

Review

The impacts of climate change on African continent and the way forward

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This paper reviews several studies on the impacts of climate change on developing countries in Africa, one of the most vulnerable continents due to lack of financial, technical and institutional capacity to cope with the impacts of climate change. Due to various anthropogenic activities, greenhouse gases are increasing in the atmosphere at an alarming rate which leads to extreme temperature and flooding, loss of soil fertility, low agricultural productions (both crops and livestock's), biodiversity loss, risk of water stress, and prevalence of various diseases. It is predicted that the temperature in Africa continent will rise by 2 to 6°C over the next 100 years. In terms of economic, the Sub-Saharan Africa will lose a total of US\$26 billion by 2060 due to climate change. The increasing occurrence of flooding and drought is also another predicted problem for Africa. Climate change can set back development of nations. Even though African countries are working on adaptation and mitigation options to minimize the adverse effects, climate change is expected to cause large damage to their economy. Thus, climate change adaptation and mitigation options require greater attention to ensure future food security and well-being of African peoples.

Key words: Adaptations, Africa, Climate Change, Impacts, Mitigations, Vulnerable.

INTRODUCTION

The global temperature and precipitation have changed rapidly over the last century due to anthropogenic increases of greenhouse gases (GHGs) in the atmosphere (for example, burning of fossil fuels, like coal, petroleum and natural gasses and widespread deforestation). The Intergovernmental Panel on Climate Change (IPCC) has predicts that the global surface temperature will increase by 1.4 - 5.8°C by 2100 years due to increasing concentration of GHGs specifically

carbon dioxide.

Temperature across Africa continent are predicted to rise by 2 - 6°C over the next 100 years and rainfall variability is predicted to increase, resulting in frequent flooding and drought (Hulme et al., 2001). According to IPCC report on Regional Climate projections of 2007, by 2050 the average temperatures in Africa are predicted to increase by 1.5 - 3°C, and the warming of Africa continent is very likely to be larger than the globe. The

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Table 1. Major African drought over 1980-2008 as reported on EM-DAT, 2009, (Adopted from Anne Bourke, 2011).

Country names	Years	Affected nearest (0.1 mn)
	2008	1.4
	2005-06	3.5
	2004	2.3
Kenya	1999-02	23.0
	1997-98	1.6
	1994-95	1.2
	1991-92	2.7
	2008	6.4
	2003-04	12.6
Ethiopia	1997	1.0
	1989-94	6.5
	1987	7.0
	1983-84	7.8
	2000-01	2.0
Sudan	1991-92	8.6
	1987	3.5
	1983-85	8.4
	2008	1.7
Eritrea	1999-03	2.3
	1993	1.6
	2008	3.3
Somalia	2000-01	1.2
	1987	0.5

increasing of the global temperature can be minimized if mitigation strategies are implemented in all regions of the world. Temperatures in all African countries are projected to rise faster than the global average increase during 21st century (James and Washington, 2013). Rainfall variability has also become more significant over the last century. For instance, precipitations in Eastern Africa show a high degree of spatial and temporal variability dominated by a variety of physical processes. Report by Williams and Funk (2011) described that over the last 3 decades rainfall has decreased over eastern Africa.

Climate change affects the biodiversity, food security, water availability, and productivity levels in Africa (Hope, 2009). The Least Developed Countries (LDCs) are dependent on agriculture, climate sensitive economic sectors, which makes more vulnerable to the impacts of climate change because of its less resilient to negative external events and low capacity to adapt than other developing countries (Bruckner, 2012). Africa continent is one of the most vulnerable continents due to its high exposure and low adaptive capacity. The vulnerability of Africa continent is only due to low level of economic development that makes less and low capacity to adapt the impacts of climate changes (Bruckner, 2012). Higher

temperatures and rainfall variability reduce crop productivity in low income and agriculture-based economies. For the majority of Sahelian countries (that is, Senegal, Mauritania, the Gambia, Guinea Bissau, Mali, Burkina Faso, Niger, Chad, Sudan and Eritrea) which depend mainly on subsistence and small-scale farming, climate change, such as increasing temperature and declining rainfall, pose considerable risks to their livelihoods (Hummel, 2015). People who are poor and marginalized usually have the least buffer to face even modest climate hazardous and suffer most from successive events with little time for recovery (Olsson et al., 2014).

African countries are more affected by climate change because of their reliance on agriculture as well as their lower financial, technical, and institutional capacity to adapt (Nordhaus, 2006; Rose, 2015; Singh and Purohit, 2014; Huq et al., 2004). The African continent is expected to be the most affected by climate change, land degradation, and desertification (Hummel, 2015). Though Africa is the lowest source of GHG emissions from inhabited continents (due to low levels of industrial development), it is the most vulnerable to the effects of climate change (Beg et al., 2011, Huq et al., 2004 and Bewket, 2012).

THE MAIN IMPACTS OF CLIMATE CHANGE

Drought and flooding

Drought

Drought has had significant impacts on food insecurity and affects the life of African people and its trend is increasing in 21th century (IPCC, 2007b). According to Emergency Events Database (EM-DAT) more than 100 million people were affected by drought in Africa. Kenya was affected by drought seven times over 1991-2008, which affects about 35 million people. Ethiopia also experienced six drought times over 1983-2008. Other African countries were also affected by drought several times (Table 1).

From Africa continent, Eastern African countries (that is, Burundi, Eritrea, Ethiopia, Kenya, Uganda, Tanzania, Rwanda, and Somalia) were among the vulnerable countries to the effects of drought due to its dependency on rain-fed agriculture. Feyssa and Gemedo (2015) also justify that climate change mainly affect the rain-fed agricultural sectors in technological and economically less developed countries in Africa. Due to drought, by 2100, arid and semi-arid regions of Africa are expected to expand by 5-8%, or 60-90 million hectares, resulting in agricultural losses of between 0.4-7% of gross domestic product (GDP) in Northern, Western Central and Southern Africa (IPCC, 2007).

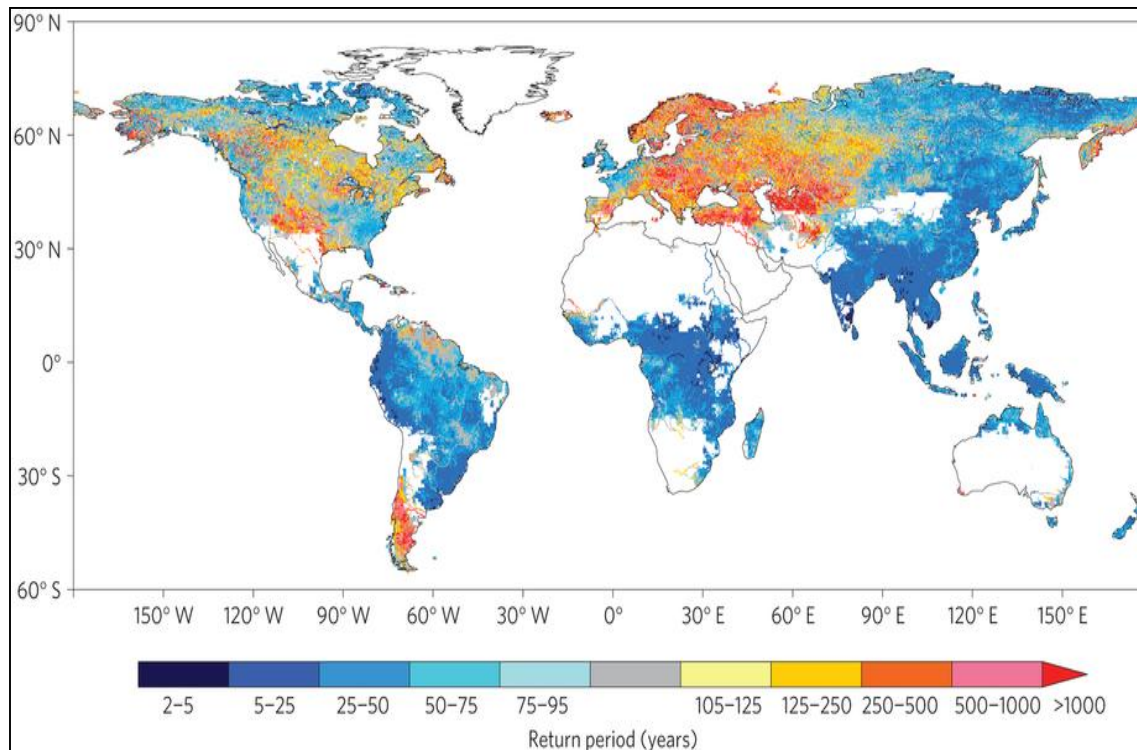


Figure 1. Multi-model median return period (years in 21c for discharge corresponding to the 20c 100-year flood (Adopted from Hirabayashi et al., 2013).

Extreme events like flooding and droughts are not similar across the continent, some regions will experience higher rainfall (the equatorial belt regions), even in drier areas there is a possibility of higher frequency of more intense downpours, which may bring flooding (Conway, 2009). Contrary to the equatorial belt regions, the northern, southern and horn of Africa are typically arid or semi-arid regions.

Flooding

Flooding leads to immediate deaths and injuries of people, infectious diseases like malaria and exposure of people to toxic substances. According to the flood portal of European Commission's Joint Research Center, Institute for Environment and Sustainability (2010), more than 1 million people were affected in over 20 African countries and approximately about 500 lives were lost and over 1.2 million people were displaced from their homes. The LDCs more suffer from climate change related disasters like floods. They lack institutional, economic, and financial capacity to cope with the impacts of climate change and to rebuild the infrastructure damaged by natural disasters (Sokona and Danton, 2001). Flooding is occurring everywhere in the world (Figure 1), however, the

degree of its impacts depends on the adaptive capacity of a country, that is, developed countries have high adaptive capacity while poor countries suffer more from the impacts of flooding. The frequency of flooding across the world varies from 2 to more than 1000 years (Figure 1).

Impact on food security/ food productions

Climate change will affect the production of crops. Climate is a primary factor for agriculture productivity, such that any environmental change affects plant and animal production (Shongwe et al., 2014). With increasing frequency of droughts and floods associated with climate change, agricultural production will decline and the state of food insecurity and malnutrition will increase (Kumsa, and Jones, 2010). It is estimated that African farmers are losing about US\$28 per hectare per year for each 1°C rise in global temperature (Kumsa and Jones, 2010). The African Partnership Forum (APF, 2007), described that, climate change can no longer be considered as an environmental problem only, as it also becomes a major threat to sustainable development and poverty reduction. Climate change can hinder sustainable development of nations by minimizing yield production,

which leads to food insecurity.

All crops are not affected equally by climate change. Crops such as rice, wheat, beans, maize and potatoes are highly affected and other crops like millet, which resist high temperature and low levels of water may be less affected (Huq et al., 2004). Sub-Saharan Africa (SSA) is the most susceptible and vulnerable places to climate change and variability anywhere in the world (Barr et al., 2010; Hummel, 2015). It is also estimated to be the most food-insecure region in the future (Thomson et al., 2011).

According to the report of the Economic Intelligence unit of 2014, food affordability in SSA is undermined by low average incomes, widespread poverty and heavy reliance on costly food imports. This report also justified that highly fragmented farming system, little use of modern farming system and low application of productivity-enhancing techniques undermines agricultural output and makes the SSA a net food importer.

The impacts of climate change on smallholder farmers, who depends only on rain-fed agriculture are among the most disadvantageous and vulnerable groups (Tetteh et al., 2014). Similar to crop productions, climate change also adversely affects livestock's productions. According to (Getu, 2015) agriculture and livestock keeping are amongst the climate sensitive sectors. The negative impacts of climate change are more severely felt by poor people in developing countries who mainly depend on the natural resources base for the livelihoods.

Climate change affects agricultural productions and exacerbates the problem of food security in Africa (Kumssa and Jones, 2010 and Mendelsohn and Tiwani, 2000). According to Food and Agriculture Organization (FAO, 2003), over 60% of Africans depends on agricultural activities for their livelihoods. Low yields of agricultural production leads to losses of economic development that hinder efforts to meet the Millennium Development Goals (MDGs) of African countries. The SSA predicted to loss a total of US\$26 billion by 2060 due to climate change (United Nations Development Programme (UNDP), 2011). The (IPCC, 2007b), estimate that climate change will reduce the yields of rain-fed agriculture up to 50% by 2020. According to (Thornton et al., 2007) in the tropics and subtropical regions, crop yields may fall by 10 to 20% to 2050 because of warming and drying, but there are places where yield losses may be more severe.

Impact on development

Africa faces the biggest development challenges of any continent because of an increase in the number of people at risk of water stress, exposure to malaria, and a drop in agricultural yields (Frankhauser and Schmidt-Traub, 2011). Climate change has the potential to undermine sustainable

development, increase poverty, and prevent the realization of the MDGs (IPCC, 2009). Failure of achieving the MDGs correlates with areas where high climate vulnerability is expected to occur (Yohe et al., 2007). It is obvious that climate change and variability will seriously hinder future development of a nation. The biophysical effects of climate change on agriculture induce changes in production and prices, which play out through the economic system as farmers and other market participants adjust autonomously, altering crop mix, input use, production, food demand, food consumption, and trade (Oxfam, 2009).

Impact on human health

Climate change also causes scarcity of water resources and severe floods that leads to outbreaks of waterborne diseases. African countries suffer serious health problems because of climate change United Nations Economic Commission for Africa (UNECA, 2011). UNECA justified that, Africa is the most susceptible continent to climate change related health problems due to the existing poverty and weak institutions to deal with health challenges posed by climate change. Change in rainfall will affect the presence and absence of vector and water borne pathogens (IPCC, 2001). Any changes in temperature and precipitation will boost the number of disease-carrying mosquitoes that leads to malaria epidemics (Lindsay and Martens, 1998). The problem of Malaria is associated to climate change. According to World Health Organization (WHO, 2003) malaria epidemics in Zimbabwe have been closely linked to climate variability caused by El Nino. Figure 2, demonstrates how climate change disturb human health. Climate change can affect the well-being of human beings either directly or indirectly. For instance, changing the quality of air, water and food can disturb human health indirectly. Climate change will likely discomfort the environmental and social conditions which might leads to social and economic disruptions.

THE WAY FORWARD

We have a number of alternatives to minimize the negative impacts of climate change in Africa continent. The possible alternatives which compact the impact of climate change on Africa continent include communication and outreach, adaptation and mitigation options and climate change related research which supports decision making.

Communication and outreach

The first and the basic one are public environmental

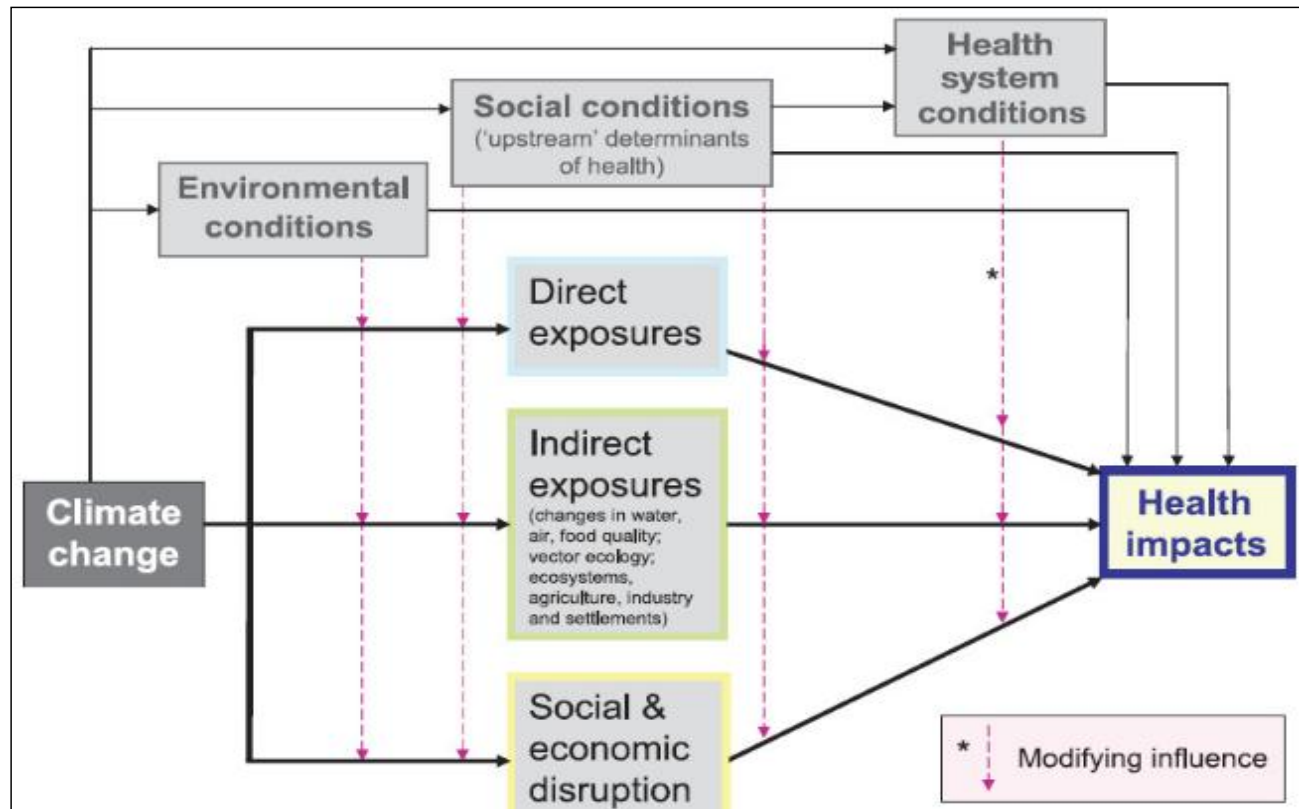


Figure 2. Pathways by which climate change affects Human Health (Confalonieri et al., 2007)

education and awareness raising across all countries. For instance, the Ethiopian government demonstrates its willingness and commitment in the area of soil and water conservation and the use of climate resilient green economy. Different awareness creation was conducted in the country by using mass media (TV, Radio, Newsletters and social Medias like face book, twitter and internet web pages) as a main tool for dissemination of information throughout the country. It is a good option to educate all peoples on the causes and impacts of climate change. The current performance and the activities of Ethiopia government and people on soil and water conservation should be seen as a model for other African countries. Although, majority of the people observed the increasing of temperature and rainfall variability from their expediciencies, majority of our people have little information concerning the basic causes of climate change and how climate change will affect the whole systems from food insecurity to risk of shortage of water and good health. So, the people of Africa should be educated and made aware of their role and how they can deliver such role in climate change adaptation and mitigations are essentials. Any governmental plan without the recognition of the people is difficult for implementation and also unsuccessful.

Adaptation and mitigation measures

After environmental education and awareness creation, the concerned stakeholders will do their best to bring change through adaptation and mitigation options. Climate change adaptation and mitigations are essential mechanisms to save the life of the vulnerable communities particularly Africa continent. An effective way to address the impacts of climate change is by integrating adaptation measures into sustainable development strategies so, as to reduce the pressure on natural resources, improve environmental risk management, and increase the social well-being of the poor is very important.

Climate change adaptation and mitigation workshops, seminars, and panel discussions are effective tools to solve the extreme temperature and rainfall variability that leads to agricultural yield reduction, water scarcity, drought and flooding, prevalence of various pathogenic diseases and expansions of deforestation in different regions. Inviting key stakeholders (High governmental officials), public and private officials, university academia's and researchers as well as individuals from all sectors; industry, road, agriculture, municipality, mining, fishery, forestry, pastoralists, hotel and tourism and other sectors

on climate change adaptation and mitigation workshops will change the attitudes of peoples towards climate change solutions.

Promoting community participation in all adaptation and mitigation plan is a key factor to implement on the ground. In generally, in order to minimize the impacts of climate change on Africa continent all governmental and non-governmental organizations, private sectors and individuals should be involved in afforestation, re-afforestation and forest conservation. Similar to forest sectors, all organizations, private and individual should give concern for water and soil conservation. The wise use of water is another task of the African people, thus, the community at large should use water in effective way, practice the culture of water harvesting and storage techniques, livelihood diversifications and enhancing the use of climate resilient green economy.

Research

Conducting research on climate change and dissemination of the finding to decision making organs and concerned stakeholders is another good way forward to minimize the impacts of climate change. Educational institutions, research centers and meteorological organization should focus on climate change research.

CONCLUSIONS

This review synthesized the impacts of climate change on Africa and its way forward for current generation to minimize damage and losses associated with climate change. Temperatures in all African countries are projected to increase faster than the global average increase in 21st century. Rainfall variability is also another concern for rain-fed dependent economy like agriculture. By reducing agricultural yields climate change can set back sustainable development, increase poverty and prevent the realizations of MDGs.

Increasing of surface temperature and rainfall variability reduce agricultural yields that severely affects the livelihoods of African people. Smallholder's farmers in Africa who depends only on rain-fed agriculture are the most vulnerable groups by the impacts of climate change. Climate change related problems like drought and flooding affects the life of African people. Although, all developing countries were affected by climate change, the severity of climate change impacts on African continent is more severe than others. Africa continent is one of the most susceptible to various climate change related problems like malaria.

The impact of climate change on Africa continent will be minimized through cooperation of various organization and stakeholders. Communication and outreach activities,

climate change adaptation and mitigation strategies and conducting research will play an important role to overcome the current problems of climate change. Thus, promoting mass communications and outreach activities, adaptation and mitigation options and conducting research on climate change will minimize the future possible impacts of climate change.

Conflict of interests

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