

VULNERABILITIES, ADAPTATION AND MITIGATION MEASURES IN AGRICULTURAL PRODUCTION IN RESPONSE TO CLIMATE CHANGE IN MALAWI

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Abstract: Climate change and variability with consequent global warming effects have recently been the world's serious concerns. Developing countries including Malawi are deemed to be more vulnerable to the effects of climate change. This paper is aimed at highlighting vulnerabilities, adaptation and mitigation measures to climate change in Malawi with reference to agricultural production. From this review it is noted that Malawi has experienced substantial climate change effects impacting on human livelihoods and agricultural production. The common devastating effects include droughts, heavy storms and floods that negatively affect crop yields and livestock production, human dwelling places and derailing economic development. It is also noted that the country has been proactive in trying to mitigate these effects. The country is a signatory to a number of international protocols on climate change including United Nations Framework Convention on Climate Change. It is encouraging irrigation with the Green Belt Initiative aimed at reducing dependence on rain-fed agriculture as one of the interventions. It has implemented policies that encourage mitigation measures such as breeding of drought resistant crops, biofuel production and carbon trading. Together with its development partners it has been active in disaster and relief activities. From this review it can be recommended that more research needs to be done to evaluate the extent of the interventions and the impacts of the mitigation measures on agricultural production and economic development in Malawi.

Keywords: Climate change adaptation; climate change effects; Malawi; mitigation measures; vulnerability to climate change.

INTRODUCTION

The Intergovernmental Panel on Climate Change (IPCC) (2007) defines climate change as changes in the mean and/or the variability of its properties that persists for an extended period, typically decades or longer. Climate variability refers to the mean state and other statistics such as standard deviations and occurrence of extremes of the climate on all temporal and spatial scales beyond that of individual weather events (Yanda *et al.*, 2010). Zhou *et al.* (2004) defined climate variability as short term fluctuations around the mean climate state within an average period typically 30 years. The general agreement by most

scientists is that the main cause of climate change is anthropogenic in nature. That is significant changes in climate are mainly caused by human accelerated increase in greenhouse gases such as carbon dioxide (CO₂), nitrous oxide (N₂O), Chlorofluorocarbons (CFCs) and methane (CH₄) (NASA, 2012). The IPCC Fourth Assessment Report concluded that there is a better than 90 percent probability that human produced greenhouse gases have caused much of the observed increase in the earth's temperatures over the past 50 years (IPCC, 2007).

The warming effect created by the gases is what is considered as a green house effect. Trout *et al.* (2007) as cited by Yanda *et al.* (2010) noted that about one third of the solar energy that reaches the top of the earth is reflected back and the remaining two thirds are absorbed by the surface and the atmosphere. The earth, on average radiate the same amount of energy back to space but in form of long waves since the earth is much cooler than the sun that sends radiation as short waves (Ochola *et al.* 2010). Hence the greenhouse effect concept comes in, as much of the thermal radiation (long waved radiation) is emitted by the earth and oceans is absorbed by the atmosphere, including clouds and re-radiate it back and this reaches the earth as heat (Ochola *et al.* 2010). This heat contributes to the global warming and climate change. Climate change and global warming have some devastating consequences on human life, agricultural activities (crop production and livestock production) and on the general environment as a whole. Observable and predicted scientific evidences show that climate change effects and consequences include: rising of global surface temperatures, droughts and famine, drying up of water, floods and El Nino and El Nina global phenomena effects, increased human, crop and animal diseases (Parry, 1990). Scientists have noted that developing countries are more vulnerable to effects of climate change compared with the developed countries (AMCEN/UNEP, 2002; IPCC, 2001).

Vulnerability refers to the degree a system is susceptible to, or unable to cope with diverse effects of climate change, including climate variability and extremes (Fussel and Klein, 2006). It is therefore important for countries to consider implementing adaptation and mitigation measures to climate change. Adaptation is considered as an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects which moderates harm or exploits beneficial opportunities (IPCC, 2007). Another important phenomenon in climate change management is mitigation which refers to the human intervention or policies to reduce the sources or enhance the sinks of carbon dioxide (Chandler *et al.*, 2002).

The aim of this paper is to review and discuss the vulnerabilities, adaptation and mitigation measures in agricultural sector (crop and livestock) in response to climate change in Malawi.

VULNERABILITIES TO CLIMATE CHANGE IN MALAWI

Malawi is a country located in south-eastern Africa situated in between 9° and 18° south of the equator and 32° and 36° east of the prime meridian. It has a relatively dry tropical climate with one distinct rain season that spans from November to April and a dry (cool/warm) season stretching from May to October (ICPAC, 2007). About 90% of the population depends on agriculture for its livelihood. The sector employs 75% of the labour force and generates over 40% of the GDP and contributes over 90% of the total export value (NSO, 2005). However, Malawi is one the countries that are vulnerable to climate change effects as demonstrated by the extreme climate events that have been occurring over the years and their effects on the country's resources. The common extreme climate events that have been occurring in Malawi include droughts, floods, strong winds and landslides with drought and floods showing increased frequency, intensity and magnitude and have adversely impacted on food and water security, water quality, energy and the sustainable livelihoods of rural communities (ICPAC, 2007; Environmental Affairs Department (EAD), 2002; EAD, 2006). Table 1 shows evidence of the impacts of climate disasters in Malawi from 1975 to 2006. ICPAC (2007) reported that the country has experienced variability and unpredictability of rainfall in the last three decades. This resulted in frequent and increasingly long dry spells, and erratic onset of rainfall that rendered the growth of agricultural GDP negative (ICPAC, 2007). Clay *et al.* (2003) reported that the frequency of droughts impacted severely on agriculture and economy, especially the smallholder sector, which accounts for a greater part of maize production, the main staple food for the country.

Table 1 Evidence of impacts of climate disasters in Malawi 1975-2006

Year	Type of disaster	Extent of damage/impacts
1975	Floods	Over 10 000 households affected
1979	Floods	Several crops and houses destroyed
1991	Floods	Over 363 households affected and over 40 houses destroyed
1992	Drought	General crop failure, water scarcity, drying reservoirs (dams, fish ponds, rivers and lowering lake level)
1999	Floods	Over 60 000 households lost houses and crops

2000, 2003 & 2004	Strong winds	Over 208 houses destroyed and several crops
2005	Army worms	Army worm infested over 2687 hectares of maize and rice and affected 10 164 farm families
2006	Hailstorm	Over 130 houses affected

Adapted and modified from ICPAC 2007

Biet *et al.* (2008) reported the following: IPCC prediction models show increased climate uncertainty at both regional and national scale for Malawi; and observations by Malawi Meteorological Service and farmers are that in recent years there is increased temperatures, delayed and shorter rainy seasons and increased intensity of rainfall. Furthermore, Kumambala *et al.* (2010) reported that based on water balance model, the water level of lake Malawi will continue to drop following a decrease in the rainfall season and an increase in evaporation rates from the lake. The latest climate change associated calamity occurred in form of heavy stormy rains that were experienced from late December 2011 to January 2012 that led to flash floods and destruction of infrastructure, including houses, school blocks and others in different districts of the country including Thyolo, Phalombe, Chikwawa and Nsanje in the southern region, Dedza and Salima in the central region and Nkhata Bay, Rumphu and Karonga in northern region of Malawi. A total of 5,270 households were affected according to the Government's Department of Disaster Management Affairs as of mid-January 2012. Their houses were either completely destroyed or partly damaged, and experienced crop damage (DREF, 2012).

Apart from the effect from the global world, Environment Affairs Department (EAD) (2002) noted that Malawi's vulnerability to climate change arises mainly from socio-economic, demographic and climatic factors. These include slim economic base, limited agro-processing facilities, over-dependency on rain-fed agriculture and fuel wood for energy, inadequate health facilities, poverty exacerbated by drought, floods, natural disasters and population pressure. Over dependence on rain fed agriculture puts a country on risk during times of droughts. The over dependency on fuel wood is aggravated by low generation of hydroelectric power and this causes too much use of firewood and charcoal by both rural and urban dwellers. This in turn leads to deforestation. On the other hand deforestation has also to a large extent been aggravated by population pressure that has led to conversion of forest land to crop land which is also in turn exposed to lack of following good agricultural husbandry (EAD, 2002, Bie *et al.*, 2008). Tobacco sector which is the main export earner, within the

agricultural sector is another threat to deforestation through opening up of new fields and fuel wood for the tobacco leaf curing. In recent years there have been more frequent outbreaks of livestock vector borne diseases in areas with higher livestock population. Thornton *et al.* (2008) noted that high temperatures and rainfall patterns lead to an increased spread of existing vector borne diseases and macro parasites of animals as well as emergence and spread of new diseases. Helminths (flatworms including liverflukes) are also greatly influenced by changes in temperature and humidity (IFAD, 2010).

ADAPTATION AND MITIGATION MEASURES TO CLIMATE CHANGE EFFECTS IN MALAWI

Despite all the challenges the Government of Malawi together with its development partners have been involved in implementing adaptation and mitigation measures to climate change effects (Bie *et al.*, 2008). It takes lead in mitigation and adaptation management of climate change in a number of ways including commitments to international protocols, disaster and relief management, formulation and implementation of policies that favour mitigation and adaptation measures against climate change.

The Government of Malawi signed the United Nations Framework Convention on Climate change (UNFCCC) during the United Nations Conference on Environment and Development (UNCED) in 1992 (UN, 2002). It is also a signatory to the Convention of Biological Diversity (CBD) and developed the National Environmental Action Plan in 1994 (GoM, 1994) after recognising the threats caused by climate change especially the adverse impacts of droughts and floods. Several development partners have also supported projects that are promoting rural communities to adapt to climate change (Bie *et al.*, 2008; EAD, 2006). The country drafted the National Adaptation Plan of Action in (NAPA) (EAD, 2006). The NAPA document was developed to enable Malawi address her urgent and immediate adaptation needs caused by climate change and extreme weather events. Specifically, the document aims at: identifying a list of priority activities, formulating priority adaptation options, building capacity for adapting to longer-term climate change and variability, and raising public awareness on the urgency to adapt to the adverse effects of extreme weather events (EAD, 2006). It established a drought warning system in 1991 with the Ministry of Water Development as a lead agency (UN, 2002). As a component of the Environmental Management Programme, the Long Lead Climate Forecasting Project was developed as an adaptive response to climate change and has enabled the Meteorological Department of

Malawi to come up with seasonal rainfall forecasts crucial for food production and disaster management (UN, 2002).

The Malawi Government has approved new policies in irrigation, land and water management. Malawi's new national irrigation policy calls for farmers' organizations to manage irrigation schemes and not the government or depending on government support as it used to be (Ferguson and Mulwafu, 2005). The policy also advocates for expansion and intensified careful use of informal irrigation by small scale farmers along drainage lines and wetlands ((Ferguson and Mulwafu, 2005). This is to maximize land for irrigation which is a good way of adapting the effect of droughts. The Malawi Growth and Development Strategy II (MDGS II, 2011-2016) identifies six broad themes of which one is Social Support and Disaster Risk Management. This ensures that there is support to all victims of calamities such as floods and drought that affect farm families a lot. From the different themes are priority areas that include agriculture and food security; climate change, natural resources and environment; Green Belt Initiative (GBI), irrigation and water development (MAIWD, 2012). The Malawi's GBI is intended to make the country independent of rain fed agriculture. The plan is to protect the gains in food security which the country has witnessed in recent years, reduce vulnerability to drought and to boost production still further by irrigating one million hectares from the 90 000 hectares currently under irrigation in areas lying within 20 kilometres of the country's lakes and perennial rivers (M'bwana, 2012)

The government, through country's research institutions endorsed and now implementing several projects to adapt and those that have a potential to adapt or mitigate the effects of climate change. Research is ongoing and some results are already obtained on breeding of drought and disease resistant varieties, rearing of animal breeds that are drought tolerant, rearing of small animals such as rabbits and guinea fowls and using agro-forestry practices, conservation agriculture and other soil management practices that help to sequester soil carbon (EAD, 2006). Oxfam, an international non-governmental organisation is promoting drought tolerant crops in a number of districts in the country (Oxfam, 2012).

The country has been working hard in implementing other programmes that affect agricultural production either directly or indirectly. The country has an afforestation or tree planting programme (UN, 2002) in such that every year the president of the country leads the nation in planting trees on a national tree planting day, which is followed by tree planting to the remaining end of the rainy season. Some work is being done and others still continuing on biotechnology for climate change adaptation including biogas production as a renewable

energy source, tissue culture to generate disease free plantlets in cassava, banana and potatoes (UN, 2002).

The government of Malawi is promoting biofuel projects as an alternative to fossil fuels. Yanda *et al.* (2010) noted that biofuels are having a growing demand which is driven by high oil prices, energy security concerns and global climate change. Biofuels have also a potential to provide a new source of agricultural income by smallholder farmers (Yanda *et al.*, 2010). In Malawi a number of projects are going on including those by private companies. Berl, a private company is working with smallholder farmers in growing of *Jatropha* for biodiesel (BERL, 2012). This approach will enable smallholder farmers to contribute to global carbon sequestration as climate change mitigation measure while at the same time realising income. Recently, Malawi has approved carbon trading in contribution to global efforts of reducing green house gas emission (Nation Online, 2013).

The Government of Malawi through the Ministry of Disaster Preparedness together with development partners have been involved in assisting victims of calamities such as drought and floods. Malawi Red Cross, Catholic Relief Agency and Adventist Relief Agency (ADRA) are amongst the organisations that have been helping the country in donating relief items when calamities occur. The government has been doing civic education to people to move from flood prone areas (especially in the lower Shire, in the districts of Chikhwawa and Nsanje) to higher ground but this is not accepted by some of these communities due to their traditional beliefs (they don't want to leave graveyards of their ancestors) (IRIN, 2012).

CONCLUSIONS

From the above review it can be noted that it is a well known phenomenon to attribute climate change to be largely influenced by human accelerated atmospheric green house gases increase. It can also be noted that most of the countries including Malawi are to a certain extent affected by climate change effects. There are a number of evidences that show that Malawi is vulnerable to climate change effects. There have been a number of calamities due to droughts, floods, heavy storms and army worms. These have been affecting agricultural production especially crops. The livestock sector is also not spared as it has been noted that incidences of vector borne disease outbreaks are common in recent years. The Government of Malawi and its development partners have been vigilant in management of climate change effects. There are a number of adaptation measures that have been implemented or planned so far. Malawi is a signatory to a number of international protocols including United Nations

Framework Convention on Climate Change. The government has developed policies that favour mitigation and adaptation of climate change. The government through different departments, universities and other research institutions is promoting research to produce drought and diseases resistant varieties and also promoting planting of already known drought resistant crops such as cassava, sorghum and sweet potatoes. Rearing of drought and disease resistant breeds of livestock and rearing of small animals such as rabbits and guinea fowl are also being promoted. The government of Malawi has improved policies on irrigation and has implemented the Green Belt Initiative that is targeted to reduce Malawi's dependence on rain-fed agriculture. The country has some warning systems for disaster preparedness and together with its development partners have been involved in relief activities. The country is also promoting afforestation and biofuel plantations that contribute to carbon sequestration. From this paper it can be recommended that more research needs to be done to evaluate the extent of the interventions and the impacts of the mitigation measures on agricultural production and economic development.

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