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CLIMATE CHANGE AND FISHERIES -

STRENGTHENING THE CAPACITY OF FISHERIES COMMUNITIES FOR ADAPTATION TO CLIMATE CHANGE: IDENTIFICATION OF POLICY INTERVENTION ENTRY POINTS

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1.0 BACKGROUND

Fisheries and aquaculture play significant roles in the provision of food supplies, enhancing food security and income generation in Africa. The sector still has considerable potential for imparting hugely on food security and livelihoods, especially in poverty stricken rural coastal and riparian communities. However there are growing evidences that climate change may pose considerable threat for this potential. Variability in climatic conditions continues to have devastating effects on broad range of ecosystems, societies and economies. These are in turn putting increasing pressure on many livelihoods and food supplies, including those in the fisheries and aquaculture sector. The fisheries and aquaculture sector is likely to exhibit varying responses to climate change phenomenon. Changes might be reflected in productivity of marine and inland water ecosystems, species distribution abundance and shortage of water for aquaculture practices. These changes can manifest in both negative (e.g. species substitution and invasions) and positive occurrences (e.g. increase growth performance of farmed species).

The full impact of long-term trends in climate change, in particular related to global warming, is less well-understood in fisheries though beginning to receive attention. Communities that are dependent on fisheries as main sources of livelihoods are likely expected to be affected by the effects of climate change.

The first Conference of African Ministers of Fisheries and Aquaculture (CAMFA I) within the context of policy and governance reforms requested Member States, Regional Economic Communities and Regional Fisheries Bodies to mainstream climate change in fisheries policies, development and management programmes.

The African Union Inter-African Bureau for Animal resources (AU-IBAR) sought for a consultancy to identify policy intervention entry points to strengthen the capacity of fisheries communities for adaptation to climate change. The specific tasks were as follows:

Tasks

1. Conduct desk review to identify drivers of climate changes, including compiling and documenting the effects of CC on fisheries and aquaculture
2. Assessment of climate change adaptation and coping strategies,
3. Establish existing knowledge and perception, institutions and practices of fishing communities of relevance to climate-change preparedness
4. Document best practices and lessons on climate change mitigation and adaptation strategies in fisheries and aquaculture
5. Propose strategic areas of intervention as entry points to strengthen the capacity t of fishing communities, highlighting role of various stakeholders ie states and non-states actors

1.1 INTRODUCTION

Africa is endowed with rich natural resources which form valuable economic commodities within the vast ecological systems of their environment. Nigeria has many plant and animal resources with some species of regional and global importance in the country's diverse ecosystems.

With adequate management, the resources can be sustainably utilized to increase revenue generation, employment creation, yields and socio-economic enhancement of the rural communities. Up till now, most natural resources are still under utilized while some prominent flora and fauna resources have been over exploited, with the associated problems of environmental degradation and climate change.

Sub Sahara Africa countries have wide range of aquatic resources, which are very rich in flora and fauna resources especially fish and fisheries resources. These fishery resources are of great social and economic value to Africa, but these are by many considered to be largely unrecognized and not utilized to their full potential.

Fish and other living aquatic resources of inland and marine water ecosystems in Africa provide important services that are seriously undervalued. Fisheries resources are a source of wealth, health, food and nutrition, mostly especially to the nations in which these resources are located. These countries however need to recognize their value and put measures in place for their sustainable exploitation, utilization and management. These vast endowments of natural marine, brackish and freshwater fisheries resources in sub-Sahara Africa could be turned into wealth, thereby contributing immensely to economic empowerment and poverty eradication in the continent. This is however not the case in Africa as these resources are presently not rationally exploited, but mismanaged and in some cases used to enrich other nations through illegal activities and poorly negotiated access arrangements. For example, in Sierra Leone, Liberia and Nigeria where activities of Illegal Unreported and Unregulated (IUU) fishing have been reported (Falaye, 2008). Also, the resources in many Lakes in Africa are declining such as in Lake Chad and Lake Asejire due to environmental factors and poor management (Omoike 2004 and Murray 2007)

The importance of Oceans, lake, rivers and floodplains as sources of fish for millions of people in Africa cannot be overemphasized. However, the impact of Climate change is fast changing the future of fisheries production patterns, either by shifting production as species move to new habitats as well as changes in the net marine primary production (Brander, 2007; Cheung et al., 2009; Falaye 2013). Similarly, WorldFish (2009) centre reported that Climate change has impacted on the productivity, distribution and seasonality of fisheries, and the quality and availability of the habitats that support them, are sensitive to climate change effects. These changes in fish production will be as a result of the rise in atmospheric temperatures leading to thermal expansion thereby changing sea level, increasing ocean acidification, altering rainfall patterns and river flows, and causing higher incidence of extreme weather events. This was substantiated by Inter - governmental Panel on Climate Change (IPCC). Climate change and variability is already being felt in many inland fisheries in Africa as a result of reduction in the size of water bodies, such as Lake Chad (UNEP, 2002). Impact of climate change on aquaculture might be manifested through weakening supply and delivery of such inputs as feed and seeds; as well as the weakening of pond productivity (Handisyde et al 2006; Allison et al 2009; Timmers 2012). This presentation focuses on the impact of climate change on fisheries and aquaculture productivity thereby providing a platform for further discussions and effective actions in the management of climate change challenges with respect to aquatic ecosystems and their valuable fisheries resources for sustainable production. The environment is the earth's life support system and the economies of the world's nations are dependent on exploitation of the natural resources. While development aims at bringing about positive change in human

life, it can also lead to degradation, pollution, incurable diseases, poverty, social conflicts and threats to human existence on earth inter alia.

Threats of climate change manifested through sea level rise with devastating flooding of low lying areas, depletion of the stratospheric ozone layer by chlorofluorocarbons, threats to ecosystem; including fisheries as well as to human health by hazardous wastes and, not the least, the loss of biodiversity which is the resource base of many national economies

2.0 FISHERIES AND AQUACULTURE IN SOCIO ECONOMIC DEVELOPMENT OF AFRICA

African fisheries contribute significantly to food security of an estimated 200 million people in the region while they also provide sources of income for over 10 million engaged in production, processing and trade. In sub Sahara Africa countries, fish has also become a leading export commodity with a current annual export value of US$4.4 (SOFIA, 2010) billion. The role of fisheries and aquatic products in supporting livelihoods, enhancing economic growth, and improving food supply in the region is critical. There is however great risk of over exploitation of the resources as the stocks are reaching their limits while on the other hand, aquaculture production has not matched its potential.

By 2010, this fisheries sector makes a significant contribution to the nutrition of the people in this region by providing regional average of 21% of the population's total animal protein intake. It provides 65% of the total animal intake in Ghana, while it reaches 63%, 57%, 36% and 8% in Sierra Leone, Gambia, Nigeria and South Africa respectively. However the per caput consumption of fish (8.3kg per capita) in this region is among the global lowest (Ajani, 2009). This is attributed to rapid population growth, stagnant capture fishery production, and the slow expansion of aquaculture in the region (FAO, 2008). The total fish supply in the region has however not kept pace with increasing demand. Generally about 200 million people representing 30 % of the continents population eat fish as their main source of animal protein.

In term of balance of trade through export, this sector is an important foreign exchange earner. Since 1985, the trade balance has been positive in value terms and Sub-Saharan Africa has remained a net fish exporter. Fish trade generated a surplus of about US$ 3.6billion in 2008, with the total value of exports estimated at US$ 4.4billion (FAO 2010). Also lot of revenues in foreign currency are generated through fisheries and fisheries related activities such as compensation, royalties and fees from fishing agreements negotiated with non-coastal countries.

Fisheries provide employment for over 4 million Africans, equivalent to about 9 % of the total employment of about 45 million people in world fisheries. Many small scale fisheries involve high food/livelihood dependency on fishing, and often represent employment of last resort particularly in weak and post conflict states. Fish exports from Africa are some 19 % of total agricultural volumes but notably 5 % of total value (SPFIF, 2010[1]). The total annual fisheries production is estimated to be about 9 million metric tonnes (of which 2.6 million tonnes came from inland fisheries) which represents about 7 % of world fisheries production and contribute at least $10 billion dollars to African economies every year (FAO, 2012[2]). About 150,000 fish farmers, producing a total of 1.3 million tons were reported in Africa (FAO 2012). On average, fish constitutes over 21 percent of daily protein intake for the region's population, and is the cheapest source of animal protein on the continent. NEPAD (2005) found that some 200 million Africans rely at least in part on fish for nutrition.

Other contributions of the fisheries and aquaculture to social and economy of this region include:

1. Promotion of gender equality and women empowerment: Lot of women are heavily involved in fish based livelihood activities such as processing and trade
2. Rural Development in relation to health as fish consumption has been related to reduction in child mortality and improves maternal health.
3. Reduction of HIV/AIDS, malaria and other related diseases: The nutritional benefits of fish consumption are also particularly important for people living with HIV/AIDS. Proper nutrition is essential for the effectiveness of anti-retroviral drugs, and fish has also been shown to contain combinations of nutrients which reduce susceptibility to secondary diseases.

[1] *SPFIF. 2010. Strategic Partnership for Fisheries Investment Fund in Africa. report*

[2] *FAO. 2012). The State of World Fisheries and Aquaculture 2012. The Food and Agriculture Organisation of the United Nations. Rome, Italy*

2.1 Trend in Fish production – Demand and supply.

In sub Sahara Africa, the fish production is from three main sources – Marine capture fisheries, inland or freshwater capture fisheries and aquaculture. Table 1 shows the production per water bodies in Africa

Table 1: *Status of global and African Fisheries and Aquaculture*

Fisheries Production	Global	%	Africa	%
Marine capture	79.50 Million tonnes	55.9	4.56 Million tonnes	57.0
Inland Capture	10.20 Million tonnes	7.2	2.50 Million tonnes	31.3
Aquaculture	52.60 Million tonnes	36.9	0.94 Million tonnes	11.7
Total	**142.3 Million tonnes**	**100**	**8.0 Million tonnes**	**100**

Adapted from SOFIA (2010)

2.2 Marine Fisheries Resources

Through marine fisheries, the livelihoods of millions of citizens along Africa's 30,490 km coastline are given a boost. The marine fisheries sector plays a crucial role for coastal nations across Africa. It contributes significantly to food security, income generation, and economic welfare.

The most common and abundance catch includes small pelagic species such as herrings and sardines with the large pelagic tuna like species also making a significant contribution, especially in the Indian Ocean. Also demersal species such as hake, sea breams, soles and crustaceans such as crabs, lobsters, shrimps, and mollusks such as abalones, conchs, oysters, mussels and scallops are also important part of the marine catches.

Over half of the Africa's fish production comes from Coastal and marine fisheries. Marine capture fisheries, concentrated along the western coast of the African continent, contribute more than 50 percent of African fish landings (see table 1). Total marine production has quadrupled in the last 50 years to a level of 4.56 million tonnes in 2008. Meanwhile, total value (first sale) of production is estimated at over US$7 billion annually (SOFIA, 2010).

Fishing in African waters is usually within the 200nm Exclusive Economic Zones where generally private licenses, joint ventures and access agreements with foreign vessels are the means of managing the larger commercial vessels, while many smaller coastal fisheries are still largely open access. Fisheries in the marine habitat in Africa are one of the most important sources of foreign exchange in the region.

Exploitation of Africa's marine fishery resources has followed an increasing general trend observed in recent years. Through the combination of heavy fishing pressure by artisanal fleets and by foreign industrial fishing vessels, (some of them practicing Illegal Unreported and Unregulated (IUU) fishing), many fish stocks are highly or over exploited, sustainability of these resources is therefore not guarantee, if urgent management action is not taken (Falaye 2006) . In addition, the effects of climate change which may modify the habitats, distribution and productivity of marine species is a factor that is becoming of increasing importance.

Nearly all the sub Saharan Africa coastal countries lack the capacity to effectively and efficiently utilize their coastal and marine assets, while simultaneously protecting them from degradation and exploitation. This has created a lot of challenges for African Marine Fisheries. The governance of commercial fisheries, particularly relating to industrial fishing by foreign boats supplying markets in Europe and Asia, is frequently undermined by a lack of transparency and accountability. Institutional quality is one of the key factors in the ability of a country to improve governance and manage corruption. Despite the socio-economic importance of fisheries resources to developing countries, often national fisheries institutions are under resourced and face challenging management situations

2.3 Inland Fisheries Resources

Throughout Africa, there are the occurrences of extensive inland water bodies from both natural and artificial rivers, lakes, streams and ponds, swamps, mangroves, salt marshes, coastal lagoons to reservoirs. In these extensive inland waters over 3,000 fish species can be found and these species form a major source of protein for a large part of the continents population. In contrast to marine fisheries, the catches from inland fisheries are almost entirely consumed on the continent. Fish, fishing and fisheries are an integral part of the culture and economy of many peoples and countries in Africa. Africa accounted for over two-thirds of total global inland capture production (FAO 2010). In 2010, reported global inland water catches exceeded 10 million tonnes and Africa was responsible for about 2.5 metric tonnes of the total global production.

The key feature of Inland fisheries is that it is often small scale and spreading over large areas. Fish are supplied into local market or exported to regional market comprising of neighbouring countries. This regional trade of the catch includes bartering or local consumption and is not always registered as part of the formal economy of a region, making estimates of catches often lower than the reality. Inland fisheries provide employment and income for several million people. A recent estimate of employment and income for seven major river basins found that in West and Central Africa alone fisheries provides livelihoods to more than 227,000 full-time fishers and yields an annual catch of about 570,000 tons with a first-sale value of $295 million, while in the whole of Africa over 10 million people are supported by fisheries (SOFIA, 2010). In 2010, total estimated landings from inland fisheries were 2.5 million tonnes, equivalent to 24.5 percent of global inland fisheries production.

As a proportion of total catches in Africa (both marine and inland), inland fisheries landings have increased from <25 % (1951) to 49 % (1999) and presently 30%.of the total catch in 2010. The five African countries with the highest reported global production (Table 2) were Uganda, Nigeria, United Republic of Tanzania, Egypt and Democratic Republic of Congo. The major fisheries included Lake Victoria, the River Congo Basin, the River Nile Basin, the River Niger-Benue Basin and the Chad Basin. It has been estimated that total annual production increased by 2 % per year during the 1980s and 1990s, yet this trend has been slowing down since then, and some of the major producers now experience stagnating or declining catches

There is also an urgent need for better data on inland fisheries that could be interpreted in both economic and ecological terms. Major sources of error in these officially reported statistics are deliberate misreporting, lack of attention to small-scale fishing activities, lack of status, capacity or training of local fishery officers as well as a reluctance to report catches because this is linked, in most countries, to license fees or other forms of taxation. The benefits this sector could provide are now threatened by ineffective fisheries governance.

Table 2: *Inland Capture Fisheries: Major Producer Countries in Africa*

Countries	2004 (Million tonnes)	2008 (Million tonnes)
Uganda	371,789	450,000
Nigeria	182,264	304,413
United Republic of Tanzania	312,040	281,690
Egypt	282,099	237,572
Democratic Republic of Congo	231,772	230,000

Adapted from SOFIA (2010)

Inland fisheries are seen as a valuable and an integral component of the lives of many people throughout Africa, and have an important contribution to make to sustainable development, including economic growth and poverty reduction.

2.4 Aquaculture

Aquaculture is probably the fastest growing food-producing sector and the latest figures for worldwide aquaculture show that it contributes 35 % of total fish production. This has been an astonishingly fast growth rate from only 16 % of total production 15 years ago. In sub-Saharan Africa aquaculture supplies around 3 % of fish production (Table 3). African aquaculture is characterized by production of protein for human consumption and the contribution of aquaculture to total fisheries production varies sharply from country to country (Falaye 2000).

Although the promise of aquaculture for income, employment and food supply has been widely recognised and often promoted, the development of aquaculture in most parts of Africa over recent decades has been disappointingly slow, and has frustrated the attempts of international development agencies, governments and private sector investors alike. However, with a greater recognition of the role of markets, and a rise in demand for aquaculture product, particularly around major urban centres, and for export purposes, the prospects for aquaculture appear to be changing, with encouraging growth in many locations. Given also that shortfalls from capture fisheries may become increasingly common, aquaculture production will have a steadily more important role in regional food supply

Aquaculture has grown strongly in most regions of the world where the potential exists, except in Sub-Saharan Africa. In the entire African region, only Egypt has achieved the scale of change observed elsewhere. In spite of decades of investment and technical input, and the continued hopes of many, aquaculture has failed to thrive where expected, and in many cases remains precarious and marginal. However, aquaculture has grown in specific conditions and contexts, and in spite of the many current economic, demographic and social challenges in the region, a more positive perspective of market-led growth, and more realistic understanding of technical potential, linked with the possibilities of broader economic regeneration, suggests that future opportunities may be much more definite.

The three top aquaculture producers are Egypt, alone accounting for 86 percent of the total for the continent, Nigeria with 7 percent and Madagascar with 2 percent (Table 3). Production has increased, but much more slowly than in other regions.

Africa currently produces about 7.68 million tonnes of fish each year, of this 4.56 million tonnes is from marine fisheries, and 2.3 million tonnes from inland fisheries (FAO 2010).

Table 3: *Trend in Aquaculture production in Sub Saharan Africa*

	1970	1980	1990	2000	2006	2008
Africa	10,271	26,202	81,015	399,788	754,406	940,440
Sub Saharan Africa	4,243	7,048	17,184	55,802	154,905	238,877

Adapted from FAO (2010)

2.5 General Trend

While capture fisheries rose steadily throughout the 1980s and 1990s, the marine fisheries remains stable and the inland capture are gradually increasing, the total production form capture fisheries presently stood at 6.9 million tonnes in 2010. In Africa, Aquaculture production has risen, but slowly. The total aquaculture production from sub Sahara Africa was 238,887 metric tonnes in 2008 representing only 0.5% of the global production. Nigeria is the leading producer in the region. These trends combined with population growth mean that per caput consumption of fish in Africa is low and stagnating, and in Sub-Saharan Africa specifically, per caput consumption has fallen in the past twenty years.

Africa's inland fisheries provide employment and income for households dependent on fishing and post-harvest activities. In 2008, over 4.1 million people across Africa relied directly on fishing as their primary source of livelihood. Also through supply from inland fisheries serves as the principal source of animal protein and essential micronutrients for millions of rural and urban-based poor. Yet catches from most inland fisheries have generally reached their maximum capacity, and many are now declining. Many of these fisheries are considered to be overfished, while the ecosystems that sustain them are threatened by eutrophication, deforestation, dams and other water management schemes. In the coming decades, increasing competition for water will be a major challenge for these fisheries.

With the exception of semi-industrial fisheries in a few large lakes and reservoirs, the level of private and public investments directed to Africa's inland fisheries is remarkably low. Yet in regions where inland fisheries and related activities are present, the potential contribution of these activities to the decentralized economic development process is substantial. To unleash this potential, an appropriate level of policy support and investment is required in different domains, including infrastructure and landing facilities, but above all, measures to reduce the high rate of postharvest losses.

3.0 CLIMATE CHANGE AND THE ENVIRONMENT

The term climate change is used to describe a marked change in the long- term average of a region's weather conditions. Climate is the average weather together with its variability. It is therefore the synthesis of weather in a given place over a period of at least 30 years (Akinsanmi, 2009). Climate parameters include temperature, rainfall, humidity, dew, wind, sunshine, mist, haze and clouds. Thus a drastic and permanent departure of climate patterns from mean values observed, constitute climate change.

According to NEST (2004), the current climate change, which is characterized by global warming, is of great concern for three main reasons:

a. The rate of global warming is much more rapid than past increase in temperature associated with natural climatic change. Temperatures are rising more rapidly than they have done for 10,000years.
b. A strong correlation exists between current global warming and increases in the atmospheric concentration of a set of heat-trapping gases known as greenhouse gases [carbon dioxide-(CO_2), Methane-(CH_4) and Nitrous Oxide (N_2O)]. Others are the halocarbons which also deplete the ozone layer and water vapour (H_2O).
c. The fact that climate change induced by human activities at industrial and subsistence levels have altered and continued to alter the composition of the atmosphere in ways that affect the climate.

Inability to recognize the necessity to balance man's livelihood needs and the environmental processes of the earth planet has resulted in global warming and climate change with the associated devastating effects.

In practical terms, each person requires up to forty trees to process the carbon dioxide that he exhales. However, up to 90% of natural covers (trees etc.) have been destroyed in many West African countries. Nigeria has only 4% cover which is a far cry of the 25% average recommended by FAO for a sustainable environment (Asiodu, 2013). On the whole, the projected impacts of unmitigated climate change in Africa are likely to have significant impacts on human livelihoods, health, water resources, fisheries and aquaculture sector and food security. All these would undermine economic prosperity across much of the continent.

The continent of Africa is practically vulnerable to climate change effects. This has reflected in fisheries and aquaculture in different ways. However, there has not been much effort at creating awareness on its impact and mitigation in this sector when compared to other agricultural sectors.

Hence, this presentation will focus on the impacts of climate change on the fisheries and aquaculture sub-sector and the need for immediate short and long - term actions to forestall further disastrous effects on the environment.

3.1 Causes of Climate Change

The exploitation of natural resources has been intensively carried out with little or no regard to environment. Unfortunately, the wanton exploitation of natural resources, soil degradation, rapid deforestation, desertification, degradation of land and aquatic habitat, oil pollution, rapid urbanization and harmful waste disposal have led to depletion of natural resources, ecological imbalance, environmental degradation and pollution. Osibanjo (2008) reported that these factors have worsened poverty in developing countries and have increased conflicts between development proponents and host communities over their resources.

The destruction and over- exploitation of natural resources of the earth in the name of development has been most catastrophic and unsustainable, as they are most times devoid of environmental considerations.

Unfortunately, these anthropogenic activities have further contributed to the exacerbation of the processes of climate change. On the other hand, sustainable development meets the need of the present, without compromising future utility. This indeed is most desirable!

3.1.1 Environmental Factors

Nigerian environmental system is characterized by combination of natural features that make it uniquely susceptible and highly fragile. The more recent phenomenon of global warming further accentuated the rate of environmental degradation (NCF, 2009). Aside from environmental threats posed by natural physical setting, human activities have further amplified vulnerability to environmental degradation (Figure 1). These include:

- **Population growth and urbanization:-** Nigeria has been experiencing relatively rapid population growth and increased urbanization over the last few decades; proportion of population living in the urban centers has risen from 15% in 1960 to 43.3% in 2000 and is projected to rise to 60% by 2015. This has put a lot of pressure on our forests as the rising farming population seeks for more land for survival while wetlands are being converted to residential areas.
- **Deforestation:-** The continuous removal of significant forest cover has resulted in a highly degraded environment with attendant reduction in biodiversity. Deforestation has resulted in changes in land use and vegetation cover as reflected in decreases in natural forests, shrub/grassland, water bodies, and increase in built-up areas. The high rate of deforestation resulted from; uncontrolled bush burning, overgrazing and oil exploration activities.
- **Desertification:-** In African countries, the effects of desertification have become acute. Land areas of between 50% and 75% of Bauchi, Borno, Gombe, Kano, Jigawa, Katsina, Kebbi, Sokoto, Zamfara and Yobe states in Nigeria are under threats of desertification. These ten states, with a population of about 27million people, account for about 38% of Nigeria's land area. In these areas, population pressure, resulting in overgrazing, over-exploitation for fuel wood of marginal land and aggravated drought due to global warming have accelerated the rate of desertification.
- **Erosion:-** Erosion is one of the most critical environmental problems affecting different parts of the country and it is particularly severe in areas of the country underlain by sandy formations. Classical erosion features are found in many African States. The degradation caused by erosion is occurring at an increasing and alarming rate, aggravated by such factors, as increased agricultural activities, civil construction works deforestation, bush burning, overgrazing, urbanization and increased population pressure.
- The vulnerability of many African countries account for their being 14 of the 20 most at risk nations of the world to natural susceptibility to extreme climate – related hazards. According to the 2013 index report, Nigeria is one of those expected to be most affected by impacts of climate change effects through sea level rise along her coast line, desertification, erosion, flooding disasters and land degradation with accompanying ecosystem destruction are mangrove and rain forests on the Atlantic Coast to the savannah in the North. The risks were also consequences of the vulnerability and inadequacies of existing infrastructure to adapt to or tackle the problems due to weak economies, governance and healthcare.

3.2 Role of oceans in mitigation of climate change

Oceans provide environmental services as well as food security and livelihood. These aquatic bodies support the earth to sequestrate carbon dioxide while, oceans currently take up a third of the carbon emitted by human activity, roughly two billion metric tons each year. The amount of carbon that would double the load in the atmosphere would increase the concentration in the deep ocean by only two percent. However, rising ocean temperatures and ocean acidification is leading to the weakening of that the capacity of the ocean carbon sink. According to IPPC (2007) reported that increases in sea level are consistent with warming; and that global average sea level rose at an average rate of 1.8 mm per year over 1961 to 2003 and at an average

rate of about 3.1 mm per year from 1993 to 2003. The thermal expansion of the oceans contributed about 57% of the sum of the estimated individual contributions to the sea level rise, with decreases in glaciers and ice caps contributing about 28% and losses from the polar ice sheets contributing the remainder. Therefore, healthy ocean ecosystems are essential for the mitigation of climate change.

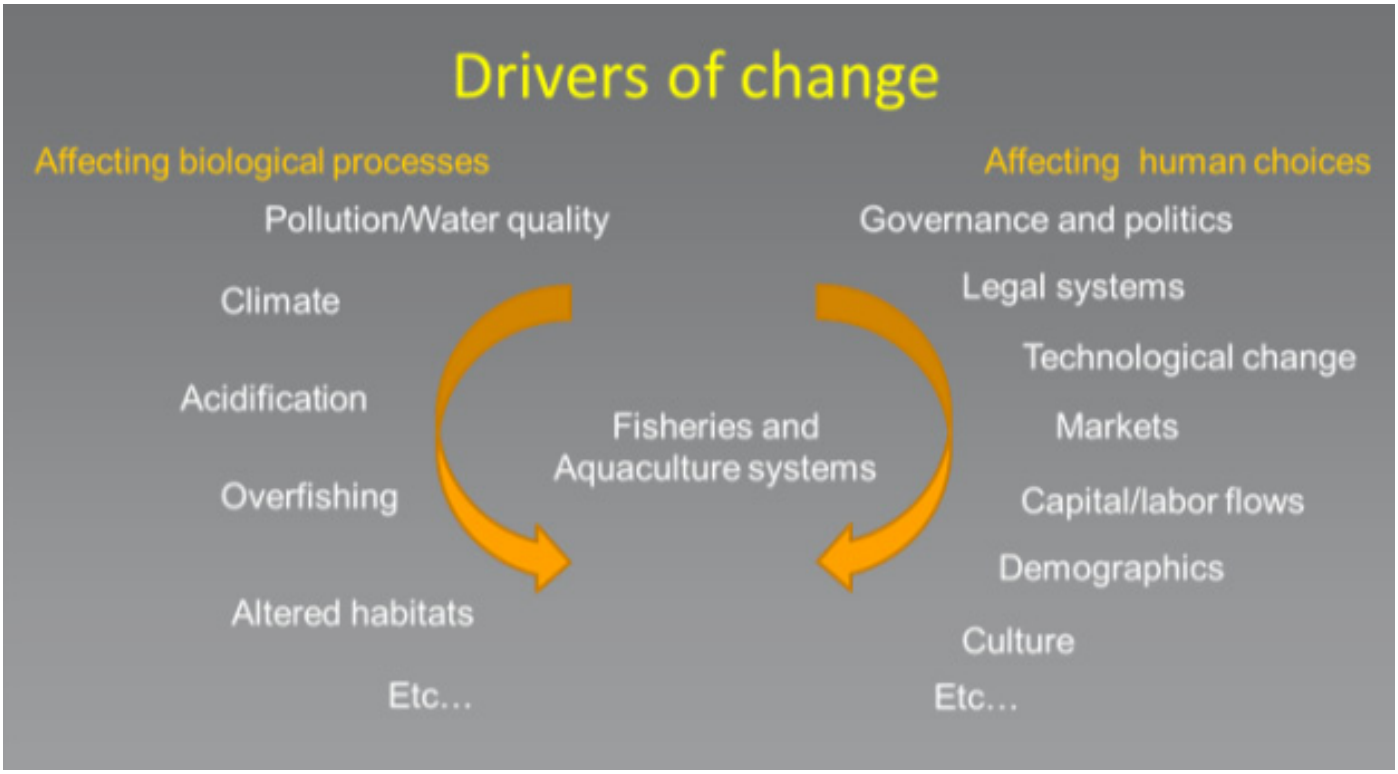


Figure 1: *Factors Affecting Climate Change*

4.0 GREENHOUSE GASES (GHG) AND CLIMATE CHANGE

The UN's Inter-Governmental Panel on Climate Change (IPCC) Report confirmed that human actions have led to an increase in average global temperature since 1750, primarily through the burning of fossil fuels (oil and gas), agricultural activities and changes in land utilisation.

In recent times more frequent storms (e.g. New Orleans), flooding(e.g. Jakarta), droughts in Africa, melting glaciers and dwindling ice caps, and the warmest winter in over 100 years have provided clear indications of the consequences of climate change.

UN's Inter-Governmental Panel on Climate Change (IPCC) in its February 2007 Report along with 1990, 1995, 2001 earlier reports makes clearer than ever before that climate change effects are already with us

Humans are the main cause of these developments.

4.1 Major Sources of Greenhouse Gases

Greenhouse gases, which are central to the climate change problem, are so called because they produce the greenhouse effect. The warming of the greenhouse because of the inability of heat to escape through the glass is the greenhouse effect. This readily allows sun rays to reach the Earth but impede the escape of the resulting earth's heat into space.

Carbon dioxide (Co2) is by far the most important greenhouse gas, contributing more than 60% of the greenhouse effect. It stays in the atmosphere for a much longer time (>100 years) than the other natural greenhouse gases (about 12 years). Carbon dioxide is mainly produced by the combustion of the fossil fuels viz coal, oil and gas, and it formed 80% of the greenhouse gas emissions of industrialized countries in 1990. The use of these fossil fuels to power industrialization since the late 1800s (about 200 years ago), has led to a phenomenal rise in the concentration of carbon dioxide in the atmosphere.

Carbon dioxide is emitted naturally into the atmosphere by respiration of most living things, both plants and animals as well as by decay of organic matter and chemical breakdown or combustion of carbon and oxygen containing minerals like calcium carbonate (used for making cement) or biomass burning or volcanic eruptions. These are the natural sources of carbon dioxide. Carbon dioxide is absorbed and sequestered naturally by plants in photosynthesis, land and in water bodies, especially the ocean.

4.2 Regional Growth of Co2 Emission and Top Ten Co2 Emitters

Although climate change is complex, it has been recognized that developed countries have significantly caused the problems (Figure 2).

The biggest shares of global emissions are USA (>21%) and China (~18%) followed by Russia (~6%), Japan (~4.5%), India (~4%) and Germany (~3.2%).

According to the International Atomic Energy Agency, energy – related emissions will rise by almost 50% to about 40 billion tons of CO2 by 2030 if counter measures are not taken.

As the world's largest coal consumer, China is expected to surpass the U.S. as the largest producer of CO2 by 2015. But China's emissions are still low, seen on a per capita basis: about 4 tons of CO_2 per year, compared to roughly 10 tons in Germany and 20 tons in the USA. (Figures 3 and 4)

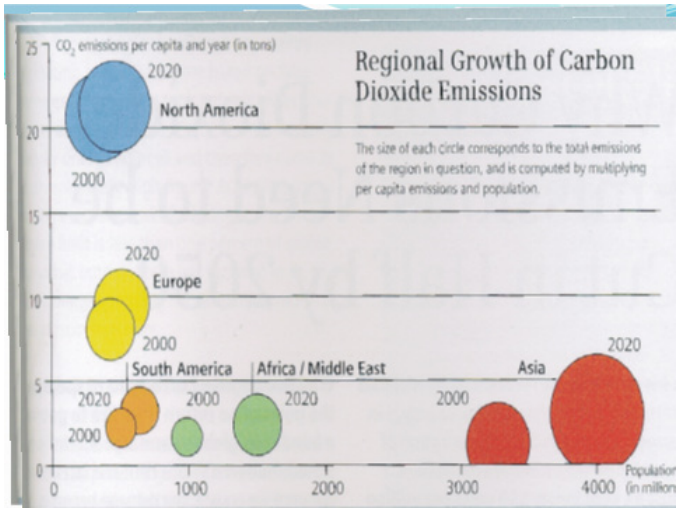


Figure 2: *Regional Growth of Carbon Dioxide Emissions.*

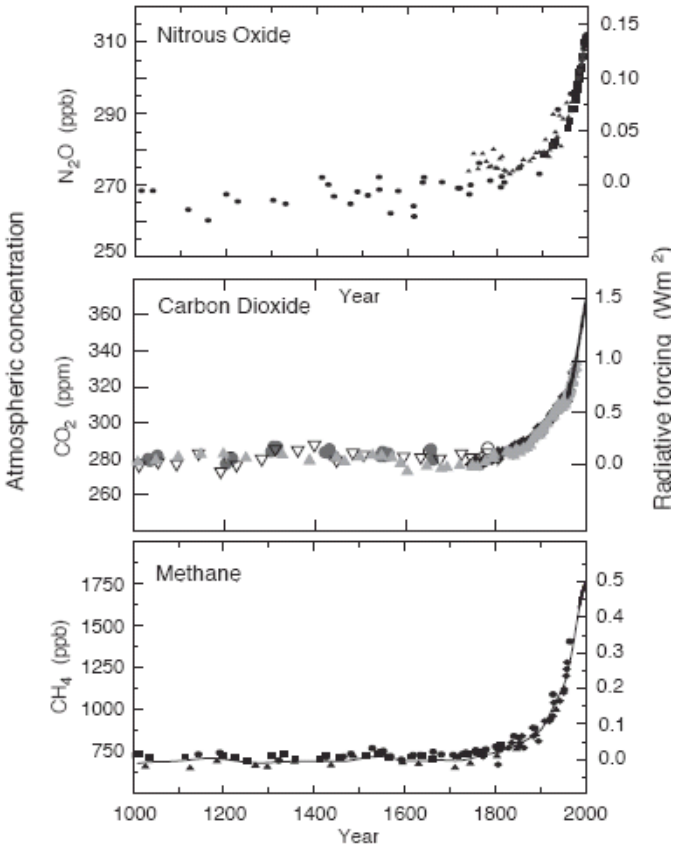


Figure 3: *Change, since 1000 AD in the atmospheric concentrations of three of the major greenhouse gases.*

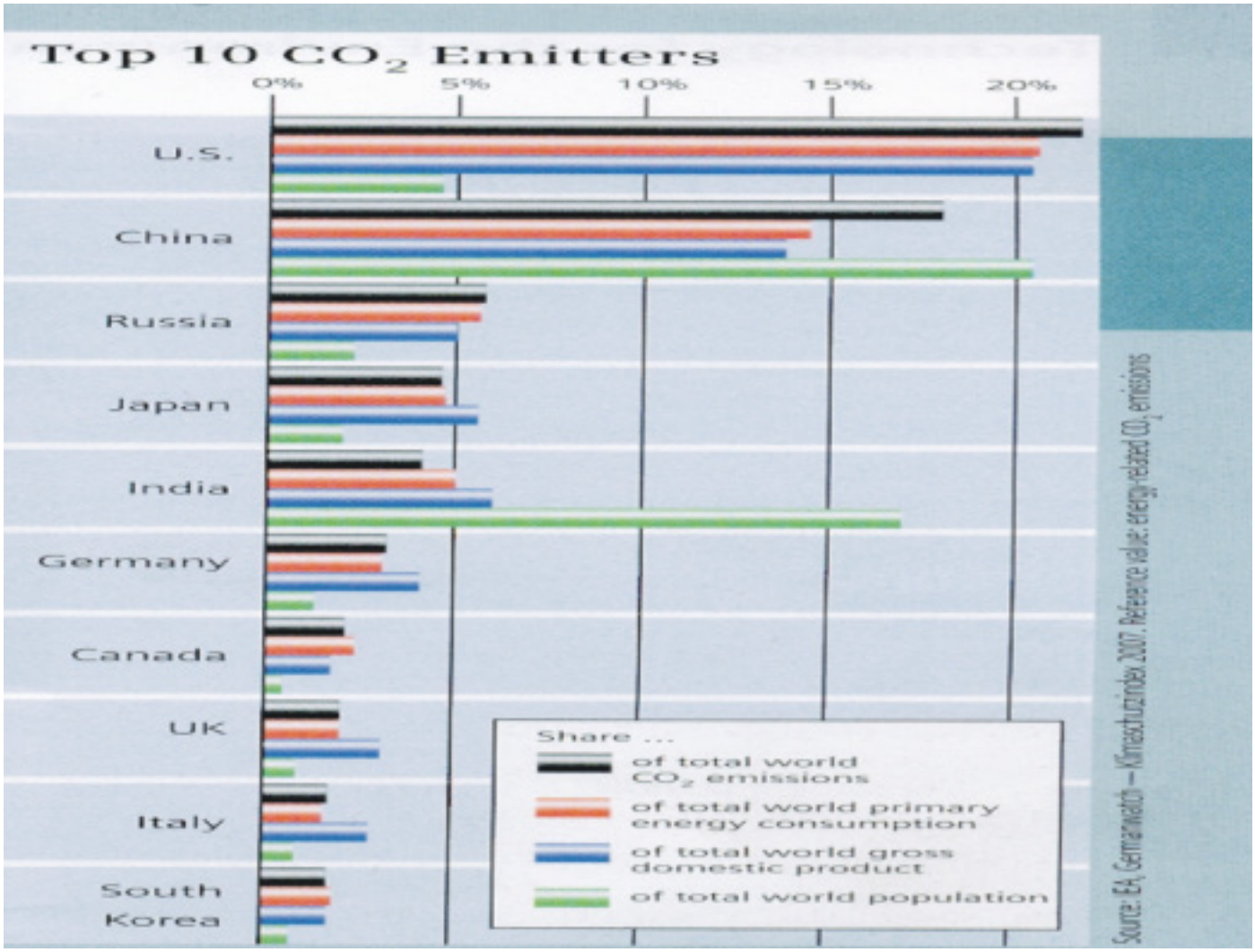


Figure 4: *Top Ten CO2 Emitters*



Figure 5: *Emission of CO2 from bush burning*



Figure 6: *CO_2 Emission from burning of used tyres in Africa*

Reduction of gas flaring would provide a win-win scenario as new gas utilisation opportunities and markets would emerge while the environment would be cleaner and healthier for the people, with concomitant reduction in Green House Gas emission.



Figure 7: *Gas flaring from an oil producing installation*



Figure 8: *Sea incursion- Proportion of Land Submerged under the sea.*



Figure 9: *Desertification*

5.0 IMPACTS OF CLIMATE CHANGE

The impacts of climate change are already being experienced across the globe. The intergovernmental panel on climate change (IPCC) has concluded that human activity (primarily related to fossil fuel consumption) is largely responsible. While climate change will affect everyone, it is expected to have a disproportionate effect on those living in poverty in developing countries.

The adverse impacts could include greater and more rapid sea level rise than previously predicted, and more frequent coastal storms, threatening the lives and livelihoods of coastal communities. (Fig. 10)

The development challenge described above is exacerbated by climate change, which amplifies the existing natural variability of the system. Depending on the area, a 1-in-100 years extreme event is now expected approximately every 1 in 10 years, or even more frequently. Temperature will rise by 1 to 2 degrees Celsius by 2050, accompanied by continually more variable rainfall. Climate change will likely exacerbate existing climate variability and increase the frequency and magnitude of extreme events (IPCC, 2007c). According to the Nigerian Meteorological Service, the country is already experiencing climate variability in the form of drought, floods, shifts in rainy season onset and completion, as well as increase rainfall intensity.

Impacts of climate change can be classified as:

- **Catastrophic:** effects of climate disasters or hazards such as typhoons, hailstorms, droughts and sudden floods
- **Chronic:** new conditions such as higher temperatures, sea level rise, saline intrusions, subsiding water tables, more or less rainfall, less predictable seasons.

They include:

- Increased incidence of extreme weather events
- Substantial reductions in surface water resources leading to accelerated desertification in sensitive arid zones (Fig.11).
- Greater threats to health such as malaria, biodiversity including the bleaching of coral species on the East African tropical reef systems and agricultural production (a predicted decline of 12% in production in Africa by 2080)
- Transnational rivers in Africa may be sensitive to even moderate reductions in rainfall, as are projected for much of western and southern Africa.
- Such reductions in rainfall could threaten sub-regional/regional security through increase in inter-communal and inter-state conflicts over scarce water resources and threaten the sustainability of hydro-electric power generation, if not managed in a proactive manner.
- Overall, the projected impacts of unmitigated climate change in Africa are likely to have significant impacts on human livelihoods, health, water resources, agricultural production and food security. – All these would undermine economic prosperity across much of the continent.

5.1. Vulnerability of Developing Countries to Climate Change

Developing Countries are most vulnerable to the effects of climate change. While the development of science and technology has enabled the advanced nations manage changes to their climate, developing countries are most vulnerable and least equipped to adapt (Table 2). The majority of developing countries are in tropical and sub-tropical regions, areas predicted to be seriously affected by the impacts of climate change: Africa, Asia, Latin America and the Small Island States such as Mauritius have all been identified as regions of concern. This is compounded by the fact that developing countries are often less able to cope with adverse climate impacts

due to low adaptive capacity. Poverty exacerbates, and is exacerbated by, the impacts of environmental change: Between 1990 and 1998, 97% of all natural disaster-related deaths occurred in developing countries. 90% of all natural disasters are climate, weather and water related. Livelihoods are highly dependent on climate-sensitive resources: agriculture in Sub-Saharan Africa, of which up to 90% is rain-fed, accounts for 70% of regional employment and 35% of gross national product. In 2004, severe flooding in Bangladesh caused by excessive rains of the annual Asian Summer Monsoon, killed over 600 people and displaced over 20 million. The greater frequency and severity of climate shocks is repeatedly eroding coping capacity.

Table 2: *Climate Change impacts in developing countries.*

Enviromental Impact	Socio-economic resources and sector affected
• Changes in rainfall patterns • Increase frequency and severity of: - Floods - Drought - Storms - Heat wave • Changes in growing seasons and regions • Changes in water quality and quantity • Sea level rise • Glacial melt	• Water resources • Agriculture and forestry • Food security • Human health • Infrastructure (e.g. transport) • Settlements displacement of inhabitants and losss of livelihood • Coastal management • Indutry and energy • Disater response and recovery plans

5.2 Vulnerability of Small Island Developing States fisheries to climate change

Many small islands which are surrounded by oceans are often susceptible to the impact of climate change. These include Small Island Developing States (SIDS) which are more vulnerable to climate change than their continental counterparts. Fifty two countries and territories have been classified by the United Nations as Small Island Developing States (SIDS), some of the SIDS are located in Africa (Table 3). These small countries are extremely dependent on the sea and its living marine resources for their existence. In some SIDS, fisheries account for over 50 percent of exports; subsistence fishing supplies between 50 and 90 percent of animal protein consumption in rural populace and remote islands; while in the Pacific, tuna fisheries contributes more than 10 percent of GDP (UN – Department of Economic & Social Affairs, 2010). African SIDS, are no exception; fish constitute the major source of animal protein and export earnings (Table 3). In the SIDS of Africa, many people live in the low elevation coastal zone (LECZ) (coast area of equal to or less than 10 metres above sea level). LECZ are vulnerable to sea-level rise, storm surges, floods and other climate change-induced hazards.

Table 3: *Country and Fish production/Consumption in some Island States of Africa*

Country	Fish Prodution (tonnes)	Export (tonnes)	Per capital supply (Kg)	Fish/Animal Protein (%)
ape Verde	18,328	14,524	11.6	11.7
Comoros	16,000	0	19.8	56.3
Madagascar	159,035	44,776	7.4	19.6
Mauritius	8,476	132,554	22.8	18.4
Seychelles	66,239	63,471	61.0	40.6
Sao Tome & Principe	4,150	6	26.5	49.3

Source: *FAO Yearbook (2009)*

Many of these states are experiencing the impact of climate change through limited availability of freshwater resources which lead to poor productivity of agriculture and resultant food insecurity. In view of the poor protection from the climatic elements, these areas are most vulnerable to soil erosion and habitat loss.

Increasing sea temperature is also responsible for environmental challenges like coral reefs destruction and acidification of the oceans resulting in loss of biodiversity, food insecurity and loss of tourism revenues.

5.3 Some Identified Vulnerabilities of relevance to the sector

Some of the most common vulnerabilities identified with specific regard to climate change and disasters include floods; heavy rains; increased variability in precipitation; storms; droughts; sea level rise (and saltwater intrusion); coastal erosion; water temperature increase; coral bleaching; changes in pattern of upwelling along the Gulf of Guinea; increase in frequency of fogs, cyclones and typhoons and increased wave energy. These factors were noted to potentially cause: degradation or destruction of spawning areas and habitats; migration of fish; changes in the ecosystem such as mangrove; reduction of biodiversity; reduction of productivity levels; changes to species life cycles; damage to/loss of gear and infrastructure; siltation of rivers, lakes and ponds (Figure 10), as well as proliferation of invasive water plants..Other vulnerabilities include significant post-harvest losses; overexploitation of fisheries resources; overexploitation of mangrove forests and deforestation in general; pollution (from oil exploration, pesticide run-off, waste); use of destructive gear (dynamite and poison/chemicals); absence or lack of implementation/enforcement of a national policy or legal framework for the sector;

illegal and unreported fishing; unsuitable fish farming; introduction of exotic species and urbanisation of the coastline.

Altogether, the vulnerabilities and their impacts lead to loss of livelihoods and income; greater risks involved in fishing at sea; food insecurity; displacement and migration of people from fishing areas; conflicts between different groups of fishers and consequent dependency on imports of fish products.



Figure 10: *Effects of the 2012 Flood Disaster on The University of Ibadan Fish Farm.*

6.0. ACHIEVING DISASTER AND CLIMATE RESILIENCE

In Africa, strategies could be developed to strengthen flood risk management and protect human lives as well as property, infrastructure, and production of goods and services by adopting cost-effective strategies that focus on managing floods and integrating the concept of living with floods, protecting key assets, and minimizing losses. Recommendations to further concretize the region's flood disaster management capacity are presented below. A number of activities could be financially supported by Flood Commission Funds, existing government programs, and possible future financing from development partners, including the World Bank, Regional Development Banks, UN, and EU, or bilateral donors. According to (PDNA 2012), three major areas of investment have been identified with details presented in Tables 4 and 5. They include:

i. Strengthen DRM (Disaster Risk Management) and climate change adaptation.
ii. Build community resilience
iii. Ensure disaster and climate change resilience in key sectors. specific actions and government agencies responsible should be put in place.

7.0. IMPORTANCE OF FISHERIES AND AQUACULTURE

Fish and fish products have substantial social economic, nutritional and food security importance. The contribution of fisheries to Nigeria's socio-economic wealth is significant, particularly in terms of employment creation, income generation provision of valuable animal protein, rural development and foreign exchange earnings through export of finfish and shellfish products.

- Fisheries resources of Africa are sources of wealth, health, food and nutrition, and gainful employment.
- They provide income for over 10 million people mostly women engaged in production, processing and trade.
- Fish has also become a leading export agricultural commodity with a current annual export value of US$4.4 billion, in sub Saharan Africa.
- In nutrition, fish and fisheries products provide regional average of 21% of the population's total animal protein intake. The per caput consumption of fish (8.3kg per capita) in this region is however among the lowest globally.

Apart from being a source of protein, micro nutrient and essential fatty acids fish provide important complement to the predominantly carbohydrate – based diet of many poor people in Africa.

- 200 million people representing 30 % of the African continent's population eat fish as their main source of animal protein.
- It is noted that fisheries account for a substantial percent of many country's Gross Domestic Product (GDP) in many African countries.
- Other social and economic importance of fisheries and aquaculture include
  - Promotion of gender equality and women empowerment.
  - Rural Development in relation to health as fish consumption has been related to reduction in child mortality and improved maternal health.
  - Reduction of HIV/AIDS, malaria and other diseases: The nutritional benefits of fish consumption are particularly important for people living with HIV/AIDS.

7.1. Climate Change Impacts on Fisheries and Aquaculture

A major challenge to the fisheries sub-sector is the drastic effects of global climate change while considering the real and potential problems associated with this global phenomenon (Figure 11).

Fish production remains the main sources of livelihood for riverine and coastal rural communities where a significant proportion engages in artisan fisheries. Nigeria along with all countries of sub-Sahara Africa, are considered highly vulnerable to the impact to climate change according to the fourth assessment reports of the intergovernmental Panel on Climate Change (IPCC) for the following reasons:

- The apparent impacts of climate change including sea level rise, flooding, loss of biodiversity, depletion of water bodies and desertification have threatened Africa's capacity to contribute to the increased growth of aquaculture and fisheries production.
- There are possibilities of many coastal towns, fishing villages and communities disappearing in Niger delta and other coastal zones of Africa, including Mahin in Ondo State, and Lagos, Nigeria.
- Desertification and loss of water bodies and fishing grounds, such as Lake Chad and Lake Kariba, with the associated drastic reduction of fishing potentials and valuable fish stocks.

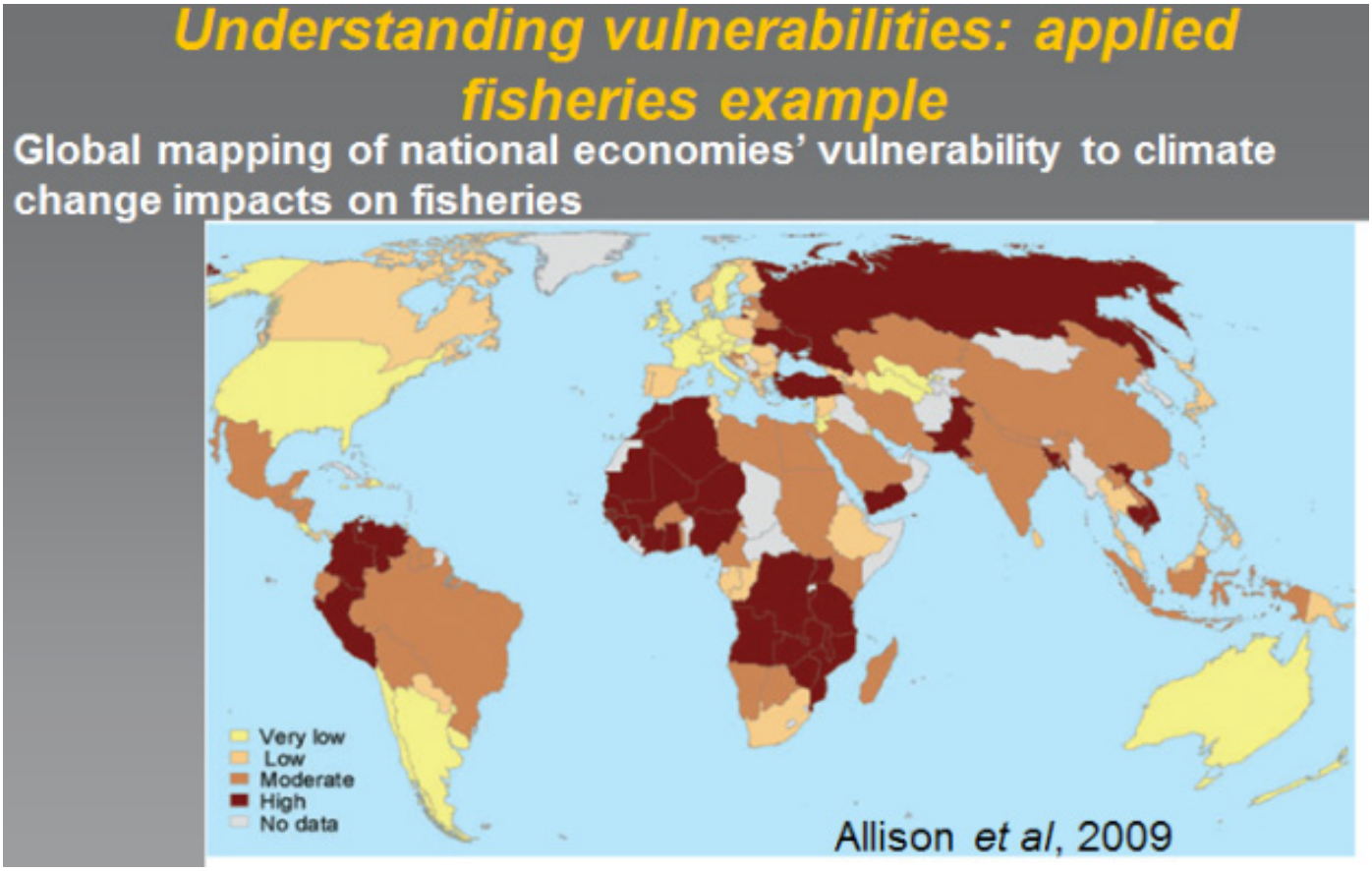


Figure 11: *Global Mapping of National Economies'Vulnerability to Climate Change Impacts on Fisheries*

There will be greater incidence of extreme weather events, coral reef and mangrove loss, and loss of biodiversity.

Coral reefs are of utmost importance as basic components of ocean ecosystems and they perform essential functions ranging from water filtration and fish reproduction to shore line protection and erosion prevention. The vital role of balancing ecological relationships by reefs keeps our marine ecosystems diverse and abundant with life.

Coral reefs are beautiful and they have great commercial value in the eco-tourism industry. The reefs are like undersea cities, filled with colorful fish, intricate formations and wondrous sea creatures which attract tourists and other recreational interests.

The impacts of climate change can however have adverse effects on coral reefs which help to protect the shoreline from storms and surge water by effectively reducing waves. This could therefore, lead to the loss of tourism value and destruction of mangroves and sea grass beds, which can easily be uprooted by large waves and high currents. Erosion prevention is therefore important in coastal areas of Africa, which are particularly vulnerable to negative effects of climate change including sea incursion.

- Temperature changes will also affect fish physiology with implications for both capture fisheries and fish farming.
- Increased ambient air temperatures could have very significant negative effects on the types of fish that can be cultured.
- Hazards and Disasters such as:
  - Flooding leading to washing away of key infrastructures –ponds, tanks and stocked species
  - Economic losses
  - Diseases and parasites infection through floodwater

- Sea-level rise, which is expected to exacerbate, inundation, storm surge, erosion and other coastal hazards, thus threatening vital infrastructure, settlements and facilities that support the livelihood of island communities.

- Ecosystem productivity in the tropical waters is likely to be reduced.
- Lake Chad in Nigeria has already suffered water loss and dwindling fish catches.
- Lake Victoria and the Congo basin are also under threat of climatic change, while the Zambezi is facing depletion of its natural resources.

Note: Zambezi basin which is the fourth largest river Basin in Africa and draws water from eight different countries in Southern Africa is also not excluded from deleterious climatic change effects.

- Fluctuating water levels through drying and flooding destroy breeding sites of fish species, expose the products (fry, fingerling), reducing and probably eliminating recruitment of future fish populations e.g. in Eleyele and Asejire reservoirs of Southwest Nigeria there has been reduction in fish landed by fisherfolk. In addition fluctuating water levels affect fisherfolks' livelihood, because there is less fish/landings for fishermen and for women who process them. Furthermore, the fluctuating water levels affect the economy of the fisherfolk, e.g. in river Numa in Kebbi State and Kainji Lake both in Nigeria, fish landing have been declining.
- Fish physiology is adapted to certain temperature ranges. Therefore increasing water temperatures will affect fish by altering physiological functions such as thermal tolerance, growth metabolism, food consumption, reproductive success and ability to maintain internal homeostasis in the face of a variable external environment (Fry, 1971).
- Additionally, increases in water temperature will also decrease water quality by enhancing eutrophic conditions and stimulating explosive growth of aquatic macrophytes. NEST and Tegler (2011) reported a 2-30C temperature increase caused a 300% to 500% increase in shoot biomass of the aquatic macrophyte, Elodea canadensi, which takes up the phosphorus in the sediment. Decomposed dead macrophyte leads to depressed levels of dissolved oxygen which can cause fish kills.
- Vegetation cover that favours fish production in wetlands may be reduced because of reduced groundwater levels. Lowered water levels lead to an overall reduction of fish habitat and fish resources and an increased in fisherfolk per unit of available fishing area further depleting resources and lowering fish catch.

7.2 Vulnerability of fisheries and aquaculture to climate change

- The effect of climate change will further exacerbate stresses on fisheries and aquaculture and put pressure on the ability to provide current benefits of food and livelihoods to many Africans (Figures 12 and 13).
- According to Allison et al. (2009), vulnerability of fishery reflects a combination of three key factors: the exposure of the fisheries to climate change, the degree of sensitivity to climate impacts, and the adaptive capacity of the sector.
- Dulvy and Allison (2009) reported that most African nations, particularly those in the East, Central and West face the double jeopardy of high vulnerability to climate effects on both their fisheries and agriculture sectors. Three countries in particular have both the highest national vulnerability to climate impacts on fisheries and 'extremely alarming' global hunger indices: Sierra Leone, Niger and the Democratic Republic of the Congo.
- Using the West African states, Lam et al (2012) predicted that all 14 countries except the Gambia, Western Sahara, Mauritania and Senegal will experience a decline in fish landings by between 8% and 21% in 2050 due to climate change. This reduction in landings will have massive implication on food security, with some countries losing as much as 7% of the protein source.

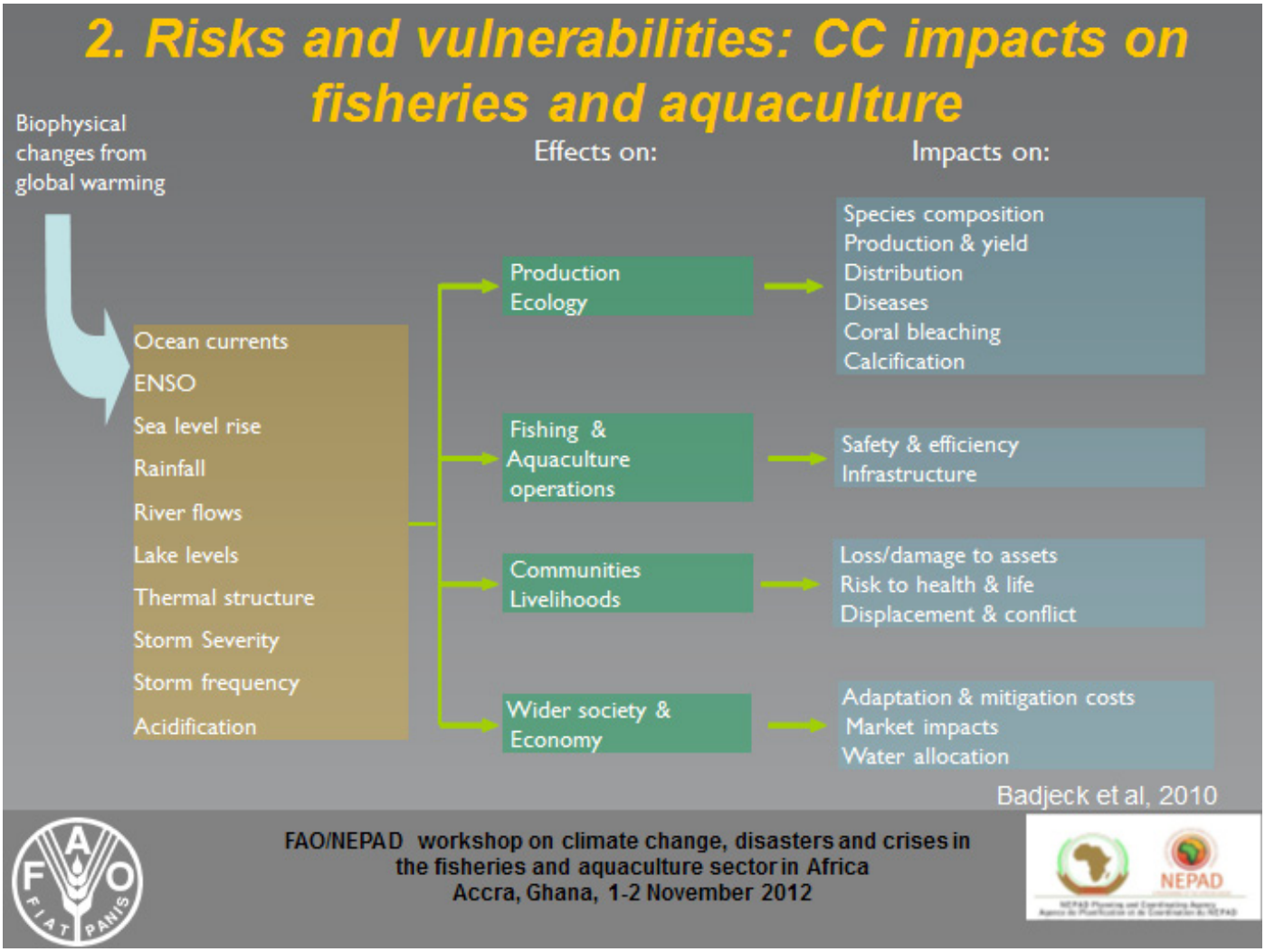


Figure 12: *Risks and Vulnerabilities –Climate Change Impacts on Fisheries and Aquaculture*



Figure 13: *Flooded integrated fish cum crop field*

8.0. REMEDIES

- Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) need to be integrated into a combined strategy to increase efficiency, reduce costs, and increase effectiveness and sustainability
- Reducing the effects of hazards can be achieved through prevention, mitigation, preparedness and effective response.
- These approaches need to be implemented at a number of different levels from global, regional, sub-regional and national to local level.
- These require an integrated approach to institutional engagement that works across sectors and between levels (Figure 14).

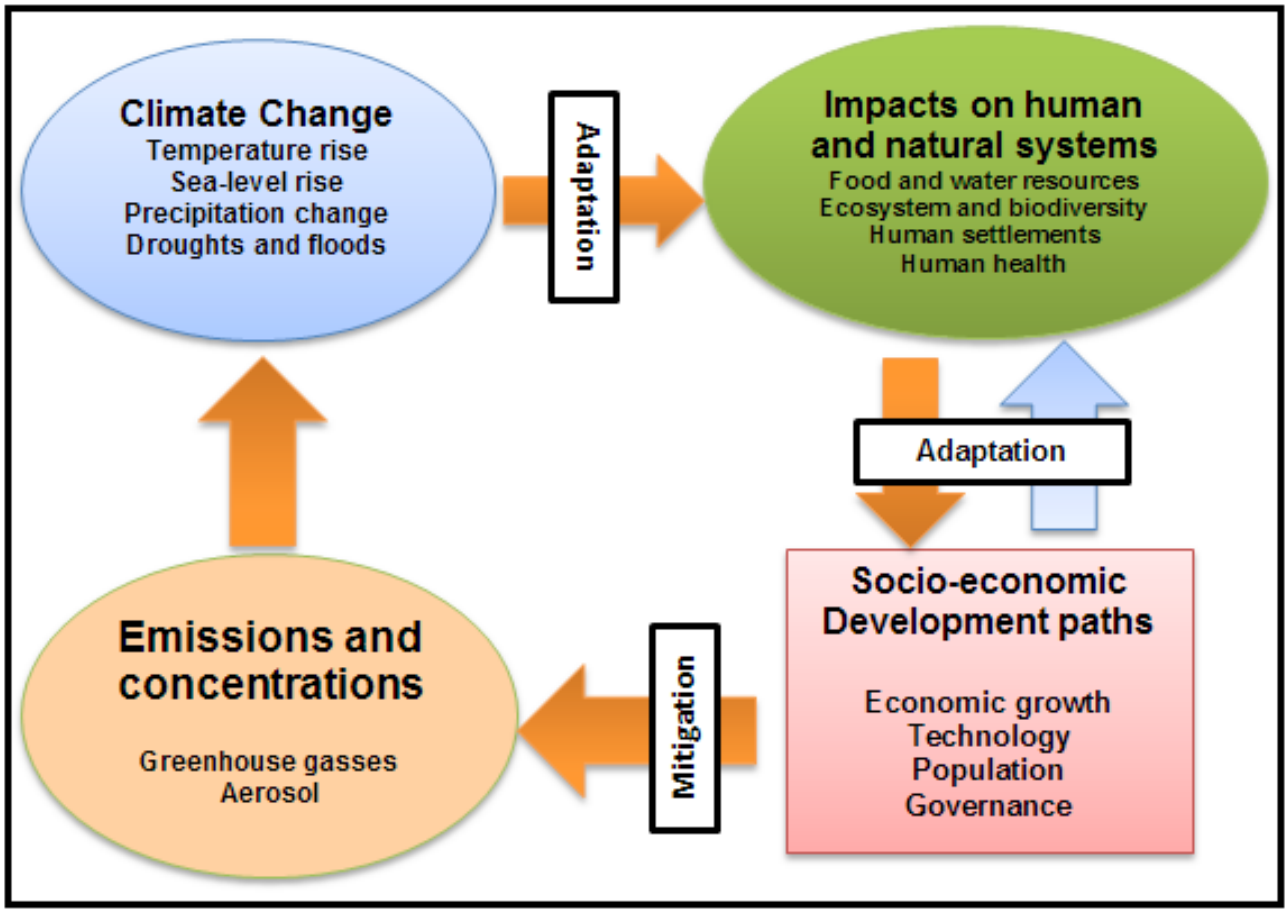


Figure 14: *Climate Change Impact Assessment steps for Remedial Action*

8.1 Responses of Policy Makers to Climate Change in Fisheries in Africa

In many developed countries adequate plans have been put in place as effective mitigative measures against climate change and other disasters. However in Africa, broad national strategies for adaptation and mitigation against the impact of climate change are few. This is due to a number of reasons including, lack of capacity among national fisheries authorities (Departments and Ministries); lack of scientific information which authorities can use as evidence for policy formulation; and institutional barrier because climate change issues at both national and international levels tend to be championed by the ministries responsible for environment. Therefore policies with specific relevance to fisheries and aquaculture will be required in African countries as effective mitigation against threats of climate change. Consequently, it was recommended at the first Conference of African Ministers of Fisheries and Aquaculture (CAMFA 1), held in The Gambia, in September 2010, that: "Member States, RECs and RFBs mainstream climate change in fisheries policies, development and management programmes "

As reported, the African Fisheries Policy Day which was jointly convened by the NEPAD Agency and the University of Dar es Salaam in July 2012 highlighted a number of the policy issues which need to be taken into account by national fisheries authorities. Some of these critical issues included the need to deepen the interaction between fisheries and environment ministries at country level, strengthening regional water management for shared water basins, enhancing the capacity of African scientists to develop location-specific strategies for adaptation; and raise the African Voice on impact of climate change to fisheries during such international discourses as the United Nation's Framework Convention on Climate Change (UNFCC)'s Conference of Parties (COP).

8.2.1 Hazard-Impact-Vulnerability-Adaption Matrix for Natural Resource: Fishery Resources Sub-Sector:

A Hazard-Impact-Vulnerability-Adaption Matrix for Natural Resource for Fishery Resources Sub-Sector for consideration is included in Table 4 below.

Table 4: *Hazard-Impact-Vulnerability-Adaption Matrix for Natural Resource: Fishery Resources Sub-Sector:*

Climate Change Hazards	Climate Change Impacts	Determinants of Vulnerability	Adaptation Options
Eco zone: ALL			
Increased aridity from temperature increase	Drying up of waterways, drawing down of water levels in reservoirs and wetlands and ground water Loss of biological diversity of fisheries resources due to habitat degradation (e.g. fish, clams, water snails). Loss of sources of livelihood Shortage of fuel wood for smoking fish Lower water level in reservoirs Water quality for fish declines because les water flow and less amount of water for dilution of nutrients Lowered groundwater levels causes reduction in vegetation cover along margins of wetlands Increase in aquatic vegetation (e.g. water hyacinth) along the edge of waterways	• High poverty levels • Prohibitive cost of protecting habitat and infrastructure: fishing gear is expensive • Lack of financial resources to use coal and smoking kilns • Not enough Fish Extension Officers employed by government • People no longer manage fish resources effectively (e.g. closed season, type of gear used) • Lack of education and use of traditional knowledge to manage fish resources • Competition for groundwater for drinking, for agriculture and for fish farming	Alternative livelihoods (e.g. farming of crops, aquaculture, trading) Where natural water bodies and fish resources declining switch to aquaculture Refinement of early warning and monitoring systems (e.g. meteorological water levels, fish catch) to improve fish resource management Research into alternative fish processing strategies e.g. utilization of solar energy Fish cooperative should be encouraged Physical harvesting and chemical destruction of macrophysics e.g. water hyacinth. Alternative utilization of weeds Dredge sited water ways

Climate Change Hazards	Climate Change Impacts	Determinants of Vulnerability	Adaptation Options
	• Increase in aquatic vegetation (e.g. water hyacinth) along the edge of waterways • Pollution/eutrophication of fresh water through the decay of aquatic vegetation and animals trapped in areas of lower water levels • Reduced groundwater available for fish culture		

Source: *NEST and Tegler, B. 2011.*

8.2.2 Policies, programmes and adaptation options addressed and implementing agency: Fishery Resources Sub-Sector

Considering policies, programmes and adaptation options addressed, as well as implementing agency - Fishery Resources Sub-Sector, a model adapted from NEST and Tegler (2011) is included in Table 5 below.

Table 5: *Policies, programmes and adaptation options addressed and implementing*

Recommended/ Suggested CCA Policy Actions	Proposed CCA Programmes	Ecozone Addressed by Proposed Policies and Programmes	CCA Options Addressed by Proposed Policies and Programme	Implementation Agency(s)
Immediate Needs				
1. Climate Change Awareness Policy	• Educate and create awareness of the implication of CC to fisheries (e.g. water level changes in water was and watershed) • Communicate through workshops, radio, seminars of the effect of CC on water resources	All Ecozones	• CC awareness should make people consider what are the CCA option they may need to implement to address CC hazard • Alternative livelihoods (e.g. farming of crops aquaculture, trading etc).	• Federal Government and Universities involved in training Field Officers • State Government Fisheries Officers • Stakeholders (e.g. CAFAN Cat fish Farmers Association of Nigeria) • NGOs • Private Sector, Individuals

Recommended/ Suggested CCA Policy Actions	Proposed CCA Programmes	Ecozone Addressed by Proposed Policies and Programmes	CCA Options Addressed by Proposed Policies and Programme	Implementation Agency(s)
	• Assess vulnerability of communities to CC hazards	• Where natural water bodies and fish resources are declining, switch to aquaculture • Fish cooperatives should be encouraged		
2. Climate Change Monitoring Policy	• Waterways monitoring and data collection program for fisheries (e.g. water levels, water quality and fish landing quantity and quality, type of gears used) • Train field officers to collect reliable data • Train agents or field officers to make reliable forecasts • Train stakeholders in risk perception and decision-making	All Ecozones	• Refinement of early warning and monitoring systems (e.g. meteorological water levels, fish catch) to improve fish resource management • Physical harvesting and chemical destruction of macrophytes (e.g. water hyacinth). • Alternate utilization of aquatic weeds • Dredging of sited water ways	All stakeholders
3. Watershed Management Policy	• Waterways monitoring and data collection program for fisheries (e.g. water levels water quality and fish landing quantity and quality type of gears used etc).	All Ecozones	• Research & alternative fish processing strategies (e.g. utilization of solar energy)	All levels of government & all stakeholders

Recommended/ Suggested CCA Policy Actions	Proposed CCA Programmes	Ecozone Addressed by Proposed Policies and Programmes	CCA Options Addressed by Proposed Policies and Programme	Implementation Agency(s)
	• Train field officers to collect reliable data • Train agents or field officers to make reliable forecasts • Train stakeholders in risk perception and decision-making			
Long term Needs				
1. CC Monitoring Policy 2. Watershed management Policy	• Programmes noted above should be continuous long term programme	All Ecozones		

Agency: Fishery Resources Sub-Sector

Source: *NEST and Tegler, B. (2011)*

9.0 RECOMMENDATIONS

Considering climate change issues – vulnerability and adaptation options, the following recommendations are made;

- There should be regional, national and local depositories for climate and allied data which can be easily accessed by researchers, development practitioners, farmers and all other stakeholders.
- Governments should ensure increased capacity in the areas of information technology and modeling in all sectors of the economy to better address vulnerability and build resilience at the local, state and national levels.
- There should be improved surveillance for emerging and re-emerging epidemic diseases, strengthening of primary health care system in line with MDGs on health.
- Countries should pursue the international programme of housing for all as well as adequate provision of basic social amenities, so as to reduce health and improve living standards
- Suitable adaptation and mitigation measures should be site specific to respond to anticipated changes in rainfall and temperature in Africa. For instance, countries should take advantage of predicted increase in precipitation in the south to increase food production in the country. Similarly, efficient water management systems are advocated for the drier Northern parts of Africa.
- There should be implementation of all existing agricultural and forestry policies and laws as well as grazing land development with special attention placed on enforcement.
- Appropriate protection strategies should be put in place for watershed conservation.
- The governments of African countries are advised to abide by commitments to stop gas flaring by the end of year 2010. An enabling environment for the private sector to participate in implementing mitigation of greenhouse gases, GHGs, from the energy sector, should be put in place.
- Gender Mainstreaming is required in all relevant policies, with greater involvement of women in decision making in Climate Change issues.
- Concerted efforts should be made by governments, NGO's, CBOs, FBOs, NGIs and the private sector to create awareness and education on environmental management matters across all segments of the nation.
- Capacity building should be facilitated in sustainable fisheries techniques with respect to climate change vulnerability and mitigation.
- Models for sustainable fisheries management and aquatic resources conservation would be required for regeneration of fish stocks and ecosystems. Fisheries management models or plans should give consideration to environmental randomness in their planning.
- There should be scientific research on integrated management of coastal and inland water environments.
- Strengthening of local, national, regional and global relationships is considered a matter of priority for effective sustainable environmental management.
- Countries, regions and AU should evolve sound policy measures with specifically designed strategy which covers resilience, mitigation and management of climate impact on fisheries and aquaculture in their respective countries.
- Member states, regional economic communities and regional fisheries bodies should mainstream climate change in fisheries policies, development and management programmes. There should be proposals for regional or sub-regional frameworks for climate change adaptation which member states can use to develop national climate change adaptation strategies.
- Scientific findings on impacts of climate change should be appropriately translated to easy common understanding. This would be effective for developing simplified messages for capacity building, awareness and implementation.

10.0 CONCLUSION

- Climate change is a serious challenge for the continent of Africa.
- Multidisciplinary approach is required to halt greenhouse gas emission and degradation of the environment.
- Otherwise more dire consequences might descend on the entire continent. This might spell even more devastating impact for future generation.
- To avert the impending doom, the time to act and quickly too, is NOW!!!.

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