

***Full Length Research Paper***

## **Africa in the 21<sup>ST</sup> Century: The Challenges of Environmental Degradation**

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### **ABSTRACT**

The environmental challenges of the world as exacerbated by various anthropogenic factors have been a thing of concern to scientists and policy makers all over the world because of its severe negative implications on biodiversity. The menace has been discussed at different levels and from various perspectives. This study is focused on Africa because of her obvious weak capacity to adapt to the impacts of the fast degrading environment. This is attributable to Africa's poor technological development and her dependence on agriculture that is still largely rain-fed and with rudimentary capital. An exploratory approach to literature review was adopted to facilitate the discernment of the concept and methodological effects of environmental degradation, the impact on the socio-economic status of Africa, and the effort of the world community to promote mitigation and adaptive strategies. The factors discovered were critically analysed and appropriate mitigation and adaptive strategies proffered to help check the ravaging menace. It was concluded that the resilience and adaptive capacity of the continent should be improved upon. Hence the need for a synergy between the various African governments and the world at large to develop appropriate mitigation and adaptive strategies that are suitable to the peculiar nature and position of Africa.

***Key Words:*** Adaptation, Mitigation, Resilience, Environmental Degradation, exacerbation, Synergy, Anthropogenic, Biodiversity.

### **INTRODUCTION**

Environmental problems seem to be the key challenges of the XXI<sup>st</sup> century (Andrew,2006). In the dry lands of Sub Saharan Africa (SSA), land degradation exacerbated by human activity, including certain traditional coping strategies which are already having a negative effect on overall food security (UNSO, 2002). This situation was engendered by the development of new technologies, which brought about increasing number of plants, factories and all kinds of manufacturing in general, hence the shift of emphasis from politics and wars towards environmental issues. The terrestrial, freshwater and marine environments have declined in virtually all aspects. New developments in industry and manufacturing were root causes of environmental degradation over the past three decades. The rapid growth of population, urbanization and globalization are the driving force of the environmental problems. However, the challenge is extremely high not only for the well-developed regions, but in poor parts of the world especially Africa. Such environmental problems as land degradation, deforestation, declining of marine resources and water scarcity or deterioration of water and air quality are on the priority list in Africa.

Following the end of the 20th century, sub-Saharan Africa entered a new phase that is often viewed negatively. The 40-odd nations that are formally independent and recognized internationally displayed symptoms of disarticulation and impoverishment. The annual per-capita income in almost all countries of the continent is below \$1 000. The \$450 average annual income in the countries of the intertropical region puts this population in the lowest quarter in the world (WRI , 1992). Some people have called this group of countries the "Fourth World."(IDRC,2011)

During the last few decades, the participation of sub-Saharan Africa in international trade has fallen from 4% of world trade in the 1960s to 1.5% in the early 1990s, affecting its economic and geopolitical position. Today, many African nation-states are having trouble merely existing. There is little money to pay public employees, and national debts, which consume a large proportion of export revenues and are nearly impossible to service. In 1993, African debt stood at \$140 billion. Some countries are paying more than a third of their export revenues in interest charges: Côte d'Ivoire, 41%; Ghana, 49%; Guinea-Bissau, 45%; Kenya, 33%; and Uganda, 81%. In most countries, income from legal exports does not cover the cost of the minimum amount of imported goods, and military expenses still absorb a large part of the states' budgets (IDRC,2011). The African expected economic growth rate is at about 5.0% for 2010 and 5.5% in 2011(IMF,2010). Persistent increases in the population exacerbate the other factors. In most African countries, population growth is over 2% annually; in some, it reaches 3.5% or more; for example, Côte d'Ivoire, 3.78%; Kenya, 3.58%; Uganda, 3.67%; and Zambia, 3.75%. The overall average for Africa is 2.98%, higher than any other continent. This is due to continuing high birth rates and decreasing death rates. Recently, death rates have begun to increase again, mainly because of wars and the Acquired Immune Deficiency Syndrome (AIDS) epidemic. Deterioration of the health-care system is also having an effect (IDRC,2011). There is widespread belief that some of the more critical problems experienced by African countries are related to the frequent natural catastrophies (mainly droughts) and wars. Population pressure has been one of the main forces promoting the various environmental degradation processes. Overgrazing, overcultivation, excessive or inappropriate use of water resources, deforestation, and elimination of natural ecosystems are,

among other reasons, a direct result of overpopulation for existing forms of production and land-occupation systems.

These analogies suggest that Africa is finding it difficult to cope with the degrading environment and therefore her socio-economic and socio-political status are seriously affected. Africa being mostly an agrarian economy that depends on rudimentary capital, rain-fed system and mostly poorly developed infrastructural facilities, lacks the capacity to adapt to the fast degrading environment.

In this paper frantic effort is made to explore various types of environmental degradation challenges faced by African nations, their originating concepts, the impacts on the socio-economic situation of Africa and possibly the international intervention policies geared towards mitigating these challenges. Furthermore a conclusion is drawn and possible recommendations proffered as mitigating and adaptive strategies to the menace of environmental degradation.

## MATERIALS AND METHODS

This study is centred on Africa. Africa is the world's second-largest and second most-populous continent, after Asia. Africa's largest country is Sudan, and its smallest country is the Seychelles, an archipelago off the east coast. (Hoare, 2002). At about 30.2 million km<sup>2</sup> (11.7 million sq metres ) including adjacent islands, it covers 6% of the Earth's total surface area and 20.4% of the total land area (Sayre, 1999). With 1.0 billion people (as of 2009) in 61 territories, it accounts for about 14.72% of the world's human population. The continent is surrounded by the Mediterranean Sea to the north, both the Suez Canal and the Red Sea along the Sinai Peninsula to the northeast, the Indian Ocean to the southeast, and the Atlantic Ocean to the west. The continent has 54 sovereign states, including Madagascar, various island groups, and the Sahrawi Arab Democratic Republic, a member state of the African Union whose statehood is disputed by Morocco.

Africa straddles the equator and encompasses numerous climate areas; it is the only continent to stretch from the northern temperate to southern temperate zones (VG, 2007). The climate of Africa ranges from tropical to subarctic on its highest peaks. Its northern half is primarily desert or arid, while its central and southern areas contain both savannah plains and very dense jungle (rainforest) regions. In between, there is a convergence where vegetation patterns such as sahel, and steppe dominate.

The survey conducted in this study is focused on prominent African countries and the impact of environmental degradation on the socio-economic position of these countries as a representation of the entire continent. An exploratory approach to literature search was undertaken to ensure that data which bothered on the concept, methodological, and impact of environmental degradation on the socio-economic existence of Africa were exposed. Some international energy policies in relation to the climate change and environmental degradation in Africa were also looked at. Finally, these factors were critically reviewed and deductive analysis given to arrive at a logical conclusion and recommendations.

## RESULTS AND DISCUSSION

### The Concept of Environmental Degradation and Implications on Africa.

Environmental degradation is a process through which the natural environment is compromised in some way, reducing biological diversity and the general health of the environment. This process can be entirely natural in origin, or it can be accelerated or caused by human activities. Many international organizations recognize environmental degradation as one of the major threats facing the planet, since humans have only been given one Earth to work with, and if the environment becomes irreparably compromised, it could mean the end of human existence.

Africa suffers from many environmental problems including deforestation, degradation and fragmentation, desertification, the loss of soil fertility, a dramatic decline and loss of biodiversity, air pollution, and water pollution. These problems hinder Africa from making progress with regard to economic development. Due to the fact that these issues are not fully understood, many Africans have been delayed in solving the problems.

### Deforestation

Deforestation is "the clearing and destruction of forests to harvest wood for consumption, clear land for agricultural uses, and make way for expanding settlement frontiers" (DeBlij, Murphy, and Foubert, 2007). Eboh (1995) defined deforestation as the loss of forest lands to arable agriculture and/or decline in the quality and quantity of forest vegetative cover through unguarded exploitation. He further stressed that three major processes culminate in deforestation in many rural areas; opening up of forest lands for arable crop production; removal (or cutting down) of forest vegetation for fuel wood, fencing sticks, building materials and so on; conversion of forested areas to cattle pasture-lands. In Nigeria about 5% of forests is lost yearly through the aforementioned processes ( Salau, 1992). Another source put the average annual deforestation at 400,000 ha between 1981 and 1985, while the average annual reforestation in the same period was 26,000 ha (World Resources, 1992). According to the United Nations Food and Agriculture Organization (FAO), forested land was transformed into agricultural land at increasing rates from 1981 to 1990. These changes made up twenty-five percent of the changes in forest cover during this time (Mabogunje, 1995). Eze et al., (2010) and UNEP (2005) maintained that deforestation by clearing or burning releases much of carbon contained in the forests into the atmosphere thereby increasing the amount of atmospheric greenhouse gases which in turn affects biodiversity.

The adverse effects of deforestation stem from the loss suffered by the ecology. These lost ecological benefits include the protection of soils from erosion, harbouring of diverse plant and animal species, providing building and construction materials as well as moderating the climate. When these benefits are lost, the agro-ecological and socio-economic balance of rural communities becomes fragile and further deforestation could then lead to a total collapse of the

natural eco-support systems. According to (Ehi-Ebewele,2008) both the flora and fauna of the Bayelsa State have been devastated due to deforestation arising from oil exploration and exploitation. The red mangrove of the brackish swamp forest has been reduced by 55%. The depletion affected about 95% of *Hippopotamus amphibus*, *Richchus senegalensis*, *Panthera pardus*, *Procolons badium*, *Colous verus*, *Loxodonta africana* and *Syncerus caffia* in the area. Evidence of increased deforestation are already emerging in parts of southeastern Nigeria where forest-sourced products like fuelwood, and building materials are becoming scarcer (Eboh,1991). Given the extensive loss of forest in recent years, African governments are trying to address the problem. The Nigerian government is planting trees and preserving vegetation that is natural to the area. Three million hectares have already been restored from land that was severely degraded in previous years. In Niger, surveyors found between ten and twenty percent more trees in 2005 than were seen thirty years earlier in the same area (Niamey, 2006).

### Land Degradation and Fragmentation

Land degradation- the weakening of the structure, stability and productive potential of the soil, is a major problem in many rural areas of Africa. Whereas the above mentioned “traditional” description of land degradation reflects predominantly the physical perspective, the other aspect – chemical degradation is aptly defined to include the loss in soil nutrient status and fertility as well as any disruptions in the soil chemistry that diminishes the ability of the soil to nourish and support optimum crop growth. The different forms of chemical degradation of soils include: salinization, acidification and soil pollution ( Eboh,1995).

Physical degradation of land productive base occurs through the process of de-fallowing, soil erosion, use of heavy machinery and trampling by cattle. De-fallowing simply refers to the decrease of the fallow duration of the fallow cultivation cycle of agriculture- whereby soil fertility is restored by allowing land to revert to its natural vegetation by fallowing. But because of demographic and socio-economic pressures, the periods of fallow phase have been declining in the southern parts of the country (Okafor,1991; Eboh and Obiechina,1993). Fallow periods are now about 1-6 years instead of between 5-20 years reported some decades ago (Eboh, 1993).

Whereas fragmentation “arises from road construction and similar human intrusions in forest areas; it leaves forest edges vulnerable to increased degradation through changes in micro-climates, loss of native species and the invasion of alien species, and further disturbances by human beings” (Mabogunje, 1995 ). Degradation and fragmentation makes up much larger area than does deforestation. They also have a greater impact on the diversity of animals and plant life.

The consequences of land degradation abound in Africa. In coastal zone of Bayelsa state which is a state in the Niger Delta Nigeria, it was observed that the concentration of the total hydrocarbon unit of soil and sediment was very high with values of 70.00 microgramme/gramme and 63.00

microgramme/gramme respectively (Ehi-Ebewele,2008). This is detrimental to the sustainability of crop production on the same piece of land and hence threatens the food security status of the continent. Nutrient depletion as a form of land degradation has a severe economic impact at the global scale, especially in Sub-Saharan Africa. Stoorvogel *et al.* (1993) estimated nutrient balances for 38 countries in Sub-Saharan Africa and found the annual depletion rates of soil fertility to be 22 kg nitrogen (N), 3 kg phosphorus (P), and 15 kg potassium (K) per ha. In Zimbabwe, soil erosion alone results in an annual loss of N and P totalling US\$1.5 billion. (Stocking, 1986; UNEP, 1994), (UNEP,2010). In Southeast Nigeria , made up of five States of Abia ,Anambra , Ebonyi, Enugu and Imo States , erosion is a serious socio economic and environmental issue that has assumed very wide range and awesome spatial dimensions and an alarming degree of apparent intractability . It is estimated that at least 70% of Imo State have a number of erosion sites ranging from gullies , rills , sheet and stream bank erosion . A community known as Nkwumeato has over 100 erosion sites and farmers are no longer finding it easy to attend to their farms and other locations (Eze , 2008 ) with the attendant food insecurity. Man’s activities which negatively influences soil and leads to soil erosion and land degradation in most nations of Africa include,

Wrong crop cultivation practices which range from improper tillage and ridge to clean cultivation and monoculture,

Overgrazing and intensification of agriculture, path creation and soil pulverization by livestock accelerates loss of soil , Creation and use of footpaths which are generally poorly located leading to streams, markets , farms, schools, places of worship etc.

Quarrying and other mining activities including the removal of building materials like laterites, gravel and stones excavation,

Artificial irrigation of large tracts of land and poor water management as well as ill advised channelization of built up areas in our urban centers,

Vibrations on roads resulting from use of heavy vehicles such as tippers, trailers, lorries, luxurious buses on the soil and the subsequent compression and crusting of the poorly constructed road surface by the vehicular movement.

In Kenya, over the period 1981–2003, despite improvements in woodland and grassland, productivity declined across 40% of cropland – a critical situation in the context of a doubling of the human population over the same period (Bai and Dent, 2006). In South Africa, production decreased overall; 29% of the country suffered land degradation, including 41% of all cropland (Bai and Dent, 2007a); about 17 million people, or 38% of the South African population, depend on these degrading areas ( Bai and Dent, 2007 ; UNEP,2010)

### Desertification and Drought

Desertification is “the encroachment of desert conditions on moister zones along the desert margins, where plant cover and soils are threatened by desiccation- through overuse, in part by humans and their domestic animals, and, possibly, in part because of inexorable shifts in the central government” (DeBlij, Murphy, and Fouberg, 2007, ). The main causes of desertification are human activities and changes in climate. Dry-land ecosystems, covering over one-third of the world’s land area, are susceptible to over and inappropriate use, which causes desertification (Niamey, 2006).

Desertification has hit Africa harder than any other continent in the world (DeBlij, Murphy, and Fouberg, 2007). Continent-wide estimate indicates that about 6.6 million square kilometres of land in Africa is at high to very high degree of desertification (Salau,1992). Two-thirds of Africa is arid or semi-arid, so many people farm the dry, marginal lands in Africa. Given the lack of good farm land in Africa, marginal, semi-arid lands are often converted into farm and ranch lands. These farms are typically used to meet local consumption needs as well as to generate exports. While uneven land use has resulted in power differences among groups of people (DeBlij, Murphy, and Fouberg, 2007), the real problems are now coming from the desertification of the converted farms. In Sub-Saharan Africa over the past fifty years, over 270,000 miles of farming and grazing lands have been turned into desert. Most of this desertification has been caused by climatic fluctuations; although some of it has likely been as a result of overgrazing, woodcutting, soil exhaustion, and misuse of the land (DeBlij, Murphy, and Fouberg, 2007).

Drought conditions result from little total annual rainfall and concentration of rains in very short period of the year. The consequences are inadequate rains for arable cropping and very short growing season which without irrigation water would seriously constrain food production. Besides drought leads to loss of pasture lands and cattle, widespread drying-up of vegetative cover and socio-geographic displacements (Eboh,1995). The Sahelian drought between 1968-1973, for instance led to the deaths of more than a hundred thousand people, loss of about twelve million cattle and widespread displacements of herders and farmers (Glantz,1980).

### Loss of Soil Fertility

According to the Forest Development Institute (IDF), the non-stop burning of forests, mostly by people trying to clear land for hunting, is hurting the fertility of soils in some parts of Africa (Luanda, 2006). Many people in rural areas purposefully burn the dry grasses in fields used for planting, but some of these fires are also set by people not thinking while tossing burning cigarettes into the dry grass. These areas of Africa are also having problems with deforestation because of the manufacturing of wood and coal (Luanda, 2006).

### Dramatic Decline and Loss of Biodiversity

Biodiversity is “the total variety of plant and animal species in a particular place; also known as biological diversity” (DeBlij, Murphy, and Fouberg, 2007). In 1957, Ghana had

about 8.3 million hectares of forestland, but only 1.2 million are left today (Boateng, 2006). African forest reserves contain over seven-hundred different types of tropical trees as well as many endangered species including thirty-four plants, thirteen mammals, twenty-three butterflies, and eight birds which are all endangered (Boateng, 2006). During mining, tons of the earth’s land is scooped up in order to get to the ore. This process causes the land to lose its biodiversity. The loss of forestland has reduced the level of biodiversity in Ghana. The problems also can be found in water sources. Because of the use of toxic chemicals by several mining companies, the bodies of water that provide millions of Africans with drinking water are being destroyed. Insufficient actions to guard against deforestation, land devastation, and the release of toxic materials into water bodies and the environment from mining are leading to the extermination of some species of plants and animals. Plant life is destroyed, streams are polluted with hazardous chemicals or are destroyed, and animals have to leave their natural habitat to safe areas (Boateng, 2006).

Even with agreements like the Convention on International Trade in Endangered Species of Flora and Fauna (CITES), the hunting of elephants, rhinoceroses, and alligators is still a key dilemma in some African countries (Mabogunje, 1995). The most serious of all is the loss of bird biodiversity because pollution is destroying their habitats.

Food sources in Africa including protein, carbohydrates, and vitamins result from biodiversity. Communities that are located near water bodies, rely on the diversity of these waters for fishing as well as using the water for recreational activities. There is a strong need to protect Africa’s biodiversity from extinction as various economic activities continue to be a threat.

### Air Pollution

Sub-Saharan Africa is one of the least urbanized regions in the world, but the urban population in Africa is growing very rapidly (Mabogunje, 1995). With this growth comes pollution. Poverty stricken citizens in Africa, particularly in the urban population, are most negatively impacted by poor air, water, and land quality. The causes of air pollution are multiple. Because many households are using charcoal or wood for energy, the amount of carbon dioxide produced by African cities has been on the rise. The 1991 global greenhouse emissions of South Africa, Zaire, and Nigeria ranked them among the top fifty countries in terms of their contribution (Mabogunje, 1995). The people that live in Africa are exposed to indoor and outdoor air pollution that can cause many different health problems. The indoor pollution partly comes from the increased use of wood and charcoal in cooking. The greatest air pollutant is the emission of green house gases in the atmosphere through anthropogenic factors that release chlorofluorohydrocarbons like CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O etc which consequently exacerbate climate change. The impact of climate change to the food security status of Africa and the overall existence of life on earth need not be over-emphasized.

### Water Pollution

A big cause of the pollution of the water in Africa is that they accept the solid waste from the United States, the European Union, and Japan. Africa is paid for accepting the waste, but they are not able to treat it properly to make it non-harmful to the environment and to the people of Africa (DeBlij, Murphy and Fouberg, 2007).

Access to water that is clean is a problem throughout Africa. Water is polluted mostly by human waste. Diseases like typhoid, cholera, and diarrhea come from contaminated water. Water pollution is the reason for many infant mortality rates and health problems of people of all ages (Mabogunje, 1995).

### Impacts and Implications of Climate Change and Environmental Degradation on Sub-Saharan Africa

The Fourth African Assessment Report on climate change released by IPCC highlights major issues related to potential impacts as a result of climate change (IPCC 2007). It indicates that Africa is one of the most vulnerable continents to climate change and climate variability. This is a result of the interaction of 'multiple stresses' including land degradation and desertification, declining run-off from water catchments, high dependence on subsistence agriculture, HIV/AIDS prevalence, inadequate government mechanisms and rapid population growth occurring at various levels, and low adaptive capacity due to factors such as extreme poverty, frequent natural disasters i.e. droughts and floods, and rainfall-dependent agriculture. The likely impacts of climate change will add to these existing stresses and exacerbate the effects of land degradation. Increased temperatures levels are expected to cause additional loss of moisture from the soil, reduced and more intense rainfall and higher frequency and severity of extreme climatic events, such as floods and droughts. These factors are already leading to a loss of biological and economic productivity and putting drylands population at risk of short- and long-term food insecurity. There is considerable variability and uncertainty in climate change projections. Nevertheless, there is a reasonable agreement from a suite of different models that Africa is one of the most vulnerable continents to climate change and variability. The IPCC 4th African Assessment Report estimates that by 2020 between 75 and 250 million people are likely to be exposed to increased water stress and that rain fed agricultural yields could be reduced by up to 50% in Africa if production practices remain unchanged.

Drought-prone areas *inter alia* are particularly deemed to suffer complex, localized impacts of climate variability/change. In the Sahel, for instance, changes in temperature and rainfall patterns have reduced the length of the vegetative period and make it difficult to continue the cultivation of traditional varieties of long and short cycle millets (Rosenzweig *et al.* 2007). Given the social, legislative, market and weather-based sources of vulnerability already prevailing in the region, reduction in agricultural productivity and land area suitable for agriculture, even if slight, would cause disproportionately large detrimental effects (IPCC, 2007; Dietz *et al.*, 2004).

The most vulnerable communities to the impacts of climate change inhabit the dryland areas. For instance, the pastoralists inhabiting drylands have been able to survive the harsh environments of the drylands by practicing various sustainable livelihood approaches including seasonal movements, keeping livestock among others. However, with the threats of changes in climate, exacerbating current trends of encroachment on grazing lands by agriculturists and other factors they may be forced to consider other livelihood options, including permanent migration, in order to cope with cumulative changes.

### International Energy Policies Geared Towards Environmental Conservation.

In an effort to confront the challenges of climate change and consequent environmental degradation, the Rio De Janeiro 'Earth Summit' in 1992 inaugurated a regulatory agency, "The United Nations Framework Convention on Climate Change (UNFCCC); with the main objectives of stabilizing the Green House Gases (GHG) concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate systems. These include emissions from these human activities; agriculture, deforestation, industrialization, exploitation of fossil fuels etc that emits CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O and other green house gases. As have been highlighted above, these anthropogenic interferences cause environmental degradation which is the focal point in this paper.

### The Kyoto Protocol

The countries which ratified the inauguration of the UNFCCC adopted the Kyoto Protocol in December 1997 as main strategy towards achieving the objectives of stabilizing the GHG concentration. This protocol was designed to assist vulnerable countries in adapting to the adverse effects of climate change and to facilitate the development of techniques that would enhance resilience towards mitigating the likely effect of climate change. Under the Protocol, Annex 1 countries (developed countries and countries in transition to market economy) are committed to reduce their overall emission of GHG's by an average of 5.2% below the 1990 levels within the first commitment phase of 2008-2012. The specific targets vary from country to country (Bhardwal and Vashist,2007). Meeting such commitments are at varying degrees of compliance. The developing countries like those in Africa do not have specific targets in this regard but are committed to taken measures to reduce GHG's emission.

The Kyoto Protocol provides several mechanisms that could be used to reduce the GHG emissions to meet the reduction targets. These mechanisms are highlighted by UNDP's Sustainable Energy and Environment Division (SEED-UNDP) with a view to clarifying differences between the mechanisms (IPCC,2007). These include the Clean Development Mechanism (CDM), The Joint Implementation, and The Emission Trading.

**The Clean Development Mechanism (CDM), Article 12.**

This mechanism was the ultimate product of a proposal made by Brazil. The Clean Development Mechanism holds the potential to assist non-Annex 1 parties in achieving sustainable development, while contributing to the ultimate objective of the UNFCCC-stabilizing green house gas levels in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

The CDM is an important potential instrument for promoting international cooperation (eg through foreign investment in the energy sector) and simultaneously addressing the issue of sustainable development. The objectives of the CDM as specified in article 12 of the Kyoto Protocol, are

- Assisting parties not included in Annex 1 in achieving sustainable development and contributing to the ultimate objective of the convention; and
- Assisting Annex 1 parties in achieving compliance with their quantified emission limitation and reduction commitments under Article 3.

Benefits to developing countries will come through investment in cleaner development paths. The benefits to industrialized countries will stem from contributing to reducing emissions at a lower cost than would be the case through domestic action only.

**Joint Implementation (JI), Article 6.**

Joint implementation allows countries in Annex 1 to implement measures jointly to reduce their GHG emissions. As it concerns Annex 1 countries, it is an important mechanism for economies in transition. In other for JI project to receive 'emission reduction units' the activities must incorporate the sustainable development priorities of economies in transition acting as host countries. For this reason JI is a mechanism for facilitating the processes of socio-economic transition and sustainable development while implicitly benefiting the global environment. Accordingly, reduction in GHG emissions need to be accomplished through activities related to such issues as poverty alleviation, energy and resource utilization and infrastructural planning and development.

**Emissions Trading, Article 17**

Emissions trading are a market-based instrument which uses "assigned amounts" to allow for trading between countries that have accepted emission reduction commitments under the Kyoto Protocol, as listed in its Annex 1. It is a way of introducing flexibility into a system where participants have to meet emissions targets. Participants can buy units to cover any emissions above their targets, or sell units if they reduce their emissions below their targets. The presence of a market for these units creates a value for emissions reductions which stimulates investment in the most cost-effective areas. Emissions trading leads to a reduction in compliance costs compared to meeting the same target through domestic/internal means only. Unlike the CDM and JI, emissions trading are not project-related. However, similar to CDM and JI, emissions trading enables achievement of commitment at least cost, by taking

advantage of marginal cost differentials in emissions abatement among countries. Since GHGs are uniformly mixing global pollutants, both the damages from emission reduction are independent of their origins. In order to minimize the costs of global emission reductions, abatement should take place where the costs are lowest since trading could allow this to happen in an efficient manner. Modalities for emissions trading remain to be established.

**CONCLUSION**

Considering the projected impacts of climate change and hence environmental degradation on ecosystems, water availability, agriculture, and the pastoral communities on the whole, practical adaptation measures including policies which will build the resilience of communities to this menace are more important than ever. Without adaptation efforts to the threats of changes in climate and its consequences, the people of the SSA may be forced to consider other livelihood options, including migration, in order to cope with the extreme changes. It is important to note that in identifying adaptation strategies and actions, the means to food security in every community will vary from place to place. Household food security will be a function of what activities make up their livelihood and each agro-ecological zone will have separate challenges to maintaining food security in light of climate change and environmental degradation. It is therefore concluded that the various African governments should seriously partner with other developed world community to build adaptation and mitigation strategies to environmental degradation that are most appropriate to their peculiar situation.

**RECOMMENDATIONS****Adaptation/Mitigation Strategies to Environmental Degradation**

Irrespective of the overall sense of despair and concern for the future of SSA, all hope is not lost in efforts to adapt to climate change and environmental degradation in Sub Saharan Africa. There are many adaptation techniques that can be used to limit the effects of climate change and desertification on livelihoods. Many of these techniques are the very same techniques that have been used for generations in order to react to shocks such as floods or drought, and can be used in the light of the increasing threat of climate change and environmental degradation. While there is hope, a sense of urgency is needed in order to prepare and adapt to the looming threat. In SSA, three categories of different adaptation measures will be utilized in order to give a clearer picture of the possibilities in the drylands of Africa. The three categories that will be used are (a) natural resource management based adaptation opportunities, (b) market based opportunities, and (c) institutional based opportunities. In this work these categories is defined as:

\* Natural Resource Management (NRM) based opportunities;

Opportunities that focus on management of natural resources such as land, water, soil, plants and animals, with a particular focus on how management affects the quality of life for both present and future generations. This discipline

has given rise to the notion of sustainable development, a principle which forms the basis for land management and environmental governance.

\* Market based opportunities;

Opportunities that result in increased income *via* a multitude of economic opportunities including livestock, market access, and eco-tourism to name a few.

\* Institutional based opportunities;

Opportunities that focus on local level structural change such as extension/education, micro-credit and migration. (UNDP-UNEP-UNCCD,2009).

It is important to note that many of the proposed and piloted adaptation measures are applicable across the agro-ecological zones, with different degree of required intensity, offering opportunities for learning and replications among locations.

#### **Natural Resource Management (NRM) based opportunities**

**Herd management:** Several herd management techniques that should be considered including herd diversity, maintenance of female-dominated herds, herd size, and herd splitting (Oxfam , 2008):

**Rain-water harvesting:** When climate changes, water movements change and human technology adapts. Rainwater harvesting (RWH) is broadly defined as the collection and concentration of runoff for productive purposes. It includes all methods of concentrating, diverting, collecting, storing, utilizing and managing runoff for productive uses. This provides water that can be used for domestic, livestock and irrigation or commercial purposes. Rainwater harvesting is one adaptation measure that does not require large capital investment, it is essentially a management approach, to provide water resources at the community level and ensure that livelihoods are maintained (IRIN , 2006).

**Cropping pattern adjustments:** Crops can be planted farther apart so that more moisture is available for each row, increasing the likelihood that they will survive a period of drought. Maize varieties that mature faster have been brought in, again limiting the threat of dry spells.

**Improved tree management and planting:** In Senegal and Burkina Faso, local land users have improved their adaptive capacity by using traditional pruning and fertilizing techniques to double tree densities in semi-arid areas. These techniques help in holding soils together and reversing desertification processes. Although tree planting is not a new phenomenon, it is being undertaken in some arid areas in a much more comprehensive way.

**Soil and water conservation:** Soil and water conservation should be stressed as a way of maintaining viable crop production for fodder and food. There are always strong links between measures for soil conservation and measures for water conservation, and this applies equally in semiarid areas. Many measures are directed primarily to one or the

other, but most contain an element of both. Reduction of surface run-off by structures or by changes in land management will also help to reduce erosion. Similarly, reducing erosion will usually involve preventing splash erosion, or formation of crusts, or breakdown of structure, all of which will increase infiltration, and so help the water conservation (FAO, 1987). The subsistence farmer cannot afford to respond to philosophical or emotional appeals to care for the soil, and this means that conservation measures must have visible short-term benefits to the farmer. For the subsistence farmer the benefit he would most appreciate might be increased yields per unit of land or better production per unit of labour.

**Agroforestry:** Agroforestry is a collective name for land use systems and practices in which woody perennials are deliberately integrated with crops and/or animals on the same land management unit. The integration can be either in a spatial mixture or in a temporal sequence. There are normally both ecological and economic interactions between woody and non-woody components in agroforestry (ICRAF, 1993). This use of integrated approach of using interactive benefits from combining trees and shrubs with crops and/or livestock should be considered (USDA-NAC, 2009).

**Better land management/Conservation Farming:** Using improved methods of land husbandry to enable resource managers to better conserve soil, water, and the integrity of natural and managed ecosystems is needed. Farmers who practice conventional farming methods on degraded soils are highly susceptible to the threat of climate change and total crop failure even in seasons of moderately poor rainfall. They are also excessively dependent on increasingly expensive fertilizers which are now unaffordable for the majority. Practicing better land management techniques such as retention of crop residues, restricting tillage, completion of land preparation in the dry season, establishment of a precise and permanent grid of planting basins, planting furrows or contoured ridges, early and continuous weeding, rotation and intercropping, dramatically increase their yields, diversify their production base and engage in economic activity, regenerate their soils and sustain adequate levels of production in all but the worst droughts, liberate themselves from dependency on food aid and excessive use of costly external inputs, practice sedentary agriculture on a sustainable basis, and regenerate rather than exploit the environments in which they live.

**Fodder banks:** Fodder banks and zero grazing are two ways to limit livestock movement. Fodder banks are plantings of high-quality fodder species in order to maintain healthy productive animals. They can be utilized all year, but are designed to bridge the forage scarcity of annual dry seasons. Fodder banks do not provide 100% of feed requirements, but supplement the available dry season forage . Zero grazing is an intensive dairy production system in which cattle do not graze but are confined in shed or stall where feed and water are brought to them. The combination of these two will limit movement of livestock allowing for re-growth of vegetation and decrease land degradation.

### Market Based Opportunities

**Drought resistant/tolerant breeds:** The introduction of drought resistant/tolerant breeds of livestock is essential for the continued success of pastoralism in the region. With increased risks resulting from climate change, herds will have to be more resilient in order to cope with stresses resulting from weather and water variability.

**Diversification of livelihoods:** Diversification of pastoral livelihoods is important given the stresses on pastoral communities and the growth in population. The need to diversify livelihood activities should also include non pastoral cash generation activities such as small businesses. Pastoralists need to further diversify their livelihoods, both within the pastoral system (i.e. increasing reliance on more drought-resistant species such as camels) and outside of the livestock production sector.

**Livestock feed supplementation and fattening:** The practice of supplementation of livestock grazing with other feeds is common during periods of shocks such as droughts, and therefore should be considered as a climate change adaptation measure. Improved fodder species to increase livestock strength and milk production are being looked in to, which would improve productivity and therefore resilience of both livestock and pastoralists in the event of increased floods and droughts via climate change (Oxfam , 2008).

**Livestock products value addition:** The creation of value added products from livestock such as hides and skins is a method that could be used to diversify livelihoods and income generation.

**Management of livestock diseases:** Both human and livestock diseases can increase during periods of stress, particularly floods and drought. Preventative measures include avoidance of areas known to be particularly susceptible to disease and migration. Education on disease management methods as well as increased veterinary assistance should be considered in order to help pastoralist maintain the basis of their livelihood system.

**Diversification of livelihoods:** Diversification of agro-pastoral livelihoods is important given the stresses on pastoral communities and the growth in population. The need to diversify livelihood activities should also include non pastoral and agricultural cash generation activities such as small businesses. Agro-pastoralists need to further diversify their livelihoods, both within the pastoral system (i.e. increasing reliance on more drought-resistant species such as camels), out of livestock production, as well as finding new and innovative ways to make a living.

**Drought tolerant crop varieties:** Most climate models project that global warming will make arable land in many developing countries less productive or unusable. Advocates of genetically modified (GM) crops often defend the technology by arguing that drought and salt-tolerant varieties can play an important role in adapting to global warming (Randerson, 2008). There is therefore need to introduce alternative crop varieties in the drylands areas that

are drought-resistant. Projected reductions in yield in some countries could be as much as 50% by 2020 (IPCC, 2007).

**Ecotourism:** Alternative income such as the introduction of eco tourism needs to be explored. Ecotourism is environmentally responsible travel to natural areas, in order to enjoy and appreciate nature (and accompanying cultural features, both past and present) that promote conservation, have a low visitor impact and provide for beneficially active socio-economic involvement of local peoples . It helps educate the traveller; provides funds for conservation; directly benefits the economic development and political empowerment of local communities; and fosters respect for different cultures and for human rights (Honey, 2008).

**Market access improvement:** It is essential that market access is improved so that communities are able to access necessary food stuffs and sell livestock and agricultural products. When markets access is blocked, overall household food security is at risk.

**Small – scale irrigation:** The introduction of small – scale irrigation will limit communities dependence on rain fed agriculture practices and increase overall household food security and income. Depending on rain fed agriculture often leads to varied yields and risk overall household food security.

**Value addition crops:** The creation of value added products from agriculture crops already being grown in the region is a method of income production that could be utilized to limit dependence one

**Zero grazing for peri-urban dairy and livestock:** Zero grazing also called ‘stall feeding’ is an intensive dairy production system in which cattle do not graze but are confined in shed or stall where feed and water are brought to them. It is an intensive system that produces a large amount of milk from a small amount of land (MAAIF Uganda). This sedentary form of livestock holding and dairy production is important as normally pastoral populations begin to move towards more peri-urban areas. The desire for meat and dairy, and value added dairy products are a growing market opportunities that could be tapped in to. In addition, zero grazing will benefit agriculture directly as a readily available fertilizer (manure) will be integrated in to agriculture production. This input will help decrease conflict for fertilizer and other inputs as a natural input will be in ready supply.

**Agribusiness:** Agribusiness is a generic term that refers to the various businesses involved in food production, including farming and contract farming, seed supply, agrichemicals, farm machinery, wholesale and distribution, processing, marketing, and retail sales. Small scale agribusiness could create new livelihoods and increase the living condition of the people .

**Diversification of livelihoods:** Diversification of agricultural livelihoods is important given the stresses on agricultural communities and the growth in population. The

need to diversify livelihood activities should also include non-agricultural cash generation activities such as animal holdings and small businesses. Agricultural communities need to further diversify their livelihoods, both within the agricultural system (introduction of drought resistant varieties and new crops), as well as finding new and innovative ways to make a living.

**High-yielding, drought-resistant varieties:** Dependent on agricultural production for their survival, drought resistant modern seed varieties are very important to the population of the sub-humid zone. While high-yielding varieties do currently exist for most of the crops cultivated in the sub-humid zone (such as maize, sorghum, millet, soybean, and cowpeas), they are not widely adopted, especially in areas with poor market access and low precipitation. The high costs of fertilizers required for these high-yielding varieties erode their profitability, especially since the removal of fertilizer subsidies. In addition, demand for food by the non-agricultural sector is weak because of limited urban demand, insufficient exports, and cheap food imports. Therefore, to realize the potential of the zone, modern, stress-resistant varieties that respond well to small amounts of external inputs are needed. Crops with shorter growing seasons will also be important as season variability is becoming more common. These varieties must also meet local tastes so that they can satisfy farmers as well as domestic urban markets or export needs.

**Introduction of Aquaculture:** Diversification of agricultural livelihoods may also lead to the introduction of aquaculture in areas where water is not a limiting factor. The farming of freshwater and saltwater organisms will give the populations another means of protein and a livelihood boost. Unlike fishing, aquaculture implies the cultivation of aquatic populations under controlled conditions. In order for this practice to have a chance at success, the amount of water available in the area for household use must be plentiful so as to allow for water to be used to cultivate fish. This practice may only be available to a select few areas where rainfall is not a limiting factor.

**Introduction of livestock holding:** The introduction of livestock holdings in the more fertile subhumid zone can be seen as an adaptation measure as communities will be able to diversify their diets and economic gains. While pastoral communities will have trouble maintaining a herd in the arid zone, the climate and amount of ground cover needed to keep animals is well suited for the sub-humid zone.

**Improved agricultural techniques/inputs:** It is essential that improved agricultural techniques and inputs are introduced in the region if crop production is to increase in order to meet the growing populations demand.

**Improved water management and irrigation:** Investment in water control is need to be planned and implemented in the much broader framework of agricultural and rural development, where production, markets, finance and infrastructure are conceived in an integrated way and are mutually supporting. Policies and institutional frameworks

must also be created in order to ensure fair and equitable access to water resources and effective access to markets for agricultural products. In addition to water management, an increase in the use of irrigation technology will help take a lot of the guesswork out of agriculture production and allow for more effective use of this scarce resource. Irrigation for crop production will not only increase reliable crop production, but will limit the water that is used and allow for water that was previously used for crop production to go towards other household needs.

#### **Institutional Based Opportunities**

**Conflict resolution and security reinforcement:** Better policies and planning needs to be implemented in order to avoid conflict and security threats as population pressure and land concentration begins to push people to migrate to different regions. In addition to conflicts over land, migration is likely to bring inappropriate technology and land management issues that will only exacerbate an already stressful and volatile situation.

**Extension and education:** Extension and education needs to be utilized in order to share knowledge and information regarding weather as well as soil conservation and water management methods.

**Migration:** Over time, pastoral groups will shift out of drier areas that are no longer viable to zones that are more humid and have more predictable rainfall patterns. In this case existing land tenure arrangements and services in these areas will come under increased strain, exacerbating relations between communities and fuelling conflict (Anderson, 2008). The movement of some people out of pastoralism and into other livelihoods should in some cases be considered, but as a last option. As much as pastoralism is in itself a viable economic activity, there is also a need to find ways of alleviating the growing population pressure on the land, as well as increasing the range of cash sources available to pastoralist families, many of whom currently rely on remittances sent from family members working elsewhere. There are already thousands of destitute expastoralists who will need special support and attention to enable them to enter other livelihoods, through accessing their right to education, health care, and other services.

**Pastoral passport:** The idea of a pastoral passport could be looked in to as an opportunity for pastoral communities that need to cross borders for grazing. For example, the Economic Community of West African States (ECOWAS) has created a system whereby pastoralists from one nation can now easily cross the border of another nation for grazing purposes without experiencing legal problems. In the ECOWAS system pastoralists have received a 'livestock passport', 'international transhumance certificate,' and a 'handbook of travel.' This promotes mobility, an essential attribute of pastoral societies (GL-CRSP, 2004).

**Commercial cooperative mechanism:** Communities can set up agriculture cooperatives that allow farmers in the village to produce and transport crops collectively in order to earn money that can be used to purchase food during periods of need.

**Early warning systems:** The current existence of uncertainty/variability makes it difficult for affected communities to institute adaptation measures and technologies in a timely and effective manner, thus the need for early warning systems and improved climate information. In addition, a security strategy for food and fodder needs to be developed that allows a timely response to minimize death, suffering, and the undermining of pastoral livelihoods during and after droughts and other disasters (GL-CRSP, 2004). With the addition of early warning systems, livestock rearing and farming can be aided by the use of models, satellite imagery, and better forecasts (United Nations Early Warning Programme, 2007).

#### **Market – based risk management:**

Market – based risk management mechanisms such as ‘insurance’-related instruments that spread and pool risks are important for supporting risk reduction, compensation and adaptation to climate-related and other disasters in developing countries. In 2006, the World Food Programme partnered with French insurance firm Axa Re to pilot a programme to provide cash payouts to farmers in the event of a severe drought. Now, they are working with the Ethiopian government to expand the programme for three years from 2009 (IRIN, 2006).

**Micro - Credit:** Small credit program can also be utilized to allow for farmers to borrow money for seeds and fertilizer in times of need. These micro-loan programs have taken off in recent years but are mainly focused on women groups and small business development. A focus on agriculture is needed if crop production is to continue in light of climate change.

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