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Impact of climate change and anthropogenic activities on renewable coastal resources and biodiversity in Nigeria

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Climates related disaster is greatly human induced warming, leading to substantial fluctuations in earth temperature which is currently a global issue of environmental concern. Human proximity and pressure in and around the coastal region has threatened flora, fauna and micro-organic resources of economic importance in most developing nations. Two-third of the word populations lives in or around the coast and 16 of the 23 world mega cities are currently in the world coastal belt. Transitively, the coastal environment, which harbors the highest percentage of biodiversity, is significantly important for economic activities and leisure. Nigeria's climate may witness increases in temperature, rainfall, storms, and sea levels throughout the twenty-first century and improper management of these desiccations can result into degradation in some parts of the country. Apart from climate change, coastal environment is subject to various anthropogenic impacts, often associated with high population, industrial and agricultural activities. Both disasters have led to heat stress, sea level rise, and erosion, salinization of the soil, evapo- transpiration, desertification and others. The overall resultant effects are feasible on environmental indicators including renewable coastal resources. It is therefore recommended among others that thinking globally and acting locally on environmental issues could save our coastal nation.

Key words: Climate change, anthropogenic, environment, population, conservation.

INTRODUCTION

Water resources are inextricably linked with climate, so the prospect of global climate change has serious implications for water resources and regional development (IPCC, 2001). Efforts to provide adequate water resources for most developing countries will confront a number of challenges, including population pressure, land use related problems such as erosion/ siltation, and possible ecological consequences on the hydrological cycle. Climate change will make addressing these problems more complex. The human population explosion, largely concentrated in and around the coastal belt is now earth's most significant environmental phenomenon.

Over 90% of the earth living and non living resources are found within a few kilometers of the coast (Ahove, 2001), where more than 4 billion people live and this proposition according to prediction will rise to 75% by 2030 (Figure 1). The coastal populations are growing at a

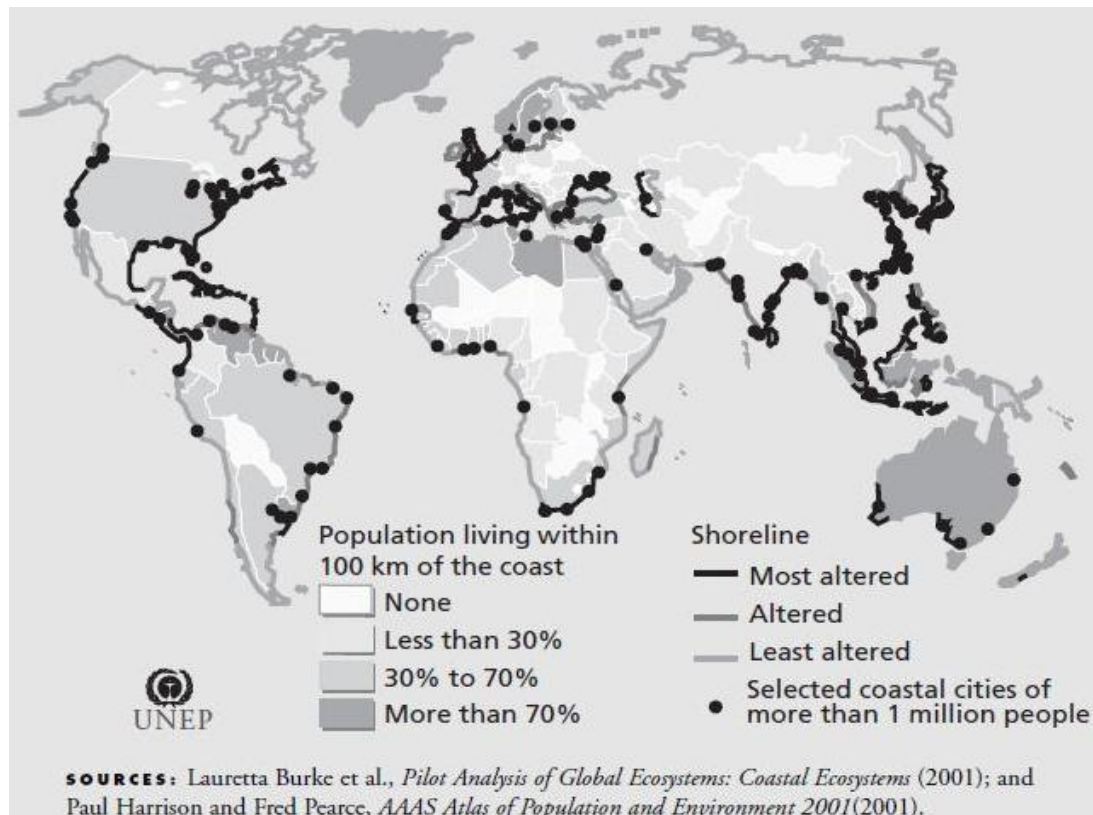*Corresponding author. E-mail: aquatobi@gmail.com.

Figure 1. Coastal populations and degradation.

rate of about 1 million people per day and 80% of the world biodiversity is concentrated within the coastal region, much of it undiscovered (IYO, 1998). As human population approaches 7 billion, the impacts, especially the coastal belt, have continued to push out other forms of life. Although it seemed the impact should stop at the ocean's edges, but that has proved contrary. The pressures of the anthropogenic activities and climate change are gulping the coastal ecosystem and the wealth of biodiversity that they harbor.

Currently, the Nigeria population of 158 million significantly put it as the most populous black nation for example, which accounts for 2.3% of the world's total population, with about 2% growth rate and having about 20% of Nigeria's residents living in one of the nine coastal states that house greater number of biodiversity resources (Nigeria Biodiversity and Tropical Forestry Assessment, 2008). And because of the large number of this population that lives below poverty line, there is increase in the pressure on the biological resources. The biggest threat to the coastal biological resources in Nigeria therefore, is poverty, through land base activities (Awosika et al., 2001); as biological resources remain their main cheap sources of food and income. In Nigeria, as at 1997 there were 5,081 plants species, out of which 0.40% are threatened and 8.5% endangered; 22,090 animal species (20,000 being insects), 0.14% 0f which

are threatened and 0.22% endangered and 1,498 species of microorganism. Given their biological, biochemical, medicinal, sociological, and economic as well as aesthetics value, mankind must ensure that these resources are adequately protected as essential component of the natural restoration process in the coastal environment (Okebukola, 2001).

This paper intends to review the biological conse-quences of climate change in addition to pressure of population increase on coastal resources. It is important that Nigeria, being a coastal nation, with densely populated coastal areas, ascertain the extent of threat of anthropogenic impacts on ecological balances, and signs of disaster must be known for sustainable environmental management, among others.

PHILOSOPHICAL INDICES OF COASTAL ENVIRONMENT

The coastal area is the land mass extending from the inland limit of tidal or sea spray influence, to the outer of the continental shelf. It is characterized by inter-connections among neighboring ecosystems and directly influenced by both the land based human activities; transitively, the coastal zone is the interface between the land and the sea. Pressures on coastal and marine

biodiversity will continue to increase, as 50% of the world's population will live along coasts by 2015, putting unsustainable pressures on coastal resources (IYB, 2010).

These observed scenarios in Nigeria for example, also occur in Senegal, where about 4.5 million Senegalese (66.6% of the national population) live in the Dakar coastal area (IPCC, 2007). And in Ghana, Benin, Togo, and Sierra Leone, most of the economic activities that form the major national economies are also located within the coastal zone. The coastal areas form the food basket of the region, such as offshore and inshore areas, as well as estuaries and lagoons supporting artisanal and industrial fisheries accounting for more than 75% of fishery landings in the region.

Nigeria has a coastline of about 860 km in a west-east stretch from Lagos to Cross River. Global estimate indicates that the flaring of petroleum dissociated gas in this coastal area of Nigeria alone account for 28% of total gas flared in the world. Nigeria, like every coastal country has a coastal based economy through the onshore and offshore oil exploration, and hence majority of the industries and commerce are located along the area in proximity with ports and borders for effective transit of goods and services. These factors put so much pressure on the coastal biodiversity and reduce their suitability.

METHOD OF STUDY

The methods used in this study to collect data include direct observation and personal contact to collect information. Data were also collected with interviews from heads of communities, community chiefs, the spokesmen, elders and other opinion leaders, who are residents with substantial knowledge of their communities. This was used to corroborate existing literature or documentation from research / academic institution to complement the information that was collected during the field work.

NIGERIA COASTAL ZONES CLASSIFICATIONS AND BIODIVERSITY

The coastline of Nigeria starts from the western border with the Republic of Benin to the eastern border with Cameroon. The coastal shore consists of barrier islands, sandy beaches, lagoons, estuaries, mud beaches, and creeks and includes the Niger Delta. Continental shelf extends from 15 km off Lagos to more than 85 km off Calabar. The Exclusive Economic Zone, established in 1978, extends to 200 NM offshore. The coastal zones of Nigeria can be classified into four major categories on their general morphology; vegetable and beach type and include the following:

The barrier – lagoon complex

This covers about 200 km from Benin/Nigeria border eastward to the western limit of transgressive mud beach

and adjacent to the gulf of Guinea backed by the Badagry creek, Lagos Lagoon and Lekki, Lagoon. These lagoons are generally shallow with depth between 1.5 to 3 m. The faunas are dominated by mollusk. Coconut and palm trees make up the floral *Avaicennia nitidae, Euphorbici hypossepofolia, Rhizophora harrisonii, Rhizophora mangle, Diodia vagnalis, Ipomea aquatica, Vigina marina*, and *Maranthus maritinia,* all resources that are greatly influenced by human activities including domestic, thermal and industrial pollution.

The transgressive mud beach

This mud beach extends to 75 km and end at Benin river mount, in Edo State, on the northwest flank of the Niger Delta but backed by freshwater swamps. Vegetations are dominated by mangrove - *Rhizophora racemosa* which has been eroded and replaced by hardy grass *Paspalum vaginatum, Acrostichum grasses, Androprogon* sp. and *Panicium* sp., the shrubs, *Delbergia* and the tree, *Cocorus mucifera* (Ajao, 1994).

The Niger Delta coast

This region is about 500 km from Benin River to the mouth of Imo River in the east. This mangrove swamp is essentially vegetated tidal flat and best vegetation along the Nigeria coast (Ibe et al., 1985). These permanent mangrove swamp forests are represented by brackish and marine communities and typified by sand crab, *Ocypoda Africana* and ghost crab, *Ocypoda cursor.* Barnacles, Oysters, Perwinkles, crustaceans are also present, hermit crab, hippopotami, manatees, monkeys, reptiles, crocodile, monitor lizards, turtles and snakes form major faunas with some indigenous birds. The continental platform of this coastal area is vital for shrimps and pelagic fisheries resources. This coast is also characterized by pollution from oil industries.

The strand coast

This coastal area is about 85 km and extends from the Imo River to cross rivers estuarine at the Nigeria – Cameroon bounder. It is typically estuarine, characterized by the palm, *Nipa fructicans. R. harrisonii* and laguncularia are also abundant.

CLIMATE CHANGE AND RESOURCES ISSUES

A resource in this paper is defined as any useful thing living or non-loving under the sun including the sun itself. Living resources, including micro-organism, fauna and flora could be referred to as "Renewable resources" while the non-living resources are the non-renewable resources, (Amosu and Babalola, 2003). The coastal

Table 1a. Summary of emission from the Nigeria energy sector 1994 emission (Gg).

Sector	Total energy condition (P)	CO_2	CH_4	N_2O	CO	NOx	NMVOC
Public electricity	100.9	5686.3	0.01	0.20	1.30	5.82	0.00
Auto generation	9.5	70.67	0.02	0.02	3.34	9.54	0.12
Petroleum refinery	765.9	6098.9	0.61	2.91	28.34	4.14	12.10
Industry	18.3	1435.9	0.05	0.12	0.30	3.06	0.04
Transport	545.1	38473.4	12.07	0.86	4728.99	322.47	896.19
Small combustion	738.5	47009	445.21	3.36	4139.25	127.87	4.71
Fugitives	5.2	58080.0	1018.23	0.00	4224.00	28.99	951.10
Total	21834	115182.1	1476.21	7.47	13125.53	501.89	1864.24

Sources: Ojo (2007).

Table 1b. Per capital sectoral and gross emission in Nigeria for 1994.

Sector	1994 specific emission					
	CO_2 kg C/cap	CH_4 kg C/cap	N_2O kg C/cap	Co kg C/cap	NOx kg C/cap	NMVOC
Energy	324.65	11.44	0.05	54.26	1.58	19.27
Industry	4.96	0.00	0.000	0.0000	0.00	3.79
Solv. Use	0.00	0.00	0.00	0.0000	0.00	0.00
Agric	0.00	18.17	0.03	14.83	0.47	0.00
Luc	212.92	0.14	0.00	0.67	0.01	0.00
Wastes	0.00	16.21	0.00	0.71	0.01	0.00
Total	542.54	45.97	0.08	70.46	2.07	23.06

Source: FGN (2003) Nigeria's First National Communication.

renewable resources are used by increasing population of the coast; it is improper management and misuse of these resources that are causing climate change through green house gases and global warming. Climate change is currently one of the most challenging aspects of environmental issues. It has been confirmed that human influence is altering the concentration of green house gases and ozone layer, both climatic dilemma are climate influenced (Ojo, 2007) (Table 1a and 1b).

The human factor has become significant in the balance of concept that determines sustainable develop-ment. The pool of atmosphere gases, with economic important effects, by inducing the green house gases, global warming and sea level rise could have serious consequences on agriculture, livestock production and management, water resources management, forests and forestry, fisheries and other economic activities, from the summary of emission from energy sectors and per capita sectoral and gross emission in Nigeria (Ojo, 2007) (Table 1).

CHARACTERISTICS AND PROBLEMS OF RENEWABLE COASTAL RESOURCES (RCR) IN NIGERIA

The impacts of climate change will exacerbate existing physical, ecological / biological, and socioeconomic stresses on the Nigerian coastal zone. Most existing studies focus on the extent to which rising sea level could inundate and erode low-lying areas or increase flooding caused by storm surges and intense rainstorms. The coastal nations of west and central Africa (e.g., Senegal, The Gambia, Sierra Leone, Nigeria, Cameroon, Gabon, Angola) have low-lying lagoon coasts that are susceptible to erosion and hence, are threatened by sea-level rise, particularly since the large populace of the countries in this area have major and rapidly expanding cities on the coast (IPCC, 1990).

Change in occupation appears to be the only way people of the region cope with the changes affecting their environment. With more people changing their means of livelihood from natural sectors to non-natural sectors, this will lead to the decrease in economic activities of the people in the region include fishing, farming and trading of these produce.

Aquatic resources account for over 50% of the fish consumed in Nigeria and come from the Niger Delta, Uyigue and Agho (2007). The daily minimum crude protein requirement of an adult in Nigeria varies between 65 and 85 g per person. However, it is recommended that 35 g of this minimum requirement should be obtained from animal sources with fisheries resources forming the greater composition (Mba, 1983; Joseph and Ajayi, 2002;
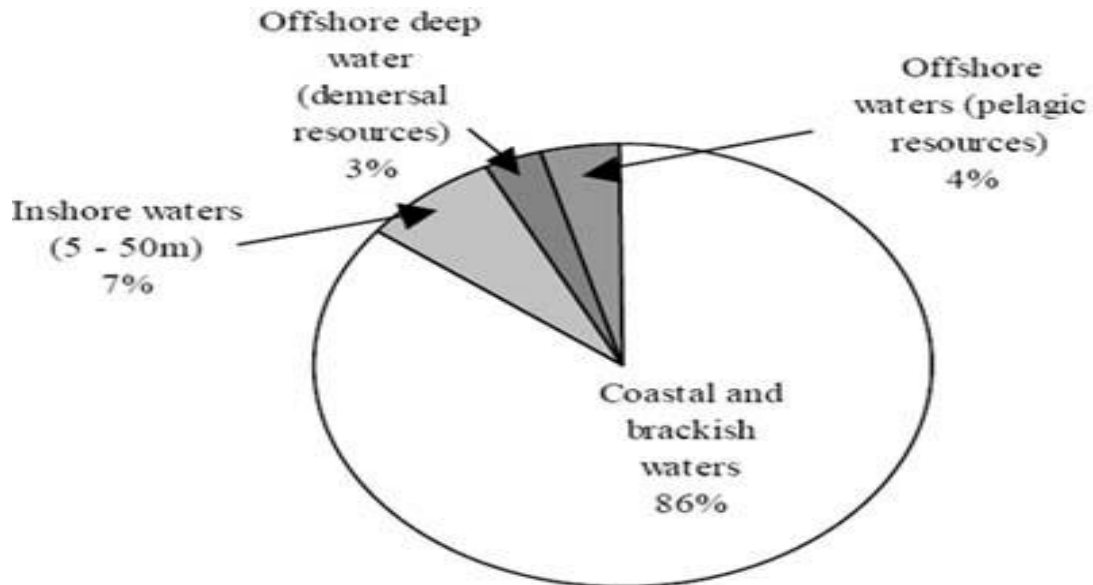
Figure 2. Distribution of potentials yields in marine waters of Nigeria (Source: Amire, 2003).
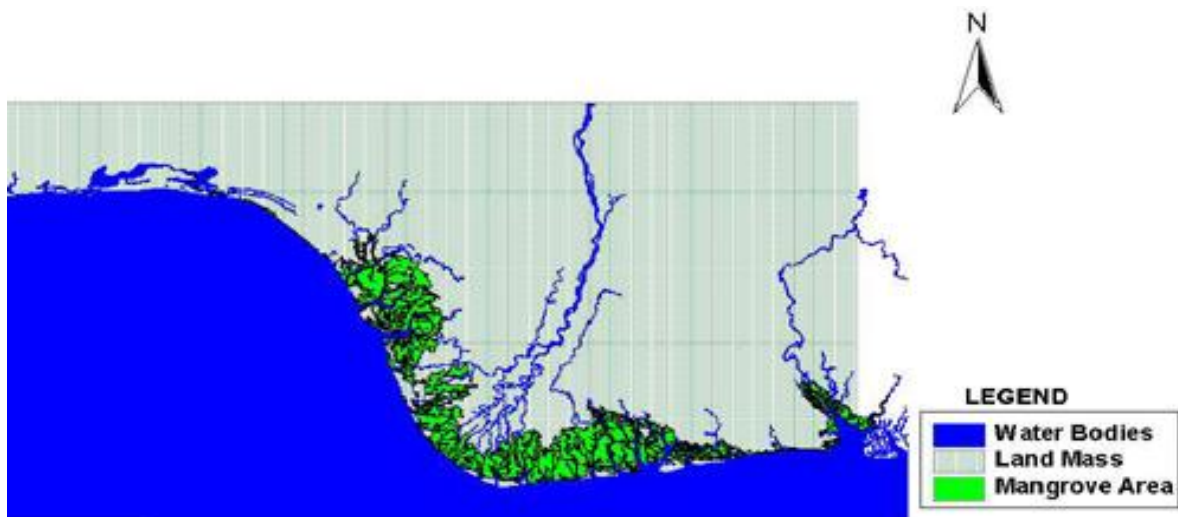

Figure 3. Showing Niger Delta area and associated relief. Source: Agbola and Olurin (2003).

Omotosho, 2004). In coastal communities of Nigeria such as the Niger Delta, renewable resources are highly consumed as source of protein, over 10.5 kg/person/year as against 7.7 kg / person / year for terrestrial meat source (Breueil and Quensiere 1995). Fisheries resources are the renewable produce of aquatic environ-ment, and diversity of these resources includes fin, shell fishes, mammal and higher aquatic plants in fresh, brackish and marine water bodies. In Nigeria, coastal fisheries also provide the highest total of fish production among inshore/ offshore water. The most predominant is the *Pseudotolithus* spp. Estimated potential yield of the inshore waters is about 16 620 mt for finfish and between

3 500-4 020 mt for shellfish resources, which are exploited by both the artisanal and industrial operators. While Offshore (50-200 m), the potential fisheries resources are estimated at about 9 460 mt, and consist of mostly tuna and tuna-like fishes (Amire, 2003) (Figure 2).

The region spans over 20,000 m² and it has been described as the largest wetland in Africa, among the three largest in the world and it is the second largest delta in the world (Figure 3). About 2,370 m² of the Niger Delta area consist of rivers, creeks and estuaries and while stagnant swamp covers about 8600 km² (Uyigue et al., 2007). The region is divided into four ecological zones namely, coastal inland zone, mangrove swamp zone,

Table 2. Ranking of environmental issues in the Niger Delta by the World Bank.

Category	High priority	Moderate priority	Low Priority
Land resource Degradation	Agricultural land degradation. Flooding (moderate high)	Coastal erosion Riverbank erosion	Sea level rise
Renewable resource degradation	Fisheries depletion, deforestation, biodiversity loss, water hyacinth expansion	Fisheries habitat degradation	Mangrove degradation, Nypa palm expansion
Environmental pollution	Sewage, vehicular emission, munbicipal solid waste and toxic and hazardious substances	Oil pollution, Industrial effluents, industrial air pollution, and industrial wastes	Gas flaring

Source: Agbola and Olurin (2003).

freshwater zone and lowland rain forest zone. The region has emerged as one of the most ecologically sensitive region in Nigeria. Non Renewable Resources (NRR) such as sharp sand, gravel, oil and gas from the region are the main source of revenue and environmental problems in Nigeria, and accounting for about 97% of the country's total export (Table 2).

ECONOMICALLY IMPORTANT RENEWABLE COASTAL RESOURCES

Fine fishes

Ranging from freshwater, brackish and marine water bodies, fish species include: Polynemids, *Galeoides decadactylus*, *Polydactylus quadrifilis*, *Brachydeuterus auritus*; catfish, *Arius* spp; grunters, *Pomadasys* spp; snapper, *Lutjanus dentatus*; groupers, *Epinephelus* spp; sharks; rays and soles *Cynoglossus* spp., *Tilapia* sp, *Sardelina* sp, *Heterotis niloticus clarias* sp, *Sole, Lates niloticus, Mugil* sp, (*Katsuwonus pelamis*), Yellow fin tuna (*Thunnus albacares*) and big eye (*Thunnus obesus*). Tuna-like fishes also targeted include: *Euthynnus alleteratus, Sarda sarda, Elagatis bipinnulata*. Priacanthidae, Sparidae, Aromidae, *Pentheroscion mbizi* etc. These categories are commercially and economical important fishery resources in Nigeria.

Shellfishes

These include shrimp and Prawns, *Peanus notialis macrobrachium vollenhovenii, macrobrachium macrobrachium,* crabs, marine turtle, lobsters, oyster, periwinkle, mollusk, turtle fishes etc.

Mammals / Aves / Reptiles

Sea lion, whales, dolphins, manatees', crocodile, hippopotami among others, has been identified.

Higher plants

Apart from the season menace of water hyacinths which could be harvest for some economic use like manure or livestock feed; Merchantable timbers, such as *R. mangle, R. racemosa, R. Harrison, Athizia zypia, Oxystoma manni* are largely exploited for fuel, wood and charcoal by urban and rural dwellers. They are also use in building of canoes and rural houses. The freshwater raphia palm (*Raphia hookerii)* are tapped for palm wine and distilled to provide local gin. Palm oil production is not excluded. Sedges are also used for mat making while the legumes are used as ropes, coconut trees that are found along the region is also important in local production of coconut oil (Adin – Agbon) and the ectodermal layer of the coconut are important as they are exported in car seat foam. But the pressures of climate change are putting all these desirable coastal renewable resources in one kind of threat or another in Nigeria (Ezenwa et al., 1990; Nigerian Environmental Study/Action Team, 1991; Agabi, 1991; Awosika, 1995; Ahove, 2001; Ibe, 2011) some are highlighted as follows:

Threatened species

Some of the threatened species include:

1. Birds – Grey Parrot (*Psittacus eriitheacus),* kingfishers *(Corythonis cristata), Halycuon senegalensis.* Herons *(Ardea cinerea).* Eagle *(Accipiitter* sp*,* land owls).
2. Mammals – Hippopotami, manatees.
3. Reptiles – Crocodile, monitor lizard.
4. Plants – *Elaeis guineensis* and *combrectum hispidum, Crystopogia Senegalense* (shrub), *Elas guineensis* (tree), *Nypa fruitcans* (tree).

Endangered species

The endangered species include:

1. Fin fishes – *Lutjanus goreensis, Tarpon atlanticus,*

Elops lacerta, Pomadasys jubelini, Gymnarchus niloticus, C. nigrodigitatus Ethmalosa fimbriata, *Sardinella* sp, croakers, *(Pseudotolytus* sp*), Illisha Africana, Cynoglosus* sp*,* marine catfishes, grunter, snappers, tilapine and Tuna.

2. Shell fishes –*Macrobrachium* sp*, Panaend notialis, Palaemon hastapus* (white shrimps) Marine turtle, pink shrimps and oyster.

3. Plants - C*rystopogia senegalensis, Costus afar, Raphia hookerii*

Adverse effect of climate change on RCR

Health and diseases

climate change and ozone layer depletion affect the physiology of aquatic animals and plants once the environment become warmer, as they might not be able to survive heat disorder, which will affect their nutrition, food, making them susceptible to nutritional diseases (Babalola and Amosu, 2006). It is a well known fact that global warming accelerates the occurrence of sun burn, heat strokes, heat rashes and other skin blemishes. Increased humidity and temperature will lead to the rapid multiplication of pests; malaria may get to epidemic stage. The more intense dynamics of winds and ocean circulation, engendered by climate change, will improve the constant recruitment of these pollutants and increase their deleterious effects. According to source, the Nigeria government and WHO data show that about 1,600 Nigerians died in 20,000 floods over a decade (Ibe, 2011). Important contaminants in Nigeria's coastal water include pathogenic micro-organisms, organochlorines, polychlorinated biphenyls, petroleum hydrocarbons and heavy metals from municipal, industrial, agricultural and run off sources. The increased discharge of nutrients into water bodies from anthropogenic sources and also from atmospheric pollution has resulted in persistence incidence of eutrophication and pathogenic algal blooms (Ibe, 1986, 2005; Portman et al., 1989; Scheren and Ibe, 2002; Scheren et al., 2002). Various diseases related to water quality (water non-vector diseases) and others that are related to soil, air borne diseases like cardiovascular ailment, are becoming rampant and common in this region. Diseases associated with water stress and climatic disorder, such as skin and eyes disease, has disrupted the state of physical, mental and social well being of the coastal population (Babalola and Amosu, 2006).

Pollution / Gas flaring / Oil spill

According to Okebukola (2001), industrial pollution from the over 5,000 industrial facilities and another 10,000 small scale industries, mostly operating illegally, is a growing problem in Nigeria coastal region. Waste and effluents from textile, tannery, petrochemical and paint industries containing heavy metals, organ chlorine, pathogenic micro organism, polychlorinated biphenyls, municipal wastes, petroleum hydrocarbons and agro allied run off ends up in the coastal water, with serious implications on the biotic resources of the coastal environment (Olowu et al., 2010; Ihenyen, 1987). Majority of the substances are non-biodegradable house hold petrochemical products such as polythene bags, plastics containers and tyre litters the industrialized coastal cities, a case of future pollution and contamination.

Records revealed that between 1976 and 1990, the region experienced 2,676 cases of oil spills (Civil Liberties Organization report, 1996) and an annual average spills in Rivers, Bayelsa and Delta States are 300 cases. The devastating impacts of these incidents on the farmlands, crops, economic trees, creeks, lakes, fishing equipment is such that in many places, the people can no longer engage in productive farming and fishing. Iyayi (2004) calculated the actual number of oil spills during the period to be in the neighborhood of 6, 971 with a total volume of 3,554,205.6 barrels of crude oil spilled, and given that water bodies polluted with oil affects the amount of dissolved oxygen in the water, which consequently impacts the lives of aquatic plants and animals, the impacts of this can better be imagined. An estimate indicates that as many as 13 million barrels of crude have escaped into the Niger Delta environment, which could be among the worst spill in the world, (roughly equal to one Exxon Valdez spill per year) (FME, 2006).

Sea level rise / Erosion problems

The global temperature is expected to rise by between 0.2 to 0.5°C per decade, together with expected thermal expansion of sea and melting of polar ice. These will cause the sea level to rise by about 3 to10 cm per decade during the next century (IPCC, 2007), which will further increase the erosion problem of the coastal area. Sheet and gully erosion are already severe in some states like Abia, Imo, Anambra, Enugu, Ondo, Edo, Ebonyi, and Delta. While coastal and marine erosion occur particularly in the coastal area of Ogun, Ondo, Delta, Rivers, Bayelsa, Akwa-ibom and Cross rivers states; the most celebrated is the overflow of bar–beach in Lagos since 1990 and the 2011 July rain.

Nigerian Environmental Study/Action Team (NEST, 2004) reported that sea level rise and repeated ocean surges will not only worsen the problems of coastal erosion that are already a menace in the Niger Delta, the associated inundation will increase problems of floods, intrusion of sea-water into fresh water sources and ecosystems, destroying such stabilizing system as mangrove, and affecting agriculture, fisheries and general

livelihoods. Ibe et al. (1985) and Ibe (1989) have demonstrated massive vegetation kill on the trans-gressive mud coast of South-West Nigeria due largely to increase in salinity. Changing ecosystem and vegetation are envisaged due to the influx of the sea. The freshwater floral and faunas, nursery and spawning areas of artisanal and industrial fishery will be seriously affected, not minding regular flooding of mangroves from the Nigerian coastline that will result to salinity problem with more effect on the mangroves ecosystem, (Ebisumeju, 1985). Apart from removing the surface soil layer and agricultural nutrient, it also carries along agro-chemicals, with their numerous ecological effects on biotic components of environment.

Desertification and salinitization of soil

Nigerian agriculture is 85% rain-fed, and many crops are sensitive to salinity shifts and temperature; while crop declined yields in the North-East due to rise in temperatures and drought is 23%. Rising sea is also flooding farmlands in the Southern coast thereby increasing it salinity, compounding the stress, is huge sheet erosion in the sandy soils of the Southeast, further resulting in lower agricultural crop production, (NEST, 2008).

The combination of more heat plus less rain raises the specter of widespread desertification, especially in Northern Nigeria. According to some estimates, fully two-thirds of Bauchi, Borno, Gombe, Jigawa, Kano, Kaduna, Katsina, Kebbi, Sokoto, Yobe, and Zamfara states could turn desert or semi-desert in the twenty-first century. Presently, the Sahel moves south by approximately 1,400 square miles a year, engulfing human settlement; data have also shown a 400% increase in sand dunes over 20 years (FME, 2008). However, hydrological modeling reveals that a 1.5 ft sea level rise would submerge more than 11,000 m^2 of coastal area (Onofeghara, 1990). Much of Nigeria's densely populated, increasingly urbanized 500 m^2 long Southern coast is less than 20 ft above sea level; the Delta region, with its easily flooded network of estuaries, rivers, creeks, and streams, sits especially low, as Lagos does.

Evapo-transpiration / Heat stress

Climate change is a reflection of natural and human influence, characterized by extreme heat, low relative humidity, high / mild wind velocity, inadequate rainfall, extreme dryness of vegetation, sea level rises and global warming (Akpan, 1995). Any increase of 1°C in the climate of the sea can result in a reduction in primary productivity and a consequent decline in fisheries (Ibe, 2011). Transitively, the warmer the water, the poorer the resource. According to Ajayi and Findlay (1989a, b), any

increase in temperature could result into effects depending on habitat characteristics. For instance, higher temperatures have reduced the size of Lake Chad, (which was once the world's sixth largest lake and the North's huge irrigation and water supply source for more than 10 million people of the riparian states), to one-tenth its size a half century ago (Coe and Fole, 2001; Habil, 2007). More heat plus less rain is already creating drought conditions in parts of Northern Nigeria. This has become troubling, since government data show that rural households harvest rain for more than half their total water consumption, and Northern groundwater tables have dropped sharply over the last half century, owing partly to less rain. Hydrological modeling has proclaimed that a 3 ft sea level rise could put almost all the Delta's onshore oil fields under water (Awosika et al., 1992).

Gas flaring has continuously been practiced in the Niger Delta region for over four decades. Today, there are about 123 flaring sites in the region, making Nigeria one of the highest emitter of green house gases in the world. Carbon dioxide emission in the area is also among the highest in the world (Iyayi, 2004), with some 45.8 billion kilowatts of heat, being discharged into the atmosphere of the Niger Delta from flaring 1.8 billion cubic feet of gas every day (Agbola and Olurin, 2003). Gas flaring has raised temperatures and rendered large areas of that region uninhabitable.

Human displacement

Normally, without sea-level rise, the rates of land loss from edge erosion specifically could reach reclamation of about 250 km² by the year 2100 (Ibe, 2011). This coastal set back is equal to average shoreline reclamation of 3 km. A 1 m rise, more than 3 million people are at risk of becoming environmental refugee, based on the present coastal population. In Niger Delta alone, sea level rise of 0.3 m, the land loss may exceed 7,000 km² while address space layout randomization (ASLR) due to erosion may take up to 120 km²; with ASLR of 1.0 m, about 2 to 3 million people could be displaced (Okebukola, 2001).

At the transgressive mud coast, it can put about 2,016 km² of land at risk and people that would be affected are put at 740,000 for a 0.2 m rise to 3.7 million for a 1 m rise and 10 million for a 2 m rise (Awosika et al., 1992). The Niger Delta has low-lying lagoonal coasts which are prone to erosion and which could be further affected by sea level rise, since there are increase development of new cities in the coastal belt (IPCC, 1996). Nigeria coastal cities, especially Lagos and Port Harcourt, are buffeted by storm surges and presently are at risk from erosion, inundation, and extreme storm (Awosika et al., 1992). Currently, inundation is the major threat for at least 96% of the land at risk (Awosika et al., 1992; French et al., 1995). With sea level rises, inundation can reach over 70% of the Nigerian coastline, putting areas of

economic importance at risk in many kilometers (Awosika et al., 1992). Research have also indicated that about 9.7 million people shall be displace in Nigerians due to rising seas by 2050 (Wheeler, 2011), which is a significant proportion of the coastal population.

Socio-economic

According to Ibe (1988), Ibe and Ojo (1994), climate change induced sea level rise would have feasible retardation impacts on socio-economic activities in Nigeria. From time immemorial, economic activities located along the Coastal belt and also the discovery of crude oil has led to large migrations to the coast with serious impact through the oil exploration from the coastal and marine environment (Ibe, 1986; Ibe and Quellenec, 1989). Destruction of habitat conservation and reserve potential, which are part of sacred groves of indigenous cultural heritage, has resulted to some changes in food and cultural activities. Abang (1995) classified the socio-economic distribution of the nation by pattern of industrials environment.

The method of demarcation is based on location (a) Kano / Kaduna / Jos zone; (b) Ibadan / Ilorin / Lagos zone; (c) Port Harcout / Enugu zone; and (d) Benin / Sapele zone. It can be deduced from the preceeding distributive classification that ¾ of the zones are in the coastal region; that is, zones (b), (c) and (d) because of economic reasons and due to access to transportation and commu-nication facilities. These three coastal zones are characterized by absolute foreign based technology, many of which have been discarded in their countries of origin, but found in these zones because of low level of local technology. The environmental impacts of these outdated technologies have resulted in serious environ-mental degradation ranging from susceptibility of coastal populations to endemic diseases such as malaria, increasing cases of water and air pollution, loss of aquatic life, destruction of arable farm land and gas flaring etc.

Increase in sea level rise, flooding and erosion will drastically reduce the size of the already narrow beaches in the country and compromise value of recreation amenities like hotels and other social facilities that are of importance to tourism could be displaced. Ibe (2011) also proposed that the influx of the sea as a result of sea level rise would adversely affect the transportation business and disrupt buying and selling services. And in some consumable industries, the reduction in supply of fisheries resources and the decimation of forests as a result of climate change will mean a decline of these industries and their output. It has been revealed that between 1992 and 2007, wind and rainstorms damaged some goods worth $720 million in economically productive goods in Nigerian (Akpodiogaga and Ovuyovwiroye 2009). Climate change induced resource decline has been said to lower economic growth and increase unemployment rate to 19% in 2009 (FGN, 2010). Although, the industrial growth trend in the coastal area apart from affecting the way of life as witnessed in the Niger Delta, has also created serious unemployment problems and makes between 27 and 33 million Nigerian to be in poverty threshold (NEST, 1992). This has resulted in increasing crime rate, over populated metropolitan cities and the development of ghettoes and decaying inner cities. Nigeria's economy is climate dependent and would cost the country between 6 to 30% of its GDP by 2050, worth between 100 and $460 billion, respectively (Treichel, 2010).

Conclusion

The Nigerian renewable coastal resources are being threatened by some factors that are influenced by human based activities through over population. The renewable coastal resources rank next to the soil in sustaining our rural and urban economy, because of dependence on forest resources such as firewood, vegetables, bush meat, livestock, timber, mats, oils, drugs, gums, resin etc, it is also important to demonstrate the basic role of physical factors in shaping the environment. The non-renewable coastal resources, more than any other, deter-mine the type, nature and character of the renewable coastal resources. In the like manner, they are of immense importance in the design of environmental policy. The failure of most environmental policies can be attributed to either lack of appreciation or conceptuali-zation of their specific contribution in the environmental setting.

RECOMMENDATION

The following suggestions are therefore advanced towards the sustainable management of renewable coastal resources for an in-depth and holistic approach in the environment:

- Drastic reduction of burning fossil fuels like coal and petroleum products and development of alternative non-fossil fuel energy sources (renewable) e.g. hydrogen fuel.
- Encourage the use of solar energy to conventional power generator.
- Practice integrated agriculture / rural development, since majority of the poor population are very close to these resource, they should be involved in the management at grass root with cultural / political traits.
- Industry must be encouraged to control pollution and develop technology that will recover and recycle their waste and effluents.
- Conservation of existing threatened and endangered species through the *in-situ* and *ex-situ* conservative

principles.
- Effective method of population management and regulation of population growth to meet the limited resources in the environment and reduce poverty level of the people.
- Enforcing environment management system (EMS) tools in public and private establishment for effective environmental and cost oriented management e.g. EIS, EU etc.
- Thinking globally and acting locally will truly reflect the spirit of globalization, for instance stopping all gas flaring in all oil refinery world over will give a global balance of the atmosphere and a conducive climate.
- Promote research in best available technology, effective for local adoption and introduction of tax rebates for industries for meeting pollution free standard.
- Creating awareness by making environmental education part of education curriculum at all school level.

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