Agro-Science Journal of Tropical Agriculture, Food, Environment and Extension
Volume 10 Number 1 January 2011 pp 61 - 71
ISSN 1119-7455

SOCIO-ECONOMIC IMPACTS OF CLIMATE CHANGE IN AFRICA

Igbokwe[1] E.M. and Mkpado[2] M.
[1] Department of Agricultural Extension
[2] Department of Agricultural Economics
University of Nigeria Nsukka, Nigeria.

ABSTRACT

This paper examined the arguments for and against the climate change phenomenon and attempted to weigh in with presentation of available evidence. It finally drew from literature and reviewed possible impacts of climate change in Africa. It concluded by calling for a wakening and preparedness by African governments for possible catastrophic events rather than waiting for external aid.

INTRODUCTION

The level of awareness and understanding of the climate change phenomenon and their impacts on our planet earth and its inhabitants have significantly improved over the past few decades. Africa's contribution to greenhouse gas (GHG) emissions (the cause of global warming) is significantly lower than the industrialized world Africa but has the lowest adaptive capacity because of the many non-climate factors that confound the adversities (low technology, poor access to capital, infrastructure and markets, high poverty and deep social and political chaos). Agriculture however, remains critical for most African countries, contributing an average of 15% of the gross domestic product (GDP) in 2006 and reaching up to 50% in many countries, and remains the main source of employment for the vast majority of the population (World Bank, 2008).

There is sufficient evidence that the world has been witnessing long term changes in climate patterns and variability with rapid acceleration in recent decades. Considerable shifts in long term temperature and rainfall averages, sea levels, frequency and intensity of droughts and floods, and their variances have been observed (IPCC, 2007). Modeling and observational research have also provided ample evidence that the experienced long term shifts in climate parameters have impacted substantially on many aspects of life on earth. The causal relationship between anthropogenic drivers (greenhouse gas emissions) and climate change has also been established albeit with lower certainty due to the complex and intricate interactions and feedback mechanisms between climate and non-climate spheres (IPCC, 2007; Stern, 2007). All of the above have been observed to happen with important regional variations and differential impacts.

This paper reviewed issues of concern in recent continent-wide research efforts attempting to contribute to bridging some of the knowledge gaps. Two opinions exist, one is of the view that climate change exists, while the other asserts that there is no phenomenon like climate change. The latter criticized methodologies and conclusions reached by researchers who assert that there is climate change. Some basic questions become paramount at this point. (i) Can increasing temperature, flooding, drought, melting of icebergs and higher incidence of diseases be associated with climate change? (ii) How will the changes affect human populations, especially, in developing countries?

Concept of Climate Change and the Causes

Article 1 of the UNFCCC (1999) Convention clearly defines climate system as the 'totality of the atmosphere, hydrosphere, biosphere, geosphere and their interactions with human beings'. The average state of the climate system is controlled by a combination of forces external to the system. The external forces include solar variability, astronomical effects, tectonic processes and volcanic eruptions while the internal radiative forces include atmospheric composition and cloud cover. The anthropogenically induced changes are caused by atmospheric composition and surface land cover with their feedback effects such as changes in atmospheric water vapour content or cloudiness caused by global temperature changes. Perhaps, this informed the same Article to define climate change as 'a change of

climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to the natural variability observed over comparable time periods'. As implied from the definition therefore, the climate system can vary naturally, and when amplified, becomes a change. For example, temperature and rainfall data in Nigeria in the last 30 years (Table1) have not shown clear quantum changes and have failed to demonstrate an increasing trend. However, between 1980 and 2000 temperature increase from fro 0 to 0.6^0C (Figure l) has been recorded for Africa. There were remarkable changes in precipitation (Figure 2) in the Africa sub-region. Again however, altermate very wet and very dry years are observable especially between 1970 and 1990 (very dry years) and 1950-1960 (very wet years). Comparing 1 with figures 1 and 2 showed that location matters with respect to change in climate variables.

Table 1: Nigeria temperature rainfall data from 1971-2009

Year	Temperature ^{0}C	Rainfall (cm)
1971-1980	29.75	135.40
1981-1990	30.23	121.27
1991-2000	29.36	124.20
2001-2009	30.57	133.51

Source: Department of Crop Science, Weather Centre, University of Nigeria

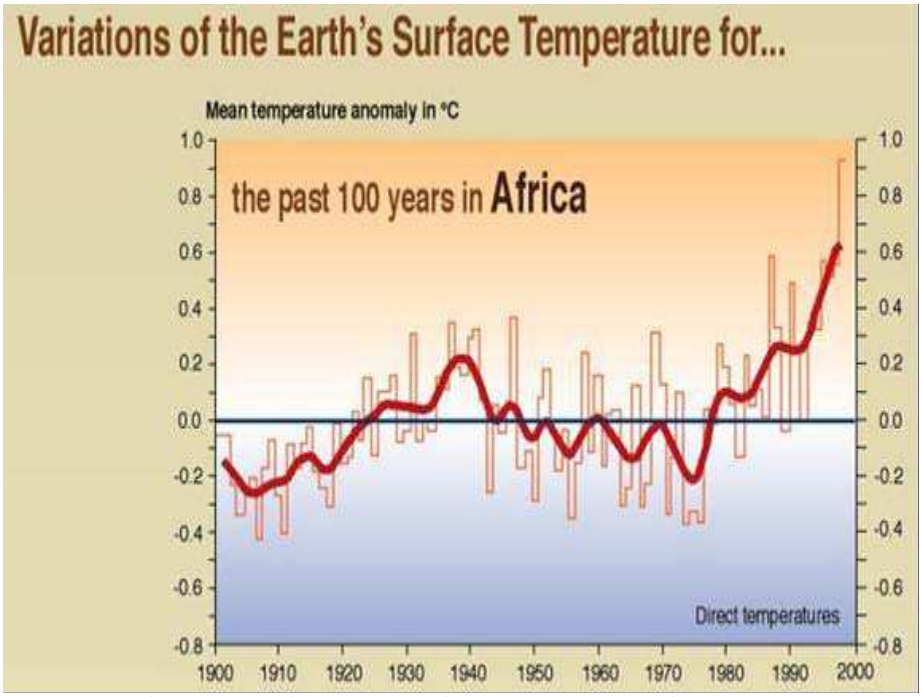

Figure 1: Variations of the Earth's Surface Temperature for the past 100 years in Africa (UNEP Grid Arendal, 2002)

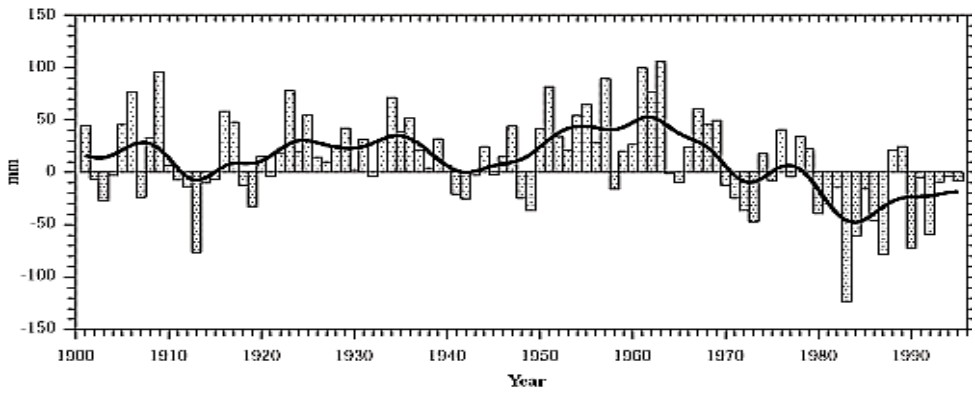

Figure 2: Observed annual precipitation changes for the Africa region (IPCC, 2001)

Tables 2 and 3 demonstrate how anthropogenic actors that contribute globally to increasing $C0_2$ emissions, increasing temperatures and variable precipitation. There is a steady increase of atmospheric carbon dioxide ranging from a mean of 1072.9 in 1975 to 23436.3 in 2002 (Table 2) in the Africa region. Such increase in a low industrial region can only be attributed to an expansive population with a consequent demand for more food, which results in increased deforestation and heavy use of external inputs especially chemical fertilizers. The former limits carbon sequestration while the latter injects varied gases into the atmosphere in addition to other second tier effects like soil degradation. Surprisingly, the mean of suspended particulate matter (SPM) for the region decreased drastically from a high of 106.6 in 1990 to 81.9 and 68.8 in 1996 and 2002, respectively. This is in spite of the rapid population growth, increased human activity (such as mining and oil exploitation). From the foregoing, it is obvious that concrete empirical evidence of climate change is yet to be presented. Alarms being raised all over the world are not mere rhetoric; they derive from frightening observations of variability in climatic elements.

Impact of Climate Change

Impacts are lasting effects impinging on humans and all the ways in which individuals and communities or social systems interact with their socio-cultural, economic and bio-physical environment (IAIA, 2003). These impacts vary depending on a range of factors and then include:

- direct impacts;
- indirect or secondary impacts, that is, not a direct result of climate change, but occur away from the original effect or as a result of a complex inter-play of other phenomena, for example, repeated flooding over farmlands, which render farmers poor may force them off the land and to seek livelihoods in other occupational areas outside agriculture or migrate to new farming areas where they may encounter hostility and communal clashes; and
- cumulative, such as impact on the ability to insure property following a series of flood events or thunderstorms; and/or synergistic, where interaction of effects produces a total effect that is greater than the sum of the individual effects (SNIFFER, 2009). For example, farmers under constant threat of floods relocate to other farmlands where they encounter hostility or hire out their labour; the combined stress from loss of livelihood due to flood risk and social conflict is enormous and therefore can induce vulnerability and in extreme cases mental ill-health or suicide.

An attempt is made below to list the impacts under the first two types because they are most perceptible. This is followed by detailed description of the key social impacts. Special emphasis is given to production agriculture because almost all the African countries, which are the focus of the study, are basically agrarian.

Biophysical impact: The direct effects

- physiological effects on crops, pasture, forests and livestock (quantity and quality);
- changes in land, soil and water resources (quantity and quality);
- increased weed and pest challenges;
- shifts in spatial and temporal distribution of impacts;
- sea level rise, changes to ocean salinity;
- sea temperature rise causing fish to inhabit different ranges.
- flooding, and
- drought

Socio-economic impact: Indirect effects

- decline in yields and production;
- reduced marginal GDP from agriculture;
- fluctuations in world market prices;
- changes in geographical distribution of trade regimes;
- increased number of people at risk of hunger and food insecurity;
- migration and civil unrest; and
- increases in pest and diseases
- Outbreaks

Table 2: Carbon dioxide statistics for cross-sections of selected African countries, 1975–2002

Year	Mean	SD	Min. Value	Max. Value
1975 -1980	12390.41	35695.94	81.3408	195580.7
1981-1985	15212.54	44705.38	101.4928	246394.8
1986-1990	17641.96	51451.21	114.6221	282432.4
1991-1995	18912.42	54760.45	89.33036	316001.5
1996-2000	21078.21	60231.82	99.16039	328109.3
2000-2002	22089.57	62199.57	108.7374	333273.5

Source: Adapted from Orubu *et al*. 2008

Table 3: Suspended particulate matter (SPM) statistics for cross-sections of selected African countries (1990 – 2002)

Year	Mean	Std Dev.	Min. Value	Max. Value
1990	106.5965	58.33957	20..65835.	290..9602
1991	100.0955	55.99181	20.45422	274.2179
1992	98.43288	54.97791	21.06273	289.8728
1993	96.57594	52.84471	21.54999	278.0982
1994	91.69567	51.53528	18.74770	275.3971
1995	86.74005	49.32354	19.07402	277.7722
1996	81.93073	44.71985	20.15645	252.2695
1997	78.29003	42.88747	18.62464	239.7411
1998	75.51525	39.59751	19.71713	220.8533
1999	75.97452	39.38208	16.03642	206.1345
2000	74.20941	38.85613	13.34442	201.9959
2001	71.51760	37.95424	12.94789	200.4462
2002	68.82277	38.65634	11.91941	219.0774

Source: Orubu et. al. 2008

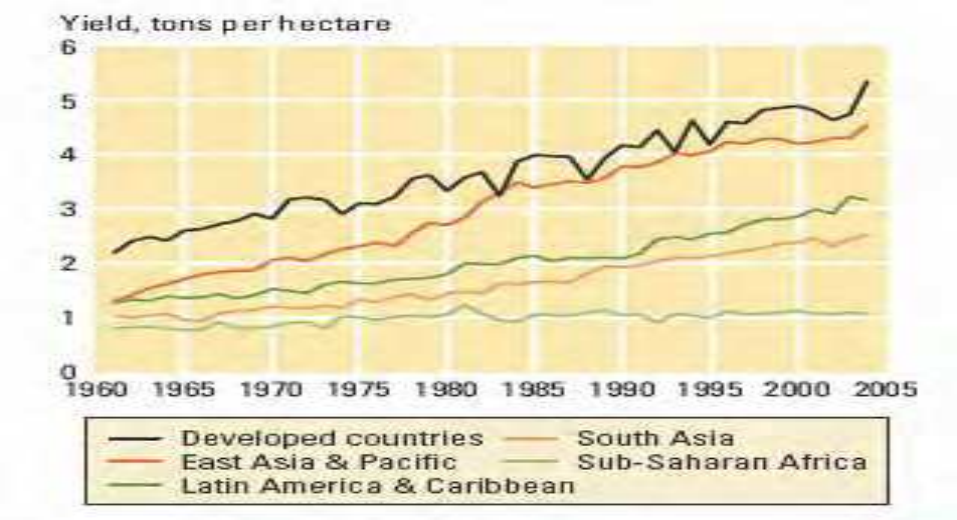

Figure 3: Evolution of cereal yields since 1960 across regions
Source: World Bank (2007)

Impact on Agriculture: Agriculture and health are the sectors mostly affected by climate change. As climatic patterns change, so also do the spatial distribution of agro-ecological zones, habitats, distribution patterns of plant diseases and pests, fish populations and ocean circulation patterns which can have significant impacts on agriculture and food production (FAO, 2007). Increased intensity and frequency of storms, drought and flooding, altered hydrological cycles and precipitation variance have implications for future food availability. The potential impacts on rain-fed agriculture *vis-à-vis* irrigated systems are still not well understood (FAO, 2007). The developing world already contends with chronic food problems. Climate change presents yet another significant challenge to be met. While overall food production may not be threatened, those least able to cope will likely bear additional adverse impacts (WRI, 2005). The estimate for Africa is

that 25–42 percent of species habitats could be lost, affecting both food and non-food crops. Habitat change is already underway in some areas, leading to species range shifts, changes in plant diversity which includes indigenous foods and plant-based medicines (McClean *et al*., 2005). In developing countries, 11 percent of arable land could be affected by climate change, including a reduction of cereal production in up to 65 countries, about 16 percent of agricultural GDP (FAO Committee on Food Security, Report of 31st Session, 2005). Changes in ocean circulation patterns, such as the Atlantic conveyor belt, may affect fish populations and the aquatic food web as species seek conditions suitable for their life cycle. Higher ocean acidity (resulting from carbon dioxide absorption from the atmosphere) could affect the marine environment through deficiency in calcium carbonate, affecting shelled organisms and coral reefs.

Agricultural innovation and climate change

Increases in crop yields per hectare have been lower in Africa than in any other region of the world (see Figure 3). To some extent this may reflect low and falling soil fertility in some areas, but lack of technical innovation is commonly seen as a major factor. Innovations popularised during the Asian green revolution have not experienced the same success in Africa. Improved varieties have accounted for a large share of the yield increase in Asia, while their dissemination has been much slower in Africa (World Bank, 2007). Also, the diversity of agro-ecological conditions as well as of the staple crops used in Africa make improved varieties more difficult to develop and to disseminate (IAC, 2004). Above all, CC will tend to increase the number of variable agro-ecological zones across the continent requiring new and adaptable crop varieties and animal breeds to meet the food and fibre demands of an ever increasing population. Yet less has been spent on agricultural research and development in Africa than anywhere else (World Bank, 2007; Binswanger et al., 2009; Igbokwe and Ozor, 2010). Lack of innovation has often been aggravated by high dissemination costs, in part due to low population density, but also due to lack of effective demand for technical innovations (Wiggins, 1995). Slow progress in the use of irrigation-less than 4% of crop land is irrigated (Binswanger et al. 2009), despite its high unexploited potential (World Bank, 2007) - is another element hindering increases in crop yields (Figure 3). Even for chemical fertilizer that was adopted in the first half of the last century African farmers still have the lowest use rate in the world (FMANR, 2006)**.** There will be need for crop and soil specific chemical fertilizers and application recommendations in varied and emerging agro-ecological zones in the region. This calls for a redefinition of agronomic research and new investment of funds as Climate change phenomenon evolves and brings about new agricultural problems.

For some analysts, technology is the number one barrier to improved productivity. The source of these problems is not fluctuating food prices on the world market, but low productivity on the farm. The production growth needed will have to come from improved farm policies, technologies and techniques, including those that address the effects of climate change (Chicago Council on Global Affairs, 2009). While these first two arguments focus on limited production potential, the following focus on external conditions that prevent the African farmers from producing at their full potential.

Health

Climatic and environmental changes have resulted in declining agricultural productivity, deterioration of water quality and quantity, and loss of biodiversity. Increasing human and animal population pressures and other changes have altered land use, land cover, and desertification, and resulted in general environmental degradation (Hulme, 1996). Global climate change, including changes in water availability, quality, and quantity, can affect the vulnerability of natural and socio-economic systems, including human health and well-being. The apparent correlation between disease outbreaks of malaria, cholera, Rift Valley fever, and meningitis (all of which are sensitive to climate var iability) are well documented (IPCC, 2001).

The presentation described the implications of climate change on eight major elements of health, including food (under-nutrition and malnutrition), safe drinking water (quantity and quality), hazards, food-, water-, vector- and air-borne diseases, and cardiovascular diseases. Temperature changes permanently above 18 degrees Celsius, for example, have recently led to the transmission of malaria in highland regions of East Africa. Adaptation requires investment and careful planning. This includes the use of food reserves/grain stores for long periods of drought, increased use of safe drinking water (simple technologies such as the Indian filter which cuts out 90% cholera), prediction of extreme weather events, increased hygiene (simple measures such

and vaccinations against meningococcal meningitis (MCM). This will involve huge investment. Specifically, climate change will lead to:

- Injury and deaths due to thunderstorms and flooding, which damage trees and property. Indirect deaths may result from electrocution and suicides due to impact on mental health.
- Water-borne diseases arise from contamination due to flooding and reduced hygiene due to water scarcity in drier areas-already some all season water bodies including lakes and streams are reportedly drying up, e.g., Lake Chad.
- Poor access to health services: This is already rated very poor in Africa and could worsen as a result of increased demand on staff, services and health infrastructure and equipment.
- Mental health: Stress, anxiety and mental health problems may result from loss of livelihoods, possessions, investments, damage to property and disruptions in lives. It may lead further to disruption in family and community relations, increase in domestic violence and suicide.

Access to safe water and sanitation

Access to safe water and sanitation services are two other important indicators of environmental quality in any country. Access to safe water generally refers to the proportion of the population with (or without) reasonable access to an adequate amount of water from improved sources such as household connections, public taps, boreholes, protected wells, or spring or rain water connections. On the other hand, access to improved sanitation services refers to the proportion of the population with at least adequate access to excreta disposal that can prevent human, animal and insect contact with excreta. These two measures of environmental quality indirectly indicate a country's disease prevention capability. For, over the period 1985 – 1989, a number of African countries were characterized by a situation in which less than 70% of the population had no access to safe water. In this category are such countries as Benin, Burundi, Central African Republic, Cote d'Ivoire, Ethiopia, Guinea-Bissau, Mali, Mozambique, Nigeria, Sierra-Leone, Sudan and Uganda. However, over the years, the proportion of the population in African countries without access to safe water has been on the decline (ADB, 2006). The same trend holds for access to sanitation services.

It should be noted that the poorest segments of society are the ones that are most ely affected by environmental degradation. se of this, policy advocacy since the 1990s, particularly at the international level, has been in favour of integrating the principles of environmental sustainability into the overall process of planning for sustainable human development. The Millennium Development Goal (Number 7) is the ultimate expression of this vision (World Bank, 2003:12).

Since the 1990s, many African countries, based on the acceptance of the concept of sustainable development, have come to recognize the need to mainstream environmental sustainability into the process of planning for development. In such efforts, they have also received support from the international community in developing environmental awareness, and in establishing the necessary legal and institutional frameworks to deal with environmental and related issues. Thus by the beginning of this 21st Century, most African countries had established national environmental policy institutions/ and completed the preparation of their environmental plans, apart from participation in a number of international treaties on the environment such as those for climatic change, ozone layer, chlorofluorocarbon, law of the sea, and biological diversity. There is therefore sufficient reason to suppose that African countries quite appreciate the need for well-directed policies of environmental protection and management. However, as the African Development Bank (ADB, 2004) has observed, in spite of the significant strides made at the national and regional levels in establishing policy frameworks for environmental management and control, environmental degradation and low quality continue to pose significant constraint on sustainable development in Africa.

Environmental degradation and climate change

According to the African Development Bank [(ADB), 2006], the continent is characterised by a number of environmental problems, which include, *inter alia*:

(i) soil erosion, (ii) desertification, (iii) deforestation, (iv) water and air pollution, (v) relatively high carbon intensity, (vi) habitat loss and threatened wild life population, and (vii) poor sanitation facilities and practices.

While soil erosion generally results from overgrazing and other poor farming practices induced mainly by population pressure, desertification has been traced to rapid deforestation arising from intense use of forest wood as fuel and timber. As noted by the ADB (2006), increasing scarcity of forests in many

African countries is illustrated by a generally declining forest-to-people ratio, which is currently less than half of what it was four decades ago. Water pollution in African countries is mainly due to unhygienic and poor sanitation practices and emissions of organic water pollutants from industrial processes. One costly consequence of organic water pollutants is the threat to public health, as disease-causing bacteria are usually present in domestic sewage and other organic wastes. Apart from harmful health effects, the degradation of water resources by organic water pollutants also has negative industrial, recreational and commercial fishing effects (Seneca and Tausig, 1984). A comparative examination of existing data (World Bank, 2003; ADB, 2006) shows that per capita emission of organic water pollutants in African countries ranks relatively higher than what obtains in some industrial countries. For example, per capita emission of organic water pollutants (kg/day) in 2000 for Algeria, Angola, Burundi, Cote d'Ivoire, Kenya, Malawi, Namibia and Nigeria stood at 0.24, 0.20, 0.24, 0.24, 0.25, 0.29, 0.35 and 0.17, respectively and for Canada, France, Germany, United Kingdom and the USA, it stood at 0.15, 0.10, 0.13, 0.15, and 0.12, respectively in the same year (World Bank, 2003).

As for air pollution, this usually arises from two major sources – primary and secondary sources, respectively. The major primary source of air pollution is suspended particulate matter (SPM), which consists of chemically stable substances such as dust, soot, ash, and smoke. Generally, the state of a country's development and pollution control technology are important determinants of particulate matter concentration (World Bank, 2003:169). Comparatively, measures of SPM for African countries are relatively high, compared to what obtains in a number of industrial countries (see Figure 2). For example SPM for Sweden, United Kingdom, United States, stood at 15, 17, and 27 $\mu g/m^3$ respectively, in 2003 (World Bank, 2003). Compare these figures to those for Angola, Nigeria, and Sudan, measured at 112.8, 94.8, and 219, respectively for the year 2002. Just like water pollution, air pollution has definite health, agricultural, and ecological consequences. Air pollutants are also responsible for significant damage to property, in addition to negative safety and amenity effects.

The major source of secondary air pollution is through a number of gaseous emissions that are characterized by high diffusion rates and instability, resulting largely from transportation and production technologies. In this category are such gases like carbon monoxide, sulphur oxides, oxides of nitrogen, and hydrocarbons such as methane. The combustion of the latter produces a large quantum of carbon dioxide as a bye-product. The flaring of natural gas is a major source of secondary air pollution, particularly in oil-producing countries in Africa (Orubu, 2005). It could be argued that, given the current level of economic development in the African continent, recorded carbon intensities (in per capita terms) are relatively high - although less than world levels. For example, Sub-Sahara's carbon dioxide emissions in per capita metric tons recorded at 0.9 was higher than the average of 0.5 for all low income countries in 1980 - although the Sub- Saharan figure dropped to 0.8 in 1999, while the average for low income countries at the world level went up to 1.0 in the same year (World Bank, 2003).

It is of interest to note that there is an on-going important debate on the role, which developing countries should play in curbing CO_2 emissions. For example, the Kyoto Protocol contains specific commitments taken by industrialised and transitional economies to reduce their emissions of CO_2 over the period 2008 – 2012 – a crucial factor in global warming and climatic change - but no serious commitment exists for developing countries up to the end of the 20^{th} century (Anderson and Cavendish, 2001). African countries may therefore do better, by deliberately coming up with measures to curb the trend towards increased carbon intensity.

Access to safe water and sanitation services are two other important indicators of environmental quality in any country. Access to safe water generally refers to the proportion of the population with (or without) reasonable access to an adequate amount of water from improved sources such as household connections, public taps, boreholes, protected wells, or spring or rain water connections. On the other hand, access to improved sanitation services refers to the proportion of the population with at least adequate access to excreta disposal that can prevent human, animal and insect contact with excreta. These two measures of environmental quality indirectly indicate a country's disease prevention capability. For, over the period 1985 – 1989, a number of African countries were characterized by a situation in which less than 70% of the population had no access to safe water. In this category are such countries as Benin, Burundi, Central African Republic, Cote d'Ivoire, Ethiopia, Guinea-Bissau,

Mali, Mozambique, Nigeria, Sierra-Leone, Sudan and Uganda. However, over the years, the proportion of the population in African countries without access to safe water has been on the decline (ADB, 2006). The same trend holds for access to sanitation services.

It should be noted that the poorest segments of society are the ones that are most adversely affected by environmental degradation. Because of this, policy advocacy since the 1990s, particularly at the international level, has been in favour of integrating the principles of environmental sustainability into the overall process of planning for sustainable human development. The Millennium Development Goal (Number 7) is the ultimate expression of this vision (World Bank, 2003:12).

Since the 1990s, many African countries, based on the acceptance of the concept of sustainable development, have come to recognize the need to mainstream environmental sustainability into the process of planning for development. In such efforts, they have also received support from the international community in developing environmental awareness, and in establishing the necessary legal and institutional frameworks to deal with environmental and related issues. Thus by the beginning of this 21st century, most African countries had established national environmental policy institutions/ and completed the preparation of their environmental plans, apart from participation in a number of international treaties on the environment such as those for climatic change, ozone layer, chlorofluorocarbon, law of the sea, and biological diversity. There is therefore sufficient reason to suppose that African countries quite appreciate the need for well-directed policies of environmental protection and management. However, as the African Development Bank (ADB, 2004) has observed, in spite of the significant strides made at the national and regional levels in establishing policy frameworks for environmental management and control, environmental degradation and low quality continue to pose significant constraint on sustainable development in Africa. Access to safe water and sanitation services are two other important indicators of environmental quality in any country. Access to safe water generally refers to the proportion of the population with (or without) reasonable access to an adequate amount of water from improved sources such as household connections, public taps, boreholes, protected wells, or spring or rain water connections. On the other hand, access to improved sanitation services refers to the proportion of the population with at least adequate access to excreta disposal that can prevent human, animal and insect contact with excreta. These two measures of environmental quality indirectly indicate a country's disease prevention capability. For, over the period 1985 – 1989, a number of African countries were characterized by a situation in which less than 70% of the population had no access to safe water. In this category are such countries as Benin, Burundi, Central African Republic, Cote d'Ivoire, Ethiopia, Guinea-Bissau, Mali, Mozambique, Nigeria, Sierra-Leone, Sudan and Uganda. However, over the years, the proportion of the population in African countries without access to safe water has been on the decline (ADB, 2006). The same trend holds for access to sanitation services.

It should be noted that the poorest segments of society are the ones that are most adversely affected by environmental degradation. Because of this, policy advocacy since the 1990s, particularly at the international level, has been in favour of integrating the principles of environmental sustainability into the overall process of planning for sustainable human development. The Millennium Development Goal (Number 7) is the ultimate expression of this vision (World Bank, 2003:12).

Since the 1990s, many African countries, based on the acceptance of the concept of sustainable development, have come to recognize the need to mainstream environmental sustainability into the process of planning for development. In such efforts, they have also received support from the international community in developing environmental awareness, and in establishing the necessary legal and institutional frameworks to deal with environmental and related issues. Thus by the beginning of this 21st century, most African countries had established national environmental policy institutions/ and completed the preparation of their environmental plans, apart from participation in a number of international treaties on the environment such as those for climatic change, ozone layer, chlorofluorocarbon, law of the sea, and biological diversity. There is therefore sufficient reason to suppose that African countries quite appreciate the need for well-directed policies of environmental protection and management. However, as the African Development Bank (ADB, 2004) has observed, in spite of the significant strides made at the national and regional levels in establishing policy frameworks for environmental management and control, environmental degradation and low quality continue to pose significant constraint on sustainable development in Africa.

Access to safe water and sanitation services are two other important indicators of environmental quality in any country. Access to safe water generally refers to the proportion of the population with (or without) reasonable access to an adequate amount of water from improved sources such as household connections, public taps, boreholes, protected wells, or spring or rain water connections. On the other hand, access to improved sanitation services refers to the proportion of the population with at least adequate access to excreta disposal that can prevent human, animal and insect contact with excreta. These two measures of environmental quality indirectly indicate a country's disease prevention capability. For, over the period 1985 – 1989, a number of African countries were characterized by a situation in which less than 70% of the population had no access to safe water. In this category are such countries as Benin, Burundi, Central African Republic, Cote d'Ivoire, Ethiopia, Guinea-Bissau, Mali, Mozambique, Nigeria, Sierra-Leone, Sudan and Uganda. However, over the years, the proportion of the population in African countries without access to safe water has been on the decline (ADB, 2006). The same trend holds for access to sanitation services.

It should be noted that the poorest segments of society are the ones that are most adversely affected by environmental degradation. Because of this, policy advocacy since the 1990s, particularly at the international level, has been in favour of integrating the principles of environmental sustainability into the overall process of planning for sustainable human development. The Millennium Development Goal (Number 7) is the ultimate expression of this vision (World Bank, 2003:12).

Since the 1990s, many African countries, based on the acceptance of the concept of sustainable development, have come to recognize the need to mainstream environmental sustainability into the process of planning for development. In such efforts, they have also received support from the international community in developing environmental awareness, and in establishing the necessary legal and institutional frameworks to deal with environmental and related issues. Thus by the beginning of this 21st century, most African countries had established national environmental policy institutions/ and completed the preparation of their environmental plans, apart from participation in a number of international treaties on the environment such as those for climatic change, ozone layer, chlorofluorocarbon, law of the sea, and biological diversity. There is therefore sufficient reason to suppose that African countries quite appreciate the need for well-directed policies of environmental protection and management. However, as the African Development Bank (ADB, 2004) has observed, in spite of the significant strides made at the national and regional levels in establishing policy frameworks for environmental management and control, environmental degradation and low quality continue to pose significant constraint on sustainable development in Africa.

Impact on safety and crime levels

Increasing scarcity of natural resources will lead to terrestrial conflicts, social unrest and fires. Resource, fuel and food insecurity lead to armed conflicts and forced migration. In Nigeria reports of armed conflicts between Fulani herders and crop farmers abound and each case involves loss of life and property. This is also true of Masai and Turkana herders and crop farmers in Eastern Africa. In the West African sub-region migration of herders from drier grasslands to wetter and coastal areas, which earlier were infested with tsetse fly and presumed inhabitable for livestock is commonplace. Rising temperatures will give rise to wild fires, which further degrade the land.

Impact on access to, and quality of goods and services

Climate change is very likely to negatively affect access to basic resources such as water, food, shelter and essential services. There are likely to be declines in rainfall especially in areas already experiencing water stress (e.g., the Sahel). Increased demands for agricultural irrigation and household use especially during the dry season will exacerbate the situation. In high precipitation regions flooding will put critical infrastructure at risk. The quality of portable water supplies may be contaminated by flood events or due to warmer temperatures. Global food security and prices have increasingly become source of concern because drought in sub-Saharan Africa will surely reduce yields by up to 20% by 2020 under medium-range CC scenarios. More and more agricultural land will come under pressure from increasing urbanization. Fisheries may be affected by rising temperatures, reduced oxygen levels and disruptions to catches and transportation in high winds. This will lead to rising food imports and food aid especially grains in developing countries that previously had relied on the two sources over the years. Access to education can also be affected. Although a switch to low carbon economy through investments in

renewable energy is expected to generate jobs as well as drive education and training in CC related skills, flooding, heat and storms can severely disrupt education, business and sector workers' lives. Recent sea surges in coastal areas like Lagos, Nigeria disrupted schooling and business for a prolonged period. In the same way these elements can adversely affect transportation and communications. Cases of road and rail wash and collapsed telecommunication masts have been recorded.

Impact on poverty and social exclusion

Climate change will disproportionately affect the poorest in society. Those already poor are more likely to live in places at risk from CC especially in African urban slums. Women and children and the elderly will be most vulnerable. This situation will be worsened by the lack of care due to breakdown of traditional social security networks and the inefficiencies or absence of national social security and emergency management mechanisms in most African countries. Also socially excluded people are less able to participate in decision making, thereby further reducing their capacity to adapt to future events. They have never participated in African societies, anyway.

CONCLUSION

The evidence of warming is growing by the day but still requires hard data to convince all doubters. Since the industrial era began, wealthy nations have released huge amounts of carbon into the earth's atmosphere and altered the surface of the planet. As greenhouse gas concentrations have risen, so too have global temperatures. The past decade was the hottest of the past 150 years, and possibly of the past millennium. The hottest 22 years on record have occurred in the 25 years since 1980. The United Nations' Intergovernmental Panel on Climate Change (IPCC) forecasts a global temperature increase of 1.4ºC to 5.8ºC above 1990 temperatures by 2100. Given this scenario, one can only speculate on the social impacts and make intelligent guesses on how to reduce the impacts and raise consciousness. ***Climate change will affect everyone*** Both the rich and the poor stand to lose as much in all countries. Those already affected by poverty, malnutrition and disease will face displacement and new hardships. In Africa, industries, livelihoods and public health will face serious threats from drought, disease and extreme weather events. However African victims will have a hard time recovering because they have always belonged to the vulnerable class even when Africa is the least polluter. ***Climate change is an issue of justice*** The impacts of greenhouse gas emissions will disproportionately affect those societies who have contributed the least to the problem. Low-lying Pacific states, collectively responsible for less than 0.6% of the world's emissions, face dispossession. Yet the worst offenders, including Australia and the United States, continue to pollute at historically high levels. Justice demands that wealthy polluters should end their reliance on fossil fuels, and embrace a future based on a fair share of resource use for all. ***Stopping climate change is up to us.*** Our actions today will determine the climate of tomorrow. By choosing to take action now will limit the future damage. The alternative is an environmental, economic and humanitarian catastrophe of our own making.

African governments should be prepared The days of massive emergency aid during national emergencies are over. Focus has shifted over time to Eastern Europe and other non-African countries. The lesson here is that African governments must institute national emergency agencies and strengthen existing ones. The level of emergency preparedness must be optimal while bureaucrats continue to negotiate endlessly in the international arena.

BIBLIOGRAPHY

African Development Bank (ADB) (2006). *Gender, Poverty and Environmental Indicators on African Countries*. ADB, Addis Ababa, Ethiopia.

African Development Bank (ADB) (2004). Africa Development Bank Group's Policy on the Environment. ADB, Addis Ababa, Ethiopia

African Development Bank (ADB) (2002). *Gender, Poverty and Environmental Indicators on African Countries*. ADB, Addis Ababa, Ethiopia.

Binswanger-Mkline, H.P., F.A. McClalla and P. Patel (2009) *Structural Transformation of African Agriculture*. Western Cape South Africa Chicago Council on Global Affairs (2009):

Food and Agriculture Organization (FAO) (2007). Adaptation to climate change for agriculture, forestry and fisheries: Perspective framework and priorities. http://www.fao.org /j9271e cc/ for agric/ forestry /fisheries .

Food and Agriculture Organization (FAO) (2005). Impact of climate change, pests and diseases on food security and poverty reduction. *Special event background*

document for the 31st Session of the
Igbokwe E.M. and Mkpado M. *rity*. Rome. 23-26 May.

Hulme, M. (1996). Climate change and Southern Africa: An exploration of some potential impacts and implications in the SADC region. Climate Research Unit, University of East Anglia, Norwich, UK.

Igbokwe, E. M. and Nicholas Ozor (2010). Technological transfer and diffusion in developing economies: Perspectives from agricultural technology. In: Ndubuisi Ekekwe (ed.) *Nanotechnology and Microelectronics: Global Diffusion, Economies and Policy*. Information Science Reference (an imprint of IGI Global), Hershey and New York, pp. 325-339.

Intergovernmental Panel on Climate Change (IPCC) (2007a). *Africa*. Cambridge University Press, Cambridge, UK.

Intergovernmental Panel on Climate Change (IPCC) (2007). *Impacts, Adaptations, and Vulnerability,* Fourth Assessment Report. Cambridge University Press, Cambridge, UK.

Intergovernmental Panel on Climate Change (IPCC) (2007). Synthesis Report: Summary for Policy Makers. Cambridge University Press, Cambridge, UK.

Intergovernmental Panel on Climate Change (IPCC) (2001). Summary for Policy Makers: Climate Change 2001: Impacts, Adaptation, and Vulnerability: Report of Working Group 11 of the IPCC.

Intergovernmental Panel on Climate Change (IPCC) (2001). *Climate Change 2001: Impacts, Adaptation, and Vulnerability*. Cambridge University Press, Cambridge, UK

International Association for Impact Assessment (IAIA) (2003). *Social Impact Assessment: International Principles*. Special Publication Series No. 2, May.

IAC (Inter Academy Counel) (2004. Realising the Promise and Potential of African Agriculture Amsterdam The Netherlands : Inter Academy Council Report, 2004.

McClean, C. J., J. C. Lovett, Kuper W., Hannah L., Sommer J.H., Barhlott W., Termansen M., Smith G.F., Tokumire S. and topin J. R.D (2005) African Plant Diversity and Climate Change *Annals of the Missouri Botanical Garden Vol 92 (2) 139-152*. www.jstor.org/stable/3298511

Orubu, C.O., D.G. Omotor and P.O. Awopegba (2008). Economic Growth and Environmental Quality: Searching for Environmental Kuznets Curves in Africa. Final Report Submitted to African Economic Research Consortium (AERC), Nairobi, Kenya.

SNIFFER (2009). Differential Social Impact of Climate Change in the UK. Final Report, Project UK22, Edinburgh, www.sniffer.org.uk.Seneca J. and M.K. Tausig (1984) *Environmental Economics* Prentice Hall Englewood Cliffs N.J. Stern N. (2007) *Review on Economics of Climate Change* London School of Economics UK United Nations Framework Convention on Climate Change (UNFCCC) (1999). Convention on Climate Change, 9 May 1992.

UNEP (2002) Report Report of the Solvents, Coatings and Adhesives Technical: STOC Assessment Report iv Disclaimer The United Nations Environment Programme (UNEP), the www.unep.org/ozone/pdf/stoc-2002-assessment.pdf World Resources Institute (WRI) in collaboration with United Nations Development Programme, United Nations Environment Programme and World Bank (2005) *World Resources 2005: The Wealth of the Poor—Managing Ecosystems to Fight Poverty*. Washington, DC: WRI.

World Bank Global Monitoring Report 2008 April 8, 2008 — A new World Bank-IMF report www.worldbank.org/gmr2008

World Bank Annual Report 2003 www.worldbank.org/annualreport/2003

World Bank (2007) World Development Report 2007: Development and the Next Generation *www.worldbank.org/ Research › WDRs › WDR 2007*