aquaculture as a source of pollution though they cherish the product. Tourist caused a lot of disturbances and noise and their activities have affected the water quality and there may be conflict over space or land usage. Aquaculture can benefit from tourist. It can attract anglers to fish in the farms. Fish can be supplied to the hotels/restaurants or sold to the tourist direct. Tourists have realised this fact and now revert to the concept of eco-tourism. This is aimed at low density, low impact use over large areas not concentrating on a particular beach of one city (International Council for the Exploration of the Sea (ICES), 1995).

The above interactions with all the threats to marine ecosystems discussed in Chapter 2, indicate that effective Coastal Zone Management or Integrated Coastal and Ocean Management is needed to address the broad social, conflicting and environmental issues of the Niger delta for sustainability of marine resources. The solution can only be achieved through the establishment of marine protected areas within an Integrated Coastal and Ocean Management regime in Nigeria. It involves basically multiple use zoning of the established marine protected areas to accommodate different users and uses. The benefit of multiple use zoning over single users (traditional sectorial approah) include the provision of framework for the resource conflicts resolution (Clark, 1997, Cicin-Sain & Knecht, 1998).

The protected area can be zone for the following uses:

1). Core protection zone as sanctuaries: These include sites with high species diversity or threatened species, critical habitats and for special research (reference). All kinds of activities are prohibited in such areas except special reference scientific research.

2). Incompatible use zone: In this case, activities that are not compatible with one another should be separated. For example recreational use e. g watching of birds should be separated to avoid conflicts.

3). Intensive or damage use zone: These are sites that can sustain such impact and use. Environmental impact assessment is necessary to ascertain the degree of impacts of different users (Kelleher, 1999; Salm, Clark & Siirila, 200). As noted earlier, the Great Barrier Reef Marine Park of Australia is a good example of MPA with multiple use zoning to reduce impacts on the sensitive zones. Marine protected areas conserve critical habitats, ecological processes and threatened species (see Section 3.4.2).

4.6. Cross River estuary: a proposed marine protected area for Nigeria

The Cross River Estuary (see Figure 3) maintains an exceptionally high level of biological productivity and plays other important ecological roles such as life support systems e.g. source of larva for the down stream areas. The estuary provides habitats

for most commercially and recreational valuable fish species in the area. As the estuary is the richest nursery or juvenile areas, feeding, breeding or rest areas for many fish and bird species, it deserves protection. Moreover, it serves the needs of migratory nearshore and oceanic fish species that require shallow (protected) habitat for breeding. The Cross River estuary is a traditional fishing site due to large availability of economic important commercial fish species. In terms of economic aspects, the beaches around the estuary are a potential attraction for tourists and therefore should be protected.

The Cross River estuary is also the focal point of the Institute of Oceanography, University of Calabar research programmes. This means that there exist information and data that will be needed for the protected area establishment at the estuary. The estuary encompasses other rich habitats such as the mangroves, wetlands, lagoons, beaches and mud flats ecosystems around it. These multiple ecosystems existing around the estuary perform numerous functions ranging from species abundance, research and educational purposes to the protection and stabilisation of the coastline. In light of the increasing depletion of mangrove forests and the adverse effect it has on coastal environments and climate change, it is necessary to establish MPAs for the protection of marine ecosystems and sustainable use of resources.

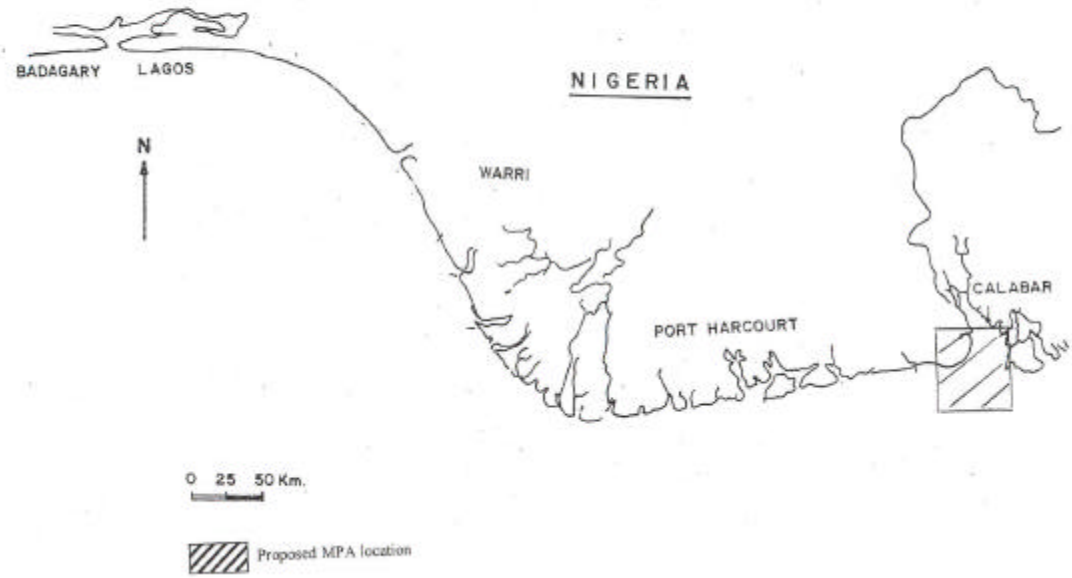

FIGURE 3: MAP OF NIGERIA SHOWING THE PROPOSED MPA LOCATION, CROSS RIVER ESTUARY.

Holzloehner (2000) has proposed that mangrove resource inventory should be conducted for update on the status and the development of a mangrove park at James Island of the inner Cross River estuary.

Although Cross River estuary is subjected to fishing and shipping activities since it is the only channel to Calabar Port, it could be made a protected area and the problems can be taken care of through the proposed integration and multiple use zoning of the protected areas for different users. In this case the entire estuary will be a management unit. Other functions of the estuary include the provision of crustaceans, shellfish, birds, mammals, reptiles, monkeys and others amphibians. The Niger delta in general is the most extensive and complex lowland forest and aquatic ecosystem in West Africa. The biological diversity in the area has a regional and global status (IUCN, 1992). A study by World Bank indicates that the delta contains great varieties of coastal and estuarine fauna and flora (World Bank, 1995).

CHAPTER FIVE
RECOMMENDATIONS AND CONCLUSIONS

5.1. Recommendations

The foregoing chapters have explained the use of MPAs as an important management option for the sustainable use and conservation of coastal and marine resources of a coastal nation such as Nigeria. Resource conservation is necessary for ecological, socio-economic, scientific, educational and cultural purposes.

Nigeria is a party to UNCLOS and the Convention on Biodiversity (CBD). These international conventions contain provisions and obligations for the establishment of the Marine Protected Areas by State Parties. For example, UNCLOS, 1982 Article 194 (5) provides that measures taken by States on the protection and preservation of marine environment "shall include those necessary to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered, species and other forms of marine life". Nigeria therefore has obligation to implement the Convention fully including a Marine Protected Area (or Areas) where appropriate. As pointed out in Chapter 3 of this dissertation, the designation of Marine Protected Area may pose some difficulties due to competing uses of the coastal zone especially oil companies, harbours and port operators, fishing, tourism to mention but a few. These issues notwithstanding, there must be positive steps taken to establish Marine Protected Areas for effective management of the Nigerian coastal and ocean resources.

In Section 3.5.7 of this dissertation, Integrated Ocean and Coastal Management (ICOM) or Coastal Zone management (CZM) was outlined as an important regime in which MPA can form an integral part. This means that the protected area should be

established as part of Integrated Coastal and Ocean Management programmes in Nigeria where the activities of users must be collaboratively managed through multiple use zoning. Under such a regime, every project or activity in the coastal area should be subject to Environmental Impact Assessment to assess the anticipated impact on the environment or other users of the coastal zone. In the case of the above regime, a system of MPAs can be used as an aid for conflict resolution (conflict management). This system will enable development in certain areas and conservation in others in a functional approach.

There must be direct public involvement in the implementation process and in deciding the coastal use of the protected area. MPAs may be for research, full reserves, recreation or subsistence. The participation of the public will better ensure compliance. In this situation the objective of the area is known. The size of Marine Protected Area must be large enough to accumulate uncertainties and zoning for the various users. In addition, the Marine Protected Area must be based on a sound legal regime with a well-defined objective

A concise definition of the boundaries of an ecosystem unit is very important for effective planning of sustainable utilization and management of marine ecosystems, activities and processes in the respective units. All the natural processes that affect the dynamics of the ecosystem must be included. Any attempt to exclude the interacting processes and users outside the limit or boundaries will result in a more complex situation thereby making management difficult or impossible.
Defining the ecosystem boundaries must incorporate natural characteristics such as topography, marine chemistry, physical oceanographic parameters and the flora and fauna distribution of the system. Social and economic characteristics of the unit may be regarded as being flexible components in terms of definition.

The following are some specific considerations for successful implementation of an MPA: 1). The criteria for selection of candidate sites must be based on ecological or biogeographical factors. Naturalness of the site, scientific or educational reasons will also necessitate the designation of protected area. Socio-economic factors for the site

selection should dwell on the impact that the MPA is likely to impose on humans inhabiting the area and their activities. Other factors for consideration must include national or international importance, practicability, regional factors and the replication i.e. the occurrence of more than one ecosystem such as coral reefs in a single proposed site. These criteria were discussed in Chapter 3.

2). MPAs must be based on sound scientific knowledge, where no or insufficient data is available; a survey of the candidate site must be intensively conducted and mapped out.

3). The type of protected area should be dependent on the objectives. It may be established with the objective as ecological reserves or ship source pollution prevention areas e. g Special Areas or Particularly Sensitive Sea Areas (PSSAs) under MARPOL.

4). It will be impossible for marine protected areas to be successful without proper funding and infra-structural resources. Governments after the initial stage of establishment may not be willing to continue funding activities in the area. This implies that there must be a mechanism put in place for financing an MPA. The best option is to develop fund or revenue generating programmes to make the MPA self-sustaining. An environmental fund can be created and demands for compensation can be made from polluters in case of any damage in the Area resulting from pollution. Tourists and visitors or even NGOs can be made to pay small amounts of money for the development and management of the Area.

5). There should be monitoring and enforcement of any regulation in place. Furthermore, the activity has to be monitored as a control and check to ensure success and compliance. There should be severe penalty for violations. The agency in-charge of enforcement must be given the authority to act, investigate violations and prosecute or take any other appropriate disciplinary action against defaulters or violators.

6). This knowledge of how an ecosystem functions will require an inventory of the processes within the systems including hydrology and anthropogenic influences. The management of coastal ecosystem requires fully integration of the upland processes and activities that affect the marine ecosystem for holistic assessment of the defined sector. The processes in different units of the ecosystem should be numerically modelled. This will enhance the understanding and predictions of the modifying processes. Moreover, it will expose and identify the gaps in knowledge in the assessment of the interactions between users of coastal resources in relation to biological productivity and diversity, habitats protection, introduction of harmful species and eutrophication.

7). Forces interacting on the biological production of a system include forestry, agriculture, fisheries, aquaculture, urban activities tourism and industrial impacts. The quality, quantity and frequency of production of these users and their activities should be taken into consideration in any management process. This will pave way to the best socio-economic balance while maintaining the integrity of the environment. The maintenance of biodiversity of ecosystems requires a multi-species inventory and assessment of the marine ecosystems. It provides information for fisheries, tourism development and maintenance. The eco-tourism industry is dependent on the protection of biological diversity of the system. Biodiversity maintenance takes into account the protection of habitat and the introduction of exotics or harmful species.

8). Habitat protection has a serious implication for fisheries. The reason being that fisheries are the most vulnerable and sensitive sector due to its dependency on natural recruitment. Habitats such as estuaries and mangroves just to mention but a few serves as recruitment areas for important commercial fish species. Aquaculture enterprises should not be sited in such sensitive areas like spawning and nursery beds for fish and shellfish as well as traditional fisheries activities. Management practices should include the rehabilitation of habitats like mangrove by replanting. This is because conservation alone may not give maximum protection. The reforestation and aforestation programmes will guarantee the protection of such mangrove

ecosystems. There is a global demand for proper conservation of mangroves due to the role in the global warming issues.

These Guidelines and the ICES Code of practice for deliberate introductions and transfer of non-native species by aquaculturists should be strictly implemented and enforced. Ballast water treatment can be achieved through water exchange, chlorination or other forms. This can be done directly on the ship or in holding tanks at shore-based receiving locations. This treatment should be equally applicable to the bottom tank sediment. This sediment is often not removed and its treatment is often ignored.

The MARPOL 73/78 Convention regulates the discharge of ballast and bilge water from ship's tank holds. These waters are contaminated and should be discharged into reception facilities at port for treatment. Wastewater treatment in ports was offered free of charge by state in Germany. Here, the water will be treated before being discharge into the environment. The free service resulted in abuse of the system in water that many ships went preferentially into the ports just for the purpose of waste treatment. There was a dramatic increase in volume of waste with a corresponding high cost to the state. The service had to be charged into the normal harbour dues resulting in loss of business. Nevertheless, that remains a good practice because polluters must pay or the ship have to pay for the waste. Nigeria should consider this procedure as possible revenue generation activity for pollution cost recovery.

It has been recognised that environmental quality is important to coastal zone users especially fisheries. There must be a representation or inclusion of fisheries managers including aquaculturists as parties in development and implementation of coastal zone management plans. There must be proper evaluation and monitoring scheme of the plan on regular basis. This will enable all necessary adjustment to achieve the best use of resources thereby maintaining the environmental integrity.

Environmental targets and programmes should be adopted by member countries to the related instruments for users to achieve sustainable use of resources.

In Nigeria, there is difficulty in the management of both living and non-living coastal and marine resources due to its inability to enforce the existing laws and regulations. Moreover, lack of human resources presents an obstacle in enforcement. This therefore calls for public education to be undertaken to increase the awareness of the law enforcement authorities to perform their duty diligently. The Department of Fisheries, under the Ministry of Agriculture has a plan and legislation in place for the management of fisheries resources but lacks human resources for improvement. This Department should be given enough human resources including monitoring boats to inspect the catches from fishermen at sea and their net sizes. Lack of monitoring has resulted in over exploitation of the marine resources.

In relation to the prevention of pollution, Nigeria should consider the introduction of VTS for the control of the increasing number of traffic in the area as an urgent need. Sabotage is identified as a source of oil spill in Nigeria. Making the host communities part of the process could prevent this and not objects of exploitation, followed by prompt clean up of any spills and payment of compensation to the affected. Tankers operating in Nigerian waters should have on board an emergency plan for oil spills. Inspections of such facilities should be carried out periodically as well as for oil terminals or refineries. Finally, the government should undertake such major task for provision of reception facilities in the ports and oil terminals for ship waste. These would go a long way in reducing potential incidents of pollution and improve economic, health and safety of the marine resources and users.

5.2. Conclusions

Nigeria is obliged as party to international conventions such as UNCLOS and CBD to established MPAs to protect its marine environment including its waters. MPAs should be established as parts of an Integrated Coastal and Ocean Management for success. This MPA designation process may be an aspect of the ICOM or CZM process or may serve as a triggering event that promotes the development of ICOM. The Department of Fisheries should be given the full mandate, resources and power for the implementation and management of marine protected areas in Nigeria.

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