

ENERGY AND CLIMATE CHANGE: CRITICAL REFLECTION ON THE AFRICAN CONTINENT

Ayodele Temitope Raphael, Olanrewaju Oludolapo Akanni and Jimoh Abdul-Ganiyu Adisa
Tshwane University of Technology, Pretoria, South Africa

ABSTRACT

Climate change is possibly the greatest environmental challenge facing the world today and its impacts is already a reality in Africa. The various impacts of climate change have led to many unfortunate natural disasters in various parts of the continents, including Africa. In this paper, an overview of global warming and climate change is first presented. Views of the international community on ways to overcome the climate change through different programmes are highlighted. Various issues regarding the effects of climate change on Africa development are discussed. The expectations of Africa's political leaders in the face of global warming and climate change are highlighted. Africa's challenge will be to promote a sustainable development into concrete policies to mitigate the continent's climate change. With the expectations and shortcomings of African leaders regarding climate change, this paper will be useful in the creation of awareness on the need for necessary intervention from Africa's political leaders.

Keywords: African continent, Africa's leadership, Climate change, Energy, global warming, Green house gas, sustainable development.

INTRODUCTION

Human race cannot survive without energy; it is one of the most fundamental parts of our universe. Over the years, there has been increase in energy consumption (Tverberg, 2012). This is due to our insatiable desires for better quality of life, increasing in population growth and the technological advancement (Jimoh, 2011). In the past, it was believed that universe could continuously be exploited without consequences. Today, climate change is a reality attesting to the fact that we were wrong. Climate change will have significant impact on development, poverty alleviation and the achievement of the Millennium Development Goals (MDGs) (Lagos, Wirth, & El-Ashry, 2009). It is believed that if the issue of climate change is carelessly handled, it will slow down or even retard the progress already made in achieving global goals as new threat emerge to public health, agricultural production, water and food security (Lagos, et al., 2009). Figure 1 shows the huge increase in world energy consumption that has taken place in the last 200 years. This rise in energy consumption is primarily from increased fossil fuel use. The relationship between the population growth and the energy consumption is shown in Figure 2. The figure shows that there is a positive correlation between population and energy consumption.

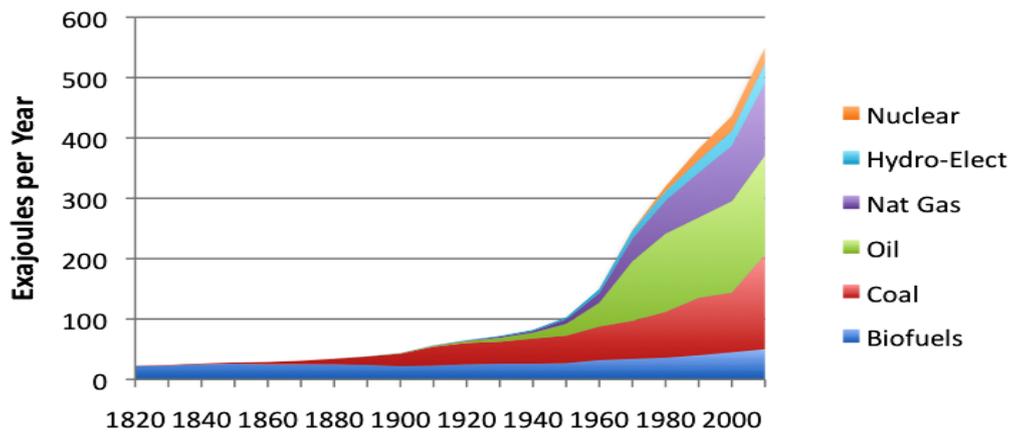


Figure 1: World energy consumption since 1820 Source: energy bulleting, source: <http://www.energybulletin.net/stories/2012-03-16/world-energy-consumption-1820-charts>

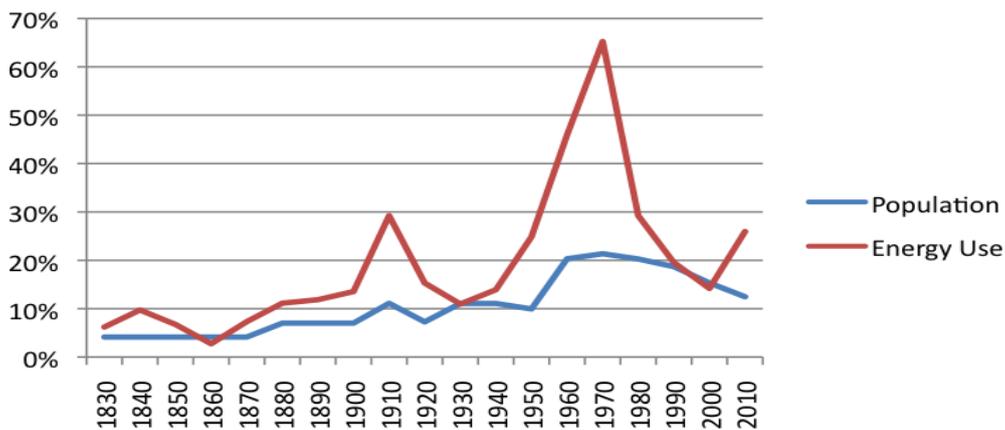


Figure 2: Decades of percentage increase in Energy Vs population change

Source: energy bulleting, <http://www.energybulletin.net/stories/2012-03-16/world-energy-consumption-1820-charts>

Many organisations have since been springing up to the acknowledgment of climate change. In 1988, the Intergovernmental Panel on Climate Change (IPCC) was created by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) to assess the scientific knowledge on global warming. The IPCC concluded in 1990 that there was broad international consensus that climate change was human-induced. That report led way to an international convention for climate change, the United Nations Framework Convention on Climate Change (UNFCCC), signed by over 150 countries at the Rio Earth Summit in 1992 (Anup 2012). Naturally, the choice and design of such programmes is prone to have an effective impact on economic activity (Pereira & Pereira, 2009). In April 2010, the Secretary-General of the United Nations (UNSG) advisory group on energy and climate change report energy for sustainable future (Woodsworth, 2012). Three key areas were identified as shown in Figure 3 and this include: ensuring universal access to modern energy services, increase in rate of improvement in energy efficiency (30% of global consumptions) and increasing the share of renewable energy in the global energy mix (40% reduction of global energy intensity).

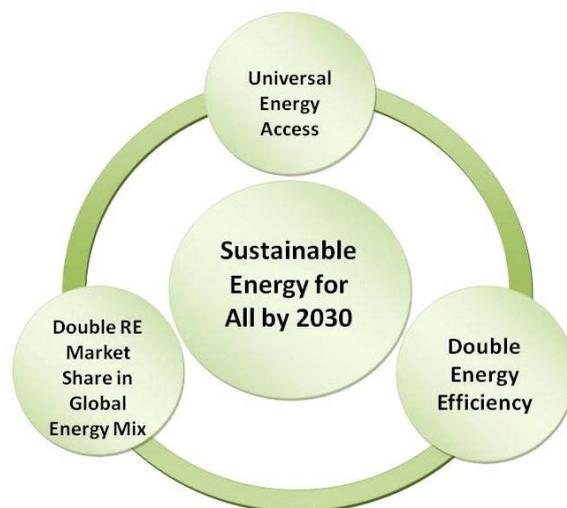


Figure 3: SG Initiative on Sustainable Energy for all(Woodsworth, 2012)

Analyst argued that the impact of climate change will be felt more in the poor regions of the world especially Africa who lack resources for adaptation and mitigation. Climate extremes and altered weather patterns threaten agricultural production and food security, health, water and energy security, which in turn undermine Africa’s ability to grow and develop. Climate and environmentally related disasters which threaten human security can induce forced migration and produce competition among communities and nations for water and basic needs resources, with potential negative consequences for political stability and conflict resolution.

The potential impacts of climate change exacerbate already existing threats to human wellbeing and undermine efforts towards achieving sustainable development (Rarieya, 2009). Furthermore, population growth, combined with environmental degradation and extreme poverty continue to threaten sustainable use of natural resources (Rarieya, 2009). It has been identified that the present and the future sustainable socio-economic development of African nations will depend greatly on the strength to handle the existing climate variability as well as adaptation to future climate changes (Ogalo, 2010). Developing countries face most of the adverse results of climate change where populations are most vulnerable and least likely to adapt to climate change. Sustainable development might be one of the ways to reduce this vulnerability. However, vagueness regarding the rate of climate change and model of economic development in African countries raise questions about whether development could occur fast enough to make a difference (Beg et al., 2002).

The African countries are more concerned with the issues of access to energy (modern fuels and electricity) in order to improve and increase industrial production and output, economic growth and development. Therefore, it will be difficult for developing countries to avoid increasing emissions as they attempt to meet their needs through fossil fuel production. The challenge, therefore, is to ensure that there are synergies between sustainable development goals and carbon dioxide reduction strategies in order to avoid the impact of climate change. However, there is unanimous agreement that sustainable development involves an integration of environmental protection and economic growth (Meyer & Odeku). Economic growth can be attained through alternative energy sources as opposed to fossil fuels. One approach that should be considered in order for developing countries to grow their economies by utilizing their natural resources without contributing to climate change is by encouraging more environmentally sustainable energy sector expansion (Meyer & Odeku).

This paper gives a general overview of global warming and climate change. It then examines the various ways through which climate change affects Africa and then highlights expectations of political leaders on climate change in Africa.

CAUSES OF CLIMATE CHANGE

The cause of climate change has been a subject of research by different scientists all over the world in the past decades. Different natural cycles and events that are known to influence climate have been examined. It was realised that there are several greenhouse gases responsible for warming, and humans emit them in a variety of ways (NOAA, 2012). Most come from the combustion of fossil fuels in cars, factories and electricity production. The gas responsible for the most warming is carbon dioxide (CO₂). Other contributors include methane released from landfills and agriculture (especially from the digestive systems of grazing animals), nitrous oxide from fertilizers, gases used for refrigeration and industrial processes, and the loss of forests that would otherwise store CO₂. Different greenhouse gases have very different heat-trapping abilities. Some of them can even trap more heat than CO₂. A molecule of methane produces more than 20 times the warming of a molecule of CO₂. Nitrous oxide is 300 times more powerful than CO₂. Other gases, such as chlorofluorocarbons (which have been banned in much of the world because they also degrade the ozone layer), have heat-trapping potential thousands of times greater than CO₂. But because their concentrations are much lower than CO₂, none of these gases adds as much warmth to the atmosphere as CO₂ does.

Evidence of a Warming World and the Effect of Climate Change

US agency, the National Oceanic and Atmospheric Administration (NOAA) in 2009 reports the findings of more than 300 scientists from 160 research groups in 48 countries. Based on comprehensive data from multiple sources, the report defines 10 measurable planet-wide features used to gauge global temperature changes as shown in Figure 4 (NOAA, 2010). The relative movement of each of these indicators proves consistent with a warming world. Seven indicators are rising: air temperature over land, sea-surface temperature, air temperature over oceans, sea level, ocean heat, humidity and tropospheric temperature in the “active-weather” layer of the atmosphere closest to the Earth’s surface. Three indicators are declining: Arctic sea ice, glaciers and spring snow cover in the Northern hemisphere. The report confirms that the past decade was the warmest on record and that the Earth has been growing warmer over the last 50 years.

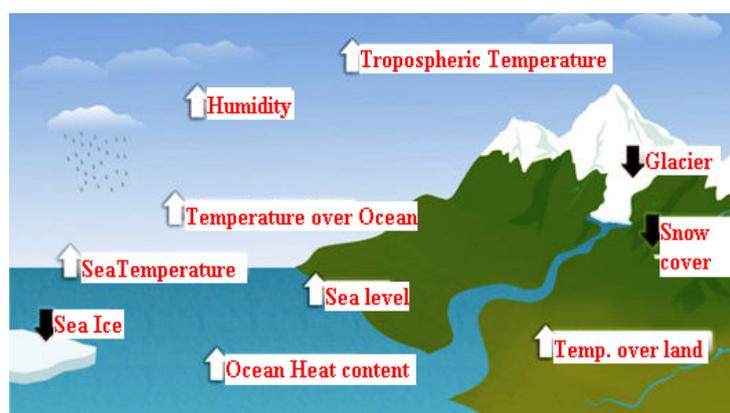


Figure 4: Ten indicators of warming world

Source: NOAA 2010: Past Decade Warmest on Record According to Scientists in 48 Countries (assessed 17th April 2012)

Over the last century, atmospheric concentrations of carbon dioxide have increased from a pre-industrial value of 278 parts per million to 385 parts per million in 2008, and the average global temperatures rose by 0.74 degree Celsius (Lagos, et al., 2009). According to scientists, this is the largest and fastest warming trend they have been able to discern in the Earth's history. The emission of CO₂ in the last six hundred and fifty thousand years is shown in Figure 5. In the past decades, CO₂ emission has never cross 300 parts per million line until now. With rising temperatures, the frequency of extreme events such as heat waves, droughts, and heavy rainfall events will increase. This will adversely affects agriculture, forests, biodiversity, water resources, industry, human health and settlements. Higher temperatures are expected to raise sea level through thermal expansion of the oceans and melting mountain glaciers and ice caps, including portions of the Greenland and Antarctic ice sheets. In addition, increased concentrations of atmospheric carbon dioxide are causing the oceans to become more acidic, threatening the viability of fisheries and marine ecosystems.

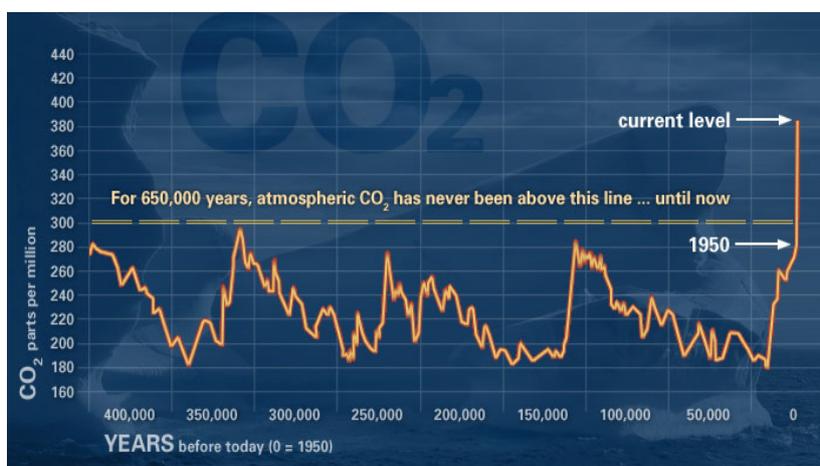


Figure 5: Emission of CO₂ in the last six decades

Source: [NOAA](#) (accessed 26th March 2012)

RESPONSES TO CLIMATE CHANGE BY THE INTERNATIONAL COMMUNITY

The international community is focused primarily on mitigation – actions taken to reduce emissions and increase sinks of GHGs to avoid harmful climate change (Willey & Gostin, 2009). The international response to climate change is embodied in the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol (Lambrou & Piana, 2006). Not left out in the international bodies is the Asia Pacific Partnership (APP). The UNFCCC is the primary mechanism for coordinating a global response to climate change. The Kyoto Protocol, adopted in December 1997, is an international agreement which builds on the UNFCCC and sets legally binding targets for cutting GHG emissions of industrialized countries (anonymous, 2012b). The first Convention of the Parties to the UNFCC (COP 1) was held in 1995. Negotiations at this and two subsequent COPs led to agreement on the Kyoto Protocol in 1997. The Kyoto Protocol set out specific commitments by individual developed countries to reduced emissions by an average of 5.2% below 1990 levels by the period 2008-2012. (<http://www.world-nuclear.org/info/infios.html>, 2012). APP partners Australia, Canada, China, India, Japan, Korea, and the United States worked together and with private sector partners to meet goals for energy security, national air pollution reduction, and climate change in ways that promote sustainable economic growth and poverty reduction (anonymous, 2012a). The APP's significant difference to Kyoto with regard to

greenhouse gas emissions is that it requires participation by developing nations. This is seen as crucial by both the United States and Australia, who contend that it would be economically untenable for their countries to significantly cut their emissions without all countries taking action (Sciencenews, 2012).

AFRICA AND THE CLIMATE CHANGE

Most analyses of the impacts of climate change who focus on medium-to long-term impacts of carbon emissions and global warming projects that the world's poor, who have contributed the least to greenhouse gas emissions, will suffer the worst impacts of climate change (CIGI, 2009; Lagos, et al., 2009). Africa is considered most susceptible to climate change due to its vulnerability and inability to cope with the physical, human and socioeconomic consequences of climate extremes (CIGI, 2009).

Impact of Climate Change on Africa's Development

Climate change is already a reality in Africa. There are prolonged and intensified droughts in eastern Africa; unprecedented floods in western Africa; depletion of rain forests in equatorial Africa; and an increase in ocean acidity around Africa's southern coast (CIGI, 2009; WHO, 2008). Rainfall and river flow decreases have begun to affect both the urban water and energy security and, by extension, urban productivity. Drops in water availability or quality also cause heightened competition for water between agriculture, manufacturing and domestic usage. Extreme weather events now seem to occur with rising frequency and higher environmental and socio-economic costs in Africa. In 1991, torrential rains led to the opening of the floodgates of the Kainji, Jebba and Shiroro dams in Nigeria, resulting in a heavy death toll and property losses. In the same year, an overflowing White Volta River claimed many lives and destroyed hundreds of houses in Ghana. After a devastating flood and the displacement of several hundred thousand people in 1998, the Komadugu Yobe valley in Nigeria flooded once more in 2001. The death toll exceeded 200, with over 35,000 displaced people. Likewise in 2009, floods in Burkina Faso that followed the heaviest rainfall in 90 years, leaving seven dead and 150,000 homeless. The effects of climate change appear to be increasingly destructive for urban infrastructures and systems in Eastern Africa (UN-HABITAT, 2010). Some of the impacts of climate change on Africa continent are briefly highlighted

Agriculture and Food Security

Agriculture, which provides a livelihood for about three-quarters of Africa's population, is mainly rain-fed. Severe and prolonged droughts, flooding and loss of arable land due to desertification and soil erosion are reducing agricultural yields and causing crop failure and loss of livestock, which endangers rural and pastoralist populations. This is evident in countries like Somalia, Malawi, Niger, Kenya and Zimbabwe. Somalia is one of the countries worst affected by a drought which has hit the Horn of Africa, leaving some 11.5 million people in need of food aid (BBC, 2006). According to the International Food Policy Research Institute (IFPRI), about 200 million people are malnourished due to agricultural crisis in Africa as a result of climate change (Plaut, 2006). In the highlands of Ethiopia and Eritrea some land is now so degraded that there is little prospect that it will ever produce a decent harvest. In sub-Saharan Africa soil quality is classified as degraded in about 72% of arable land and 31% of pasture land. soil fertility is declining by the year through soil erosion (Gerald et al., 2009).



Figure 6: Drought in Somalia

Source: BBC news <http://news.bbc.co.uk/2/hi/africa/4662232.stm>.

Health

Each year, about 800 000 people die from causes attributable to urban air pollution, 1.8 million from diarrhoea largely resulting from lack of access to clean water supply and sanitation, and from poor hygiene, 3.5 million from malnutrition and approximately 60 000 in natural disasters (WHO, 2008). A warmer and more variable climate threatens to lead to higher levels of some air pollutants, increase transmission of diseases through unclean water and through contaminated food. Climate change also brings new challenges to the control of infectious diseases. Many of the major killers are highly climate sensitive as regards temperature and rainfall, including cholera and the diarrhoeal diseases, as well as diseases including malaria, dengue and other infections carried by vectors. Climate change threatens to slow, halt or reverses the progress that the global public health community is now making against many of these diseases.

Population displacement and forced social transition.

Climate change can eventually force people to abandon where they live in order to seek new homes and livelihoods as a result of flooding communities, destruction of ecological and agricultural systems. Forced displacement is associated with a range of health issues, including social isolation and mental disorders and, in many cases, reduced socioeconomic status and associated health problems. Already, droughts and the drying of river basins in southern and eastern Africa as well as floods and rising sea levels in western Africa have induced migration of individuals and communities in search of alternative livelihoods. Examples of climate change-related migration in Africa include: the continuous movement of pastoralist communities of northern Kenya ravaged by both droughts and floods; rural-urban migration in Ethiopia due to adverse environmental changes in its highlands; and internal displacement of population in the low-lying and flood-prone plains of the river Niger in Nigeria.

In many part of Africa, drought caused many rural families to abandon their farms and move to cities, with a range of negative social and health effects. When migration crosses ethnic and/or national boundaries, such as forced migration from low-lying, small island states, the social transition is more difficult and the associated health effects are likely to be more severe.

Conflict and War

Climate change may seriously threaten political and economic stability, for example, when communities and nations struggle to access scarce water resources or when forced migration puts previously separate groups into conflict over the same resources. Given the history of ethnic, resource and political conflicts in Africa, climate change could aggravate territorial and border disputes and complicate conflict resolution and mediation processes. Conflict zones and potential flash points in Africa, such as Darfur, the Sahel, the Horn of Africa, the DRC and northern Kenya (CIGI, 2009; WHO, 2008), all have populations living in fragile and unstable conditions making them vulnerable to climate change's effects and the risk of violent conflict. Declining water resources and diminishing arable land are already intensifying competition for those resources, and creating tensions for displaced populations or those moving in search of improved livelihoods. In northern Darfur, Sudan, precipitation has fallen by a third in the past 80 years. The resulting desertification, along with other environmental pressures, has added to the stress on traditional agricultural and pastoral livelihoods. By early 2008, fighting in the region had cost between 200 000 and 500 000 lives and displaced over 2.5 million people, many of whom are living in refugee camps in precarious health conditions (CIGI, 2009; WHO, 2008).

SHORTCOMINGS OF AFRICAN NATIONS

Though, in response to Africa's various actions to climate change, the region is faced with many challenges due to various shortcomings (Denton, Sokona, & Thomas, undated; Mutambo, 2012; UN-HABITAT, 2010). Well designed plans are often executed with poor materials by unregulated and corrupt contractors (UN-HABITAT 2010). It is generally agreed that effective action to halt environmental degradation will be slow because of political reluctance to address the economic and social causes (Mutambo 2012). Mayors are expected to develop adaptation policies, but most lack the technical, human and financial resources for effective action. In 2009, 31 mayors from various African countries endorsed the 'Nairobi Declaration' in a bid to enhance integration of climate change interventions into their urban development plans. The recommendations have yet to result in policies and practical programmes. Climate change per se is not considered a key policy priority by governments in Africa. Senior government officials and most members of civil society do not understand the climate issue very well. Formulation of a sound response strategy on climate change can only occur when the stakeholders foresee potential consequences that could jeopardize national efforts to achieve sustainable development. Successful implementation of an awareness-raising program can only occur if the right groups of people are targeted. Efforts to raise awareness among top officials within the relevant ministries in Africa are hampered by institutional and structural difficulties. Another problem seems to stem from the way African governments depend on the West to help them circumvent problems related to climate change.

POLITICAL ISSUES ON CLIMATE CHANGE: AFRICA'S CHALLENGES

Lack of Data

Climate change is a major threat to sustainable growth and development in Africa. Although Africa is the continent least responsible for climate change, it is particularly vulnerable to the effects. Unfortunately most analyses of the impacts of climate change that have influenced UNFCCC agreements cover mainly countries and regions for which relevant data are readily available. This leaves out most developing countries and regions, particularly Africa, due to unavailable data and trajectories. From an African perspective, this omission is serious and costly (Lagos, et al., 2009).

Misplacement of Africa's Priority

Given the far-ranging adverse impacts of climate change, adaptation is considered as one of the integral component of an effective strategy to address this critical issue, this is lacking in Africa. However, existing adaptation mechanisms and resources under the Kyoto agreement designed to mitigate climate change's effects on Africa (and other developing regions) have been directed at limiting future carbon emissions, rather than addressing the region's vulnerability and lack of resilience to the impacts of climate change on its economies and populations (CIGI, 2009). Africa's concern about climate change is not mainly in terms projections of carbon emission and future environmental damages. It is more about the links between climate change and droughts, desertification, floods, coastal storms, soil erosion-contemporary disaster events that threaten lives and livelihoods, and hinder the continent's economic growth and social progress.

Lack of Relevance of Africa in Global Negotiations

Due to the limited relevance of past and current global climate change agreements to Africa's climate and environmental problems, the hardest hit region has benefited least from the international climate change regime, which relates almost exclusively to funding and investments for green, low carbon growth. For example, Africa's participation to date in the Clean Development Mechanism (CDM) and carbon trading arrangements under the Kyoto Protocol has been minimal. Africa's negligible role in previous international climate change negotiations can be remedied by concerted action on the part of African leaders.

Access to Funding

The World Bank estimates that between 2010 and 2050 the annual cost to adapt to climate change in Sub-Saharan Africa is \$18 billion a year (Caravani, Bird, & Schalatek, 2010). In order for Africa to develop in a low carbon, sustainable way, Christian Aid has calculated that the region will require funding between \$510 and \$675 billion between 2010 and 2030. The current model of financing through the Clean Development Mechanism (CDM) of the Kyoto Protocol and other sources of climate finance are not providing anywhere near this level of funding. There are lacks of commitments and unwilling attitude to dispatch fund to the developing nation (Odinga, 2011). The reason is that recipients have had to conform to funders' requirements, rather than funders respecting recipients' budget cycles, priorities and systems. Climate change finance is poorly integrated into local budgets. This is partly a result of weak country capacity, partly a result of not knowing how to define climate change.

Institutional and Technical Capacity Weakness

Full understanding of the issues, realities and the challenges associated with climate change in Africa at the local level are lacking. The Political institutional framework that needs to provide political awareness of threats is weak (Ekweozoh & Njoku, 2010) . Scientific & technical capacity to embark on programs to address climate change that needed to be home grown, linking national policies and strategies, including domestic resource mobilization, to climate change issues are weak and in most part of Africa not existing (Mulugetta, 2011). Without these ingredients, Africa may continue to be adversely affected by climate change.

EXPECTATIONS OF AFRICA'S POLITICAL LEADERS ON CLIMATE CHANGE

Need For Effective One Voice

For Africa, the immediate need is not essentially that of reducing greenhouse gas emission, which is relatively low in the global context. According to the World Bank's World Development Report 2010 (CIGI, 2009), high-income industrialized countries, with one-sixth of the world's population, are responsible for nearly two-thirds of greenhouse gases. The need is for Africa to ensure that the current development impacts of climate change on its economies and populations are recognized and that a development agenda is integrated into the various international agreements. It is important that Africa should speak with a strong unified voice and present a common position in future international negotiations, and that this voice should be heard (APF, 2007).

Capacity Building on Climate Change

One of the main problems in understanding the implications of climate change is the collection of reliable meteorological data of sufficiently high resolution and continuity. This is crucial for detecting important local and regional scale climatic trends as well as validating regional projections of climate models (and hence reducing uncertainties in the projections)(Few, Osbahr, Bouwer, Viner, & Sperling, 2006). Insufficient and unreliable meteorological datasets for the countries in Africa have remained a fundamental problem. It is therefore imperative for Africa to develop capacity for research and data collection, including meteorological infrastructure, to monitor climate change impacts, and formulate and implement policies to protect natural resources, including forests, and conserve energy based on clean low carbon technologies. Building capacities in these areas will enable data generation that can provide reliable and appropriate information on present and future climate risks as improved data sources and modelling capacity are vital ingredient in which adaptation decisions and actions can be based(Few, et al., 2006). Curriculums that will adequately develop capacity in science with respect to climatic extremes and climate change should be strengthened in both government meteorological/hydrological agencies and relevant departments in higher institution of learning. Short and long time forecasting climate models especially for drought and wind storm can provide information that can lead to useful policies that will enhance adaptation mechanism for alleviating the impact of climate change.

It is argued by Smit and Pilfosora (2001, p 882) as referenced by Grothmann and Patt (2005) that countries with limited economic resources, low levels of technology, poor information and skills, poor infrastructure, unstable or weak institutions and inequitable empowerment and access to resources have little capacity to adapt and are highly vulnerable (Grothmann & Patt, 2005). The urgency for capacity-building for normalising climate information in various development sectors is a fundamental concern for Africa. There are a number of institutions across Africa that frequently hold training courses as an auxiliary to capacity-building activities in the area of climate variability and change (Ogallo, 2010). Among them are USAID and RERA.

Need For Information and Awareness at the Grassroots Level

There has been persistent gap between the climate risk information and the ability of decision-makers and vulnerable stakeholder to interpret and react to such information in Africa (Few, et al., 2006). In view of this, diverse dissemination strategies that will tailor and package information on climate change to the end users bearing in mind their characteristics and their environment should be identified and adapted. Also, training should be provided for the use and advance of early warning which will tailor stakeholders to reach consensus on necessary measures quickly. African countries should

realize that climate change does not just require state-of-the-art information and new technologies, but also the need for people to respond, change their behaviour and find new livelihoods. People at community and grassroots levels should take part in the planning and execution of programs and projects to minimize how climate change affects human and socioeconomic development (Plaut, 2006). Civil society organizations in all the countries were not yet organised around climate change. The role of the media can be further strengthened.

As interpreted by Sampei and Aoyagi-Usui (2009), many campaign programmes in various environmental fields- including energy conservation campaigns and waste reduction campaigns- have used the mass media, one of the studies include that of Davies (2008) (Sampei & Aoyagi-Usui, 2009). In the European countries, with no exception of the Netherlands and United Kingdom, mass media have gained reputation for these countries national campaigns for the reduction of GHGs (Sampei & Aoyagi-Usui, 2009; Staats, Wit, & Midden, 1996). Public views investigated in developed countries have identified television and daily newspapers as primary sources of information (Sampei & Aoyagi-Usui, 2009). The urgent need to mitigate and adapt to climate change is becoming more widely understood in scientific and policy circles, but public awareness lags behind (Stephen, 2005) especially in Africa.

Good Representation at Global Meetings

African countries need to ensure that they are represented at appropriate and relevant levels at international meetings while discussing issues of climate change, including agenda setting, negotiations and implementation aspects. African countries contribute a small portion of the various international associations fighting against climate change. This needs to be addressed by the governments of Africa. There is need for more participation of the African countries since most of the climate disasters occur in Africa. African authorship in the IPCC reports contribute only 4%, with the majority from North America and Europe (Ho-Lem, Zerriffi, & Kandlikar, 2011). Without great participation of the African leaders in Climate committee, it becomes a grave task for the continent's involvement in capacity building, networking with the right organizations to help channel the course of greenhouse mitigation required for its development and future generation survival. Many international organizations are ready to assist the African continent in mitigating greenhouse gases after incorporating their various mitigation options successfully in Europe and various parts of the world. Though little emission is recorded in Africa except South Africa compared to the rest of the world, it is still imperative that a continent like Africa needs to make use of its resources and potential wisely in assisting and protecting the lives of her citizens. This can only be successfully achieved by integrating with the rest of the world in its fight against greenhouse gas emission.

CONCLUSION

There is now widespread agreement that the earth is warming, due to emissions of greenhouse gases caused by human activity. It is also clear that current trends in energy use development and population growth will lead to continuing—and more severe—climate change. The challenge for Africa is to provide a starting point that will take into consideration the need and imperative to translate a regional vision of sustainable development into more concrete policies for a lasting solution to the region's climate change. In most African countries, climate change is perceived as an alien concept with little urgency compared to other economic, social, and political matters—even more so given the increasing urgency of dealing with poverty alleviation, debt servicing, unfavourable terms of trade, the need for basic infrastructures and political stability. Where climate change is recognized as a crucial concern, it is mostly viewed as a trivial issue. Climate

change affects everyone, therefore, everyone should be held responsible in addressing the issues; though with different degrees of responsibilities.

REFERENCES

- anonymous. (2012a). Asia-Pacific Partnership on Clean Development and Climate. <http://www.asiapacificpartnership.org/english/default.aspx>. Retrieved 9 May 2012, 2012
- anonymous. (2012b). International response to climate change. http://www.climatechange.qld.gov.au/pdf/international_response.pdf. Retrieved 9 May 2012, 2012
- Anup, S. (2012). climate change and global warming <http://www.globalissues.org/issue/178/climate-change-and-global-warming>.
- APF. (2007). *Climate Change and Africa*. Paper presented at the 8th Meeting of the Africa Partnership Forum (APF), Berlin, Germany.
- BBC. (2006). Drought in Somalia, Tuesday, 14th March, 11.54GMT.
- Beg, N., Morlot, J. C., Davidson, O., Afrane-Okesse, Y., Thomas, J. P., Rovere, E. L. L., et al. (2002). Linkages between climate change and sustainable development. *Climate Policy*, 2, 129-144.
- Caravani, A., Bird, N., & Schalatek, L. (2010). Climate Finance Fundamental. *Regional Briefing: Africa*.
- CIGI. (2009). *Special Report on Climate Change in Africa: Adaptation, mitigation and Governance challenges*.
- Denton, F., Sokona, Y., & Thomas, J. P. (undated). Climate change and sustainable development strategies in the making: what should west African countries expect? .
- Ekweozoh, P. C., & Njoku, G. N. (2010). *Technology Transfer Issues in Climate Change: Challenges and Prospects for Africa*. Paper presented at the Proceedings of the Second Science with Africa Conference
- Few, F., Osbahr, H., Bouwer, L. M., Viner, D., & Sperling, F. (2006). *Linking Risk Management for Sustainable Poverty Reduction*.
- Gerald, C., Nelson, M., Rosegrant, J., Richard, R., Timothy, S., Tingju, Z., et al. (2009). Climate Change Impact on Agriculture and Costs of Adaptation. *IFPRI Food Policy Report*.
- Grothmann, T., & Patt, A. (2005). Adaptive capacity and human cognition: The process of individual adaptation to climate change. *Global Environmental Change*, 15, 199-213.
- Ho-Lem, C., Zerriffi, H., & Kandlikar, M. (2011). Who participates in the Intergovernmental Panel on Climate Change and Why: A quantitative assessment of the national representation of authors in the Intergovernmental Panel on Climate Change. *Global Environmental Change*, 21, 1308-1317.
- <http://www.world-nuclear.org/info/infios.html>. (2012). Retrieved 05/05/2012, 2012
- Jimoh, A. A. (2011). Towards Green and Power System of the Future. *Invited distinguished lecture presentation at the University of Wisconsin (UWM), Milwaukee, USA*.
- Lagos, R., Wirth, T. E., & El-Ashry, M. (2009). Facilitating an International Agreement on Climate Change: Adaptation to Climate Change. A Proposal of the Global Leadership for Climate Change. www.globalclimateaction.org.
- Lambrou, Y., & Piana, G. (2006). *Gender: The missing component of the response to climate change*.
- Meyer, E. L., & Odeku, K. O. Climate Change, Energy, and Sustainable Development in South Africa: Developing the African Continent at the Crossroads. *Sustainable Development Law & Policy*, Winter 2009, 49-53, 74-75.

- Mulugetta, Y. (2011). *Accessing Climate Change Finance for Development in Africa: issue Paper 2*. Paper presented at the Forum on Financing for Development: Mobilizing Resources for Economic Transformation in Africa, Addis Ababa.
- Mutambo, A. (2012). Adapting to change. <http://www.focac.org/eng/jlydh/mtsy/t875455.htm>
- NOAA. (2010). Past Decade Warmest on Record According to Scientists in 48 Countries.
- NOAA. (2012). Causes of global warming. <http://environment.nationalgeographic.com/environment/global-warming/gw-causes/> accessed 17th of April.
- Odinga, R. (2011). Release Climate Change Funds. *daily nation, Kenyan national newspaper*, <http://allafrica.com/stories/20110121111.html>
- Ogalo, L. (2010). The Mainstreaming of Climate Change and Variability Information into Planning and Policy Development for Africa. *Procedia Environmental Sciences, 1*, 405-410.
- Pereira, A. M., & Pereira, R. M. M. (2009). Is Fuel-Switching a No-Regrets Environmental Policy? VAR Evidence on Carbon Dioxide Emissions, Energy Consumption and Performance in Portugal.
- Plaut, M. (2006). Africa's Hunger- A Systematic Crisis. <http://news.bbc.co.uk/2/hi/africa/4662232.stm>.
- Rarieya, M. J. (2009). *Climate Change and Sustainable Development in Africa Lesson from Kenya and Policy Implication*. Paper presented at the Climate Change and Sustainable Development in Africa, United Nation University Institute of Advanced Studies, Yokohama.
- Sampei, Y., & Aoyagi-Usui, M. (2009). Mass-media coverage, its influence on public awareness of climate change issues, and implications for Japan's national campaign to reduce greenhouse gas emissions. *Global Environmental Change, 19*, 203-212.
- Sciencenews. (2012). The Asia-Pacific Partnership and the Kyoto Protocols: In conflict or cooperation? <http://www.sciencedaily.com/releases/2010/01/100111102529.htm>.
- Staats, H. J., Wit, A. P., & Midden, C. J. H. (1996). Communicating the greenhouse effect to the public: evaluation of a mass-media campaign from a social dilemma perspective. *Journal of Environmental Management, 46*, 189-203.
- Stephen, R. J., Sheppard. (2005). Landscape visualisation and Climate Change: the potential for influencing perceptions and behaviour. *Environmental Science & Policy, 8*, 637-654.
- Tverberg, G. (2012). World energy consumption since 1820. *Energy Bulletin*, <http://www.energybulletin.net/stories/2012-03-16/world-energy-consumption-1820-charts> accessed 30th of March 2012.
- UN-HABITAT. (2010). The state of African Cities 2010. Governance, inequality and urban land markets . In UN-HABITAT (Eds.)
- WHO. (2008). Protecting Health from Climate Change. *WHO Library Cataloguing, ISBN 978 92 4 159652 7*.
- Willey, L. F., & Gostin, L. O. (2009). The international response to climate change. An agenda for global health. *JAMA, 302*(11), 1218-1220.
- Woodsworth, G. (2012). *Climate change and Energy Access*. Paper presented at the Inaugural Africa's Public Official Energy and Environment Workshop Pretoria.

ABOUT THE AUTHORS:

Ayodele Temitope Raphael is affiliated with the Department of Electrical Engineering, Tshwane University of Technology, Pretoria, South Africa.

Olanrewaju Oludolapo Akanni is affiliated with the Department of Industrial Engineering, Tshwane University of Technology, Pretoria, South Africa.

Jimoh Abdul-Ganiyu Adisa is affiliated with the Department of Electrical Engineering, Tshwane University of Technology, Pretoria, South Africa.