Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.4, No.15, 2014

Climate Change Adaptation and Mitigation Measures in Ethiopia

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Abstract
Ethiopia has been identified as one of the most vulnerable countries to climate variability and change, and is frequently faced with climate-related hazards, commonly drought and floods. The variability of rain fall and the increasing temperature were a cause for frequent drought and famine, and putting disastrous impact on the livelihood of the peoples. At the national level, World Bank suggests that climate change may reduce Ethiopia's GDP compared to a baseline scenario by 2-6% by 2015, and by up to 10% by 2045. The most vulnerable sectors to climate variability and change in the country are agriculture, water and human health. To cope up the effects of climate change, adaptation and mitigation measures are being practicing in the country. At the higher level, the governments has signed and ratified all the Rio Conventions, namely the United Nations Framework Convention on Climate Change and its Protocol, the Bio-diversity Convention and the Conventions to Combat Desertification. Following these, the government has initiated the Climate-Resilient Green Economy both to adapt and mitigate climate change. There are also different adaptation measures undertaking by different peoples at different levels. Thus, the purpose of this paper is to present adaptation and mitigation measures undertaking throughout the country at different levels.
Keywords: Climate change, adaptation, mitigation

1. Introduction

Global climate change is the hottest environmental issue today and will continue in the future. This is because of its devastative impacts in different ways. Global climate change is caused by both natural factors such as volcanic eruption, variations in the Earth's orbital characteristics and variations in solar output, and human induced causes mainly by the emission of greenhouse gases. It is not new phenomena, but the warming that is occurring today is unprecedented with respect to the rate of change.

According to the Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (IPCC), the Earth's average surface temperature increased 0.6 ± 0.2°C in the 20th century. This trend is expected to persist, with an increase of 1.4 to 5.8°C by 2100 (Parry *et al*., 2005). In Ethiopia, mean annual temperature has increased by 1.3°C between 1960 and 2006, an average rate of 0.28°C per decade. The mean annual temperature is projected to increase by 1.1 to 3.1°C by the 2060s, and 1.5 to 5.1°C by the 2090s. Under a single emissions scenario, the projected changes from different models span a range of up to 2.1°C (McSweeney *et al*., 2007). In addition, climate projections suggested an increase in rainfall variability with a rising frequency of both severe flooding and droughts due to global warming (World Bank, 2010).

The Intergovernmental Panel on Climate Change's (IPCC, 2007) findings suggests that developing countries like Ethiopia will be more vulnerable to climate change. Ethiopia's extreme vulnerability to the impacts of climate change is due to social, economic and environmental factors. In particular, high levels of poverty, rapid population growth, high level of reliance on rain-fed agriculture, high levels of environmental degradation, chronic food insecurity and frequent natural drought cycles increase climate change vulnerability in the country (Aklilu *et al*., 2009). Vulnerability assessment indicated that the most vulnerable sectors are agriculture, water and human health. In terms of livelihood approach smallholder rain-fed farmers and pastoralists are found to be the most vulnerable. The arid, semi-arid and the dry sub-humid parts of the country are affected most by drought (Kidane *et al*., 2009). The variability of rain fall and the increasing temperature were a cause for frequent drought and famine. At the national level, World Bank (2010) suggests that climate change may reduce Ethiopia's GDP compared to a baseline scenario by 2-6% by 2015, and by up to 10% by 2045. Thus, mitigation and adaptation measures are meaningful to cope up the effects of climate change.

Mitigation refers to any activities that reduce the overall concentration of greenhouse gases in the atmosphere. This includes efforts to switch from fossil fuels to renewable energy sources such as wind and solar, or to improve energy efficiency. It also includes efforts to plant trees and protect forests, or to farm land in ways that prevent greenhouse gases from entering the atmosphere. While, adaptation refers to activities that make people, ecosystems and infrastructure less vulnerable to the impacts of climate change. This includes things like building defenses to protect coastal areas from rising seas, switching to drought or flood resistant crop varieties, and improving systems to warn of heat-waves, disease outbreaks, droughts and floods (Shanahan *et al*., 2013).

Throughout human history, societies have adapted to natural climate variability by altering settlement and agricultural patterns and other facets of their economies and lifestyles (Meseret, 2009). In recent years,

adaptation to climate change has received increasing attention, especially in the United Nations Framework Convention on Climate Change (UNFCCC) and among development and disaster specialists (Maarten *et al*., 2007). In Ethiopia, through the National Adaptation Program of Action (NAPA) process, twenty priority project ideas were identified that address immediate climate change adaptation needs of the country. These projects broadly focus in the areas of human and institutional capacity building, improving natural resource management, enhancing irrigation agriculture and water harvesting, strengthening early warning systems and awareness raising quite relevant areas in improving Dry lands livelihood systems (Kidane *et al*., 2009). However, the concept of mitigation is relatively new concept, and it mainly focus on limiting the emission of greenhouse gases. For this aspect, Ethiopia has developing the green economy strategy (EPA, 2011). Although mitigation and adaptation measures pursued to effectively address climate change, negotiations under the UNFCCC have tended to focus primarily on efforts to reduce greenhouse gas emissions (Parry *et al*., 2005). Therefore, this paper aims to give an overview on adaptation and mitigation measures undertaking in Ethiopia in response to climate change.

2. Climate change adaptation and mitigation measures in Ethiopia

2.1 Climate change adaptation mechanisms

Ethiopia is extremely vulnerable to the impacts of climate change (Aklilu *et al*., 2009). Similarly, Burnett (2013) reported that Ethiopia has been identified as one of the most vulnerable countries to climate variability and change, and is frequently faced with climate-related hazards, commonly drought and floods. Since the early 1980s, the country has suffered seven major droughts five of which have led to famines in addition to dozens of local droughts. Major floods also occurred in different parts of the country in 1988, 1993, 1994, 1995, 1996 and 2006 (World Bank, 2010). Vulnerability is not the same for populations living under different social, economic, political, institutional and environmental conditions. For example, pastoralists in Yabello Woreda tend to be more vulnerable to climate change than farmers (Oxfam international, 2010).

It is now well recognized that climate change poses serious threat to agricultural production, natural resource base and the livelihood of communities. The threat is particularly sever in the dry lands. In line with this attempts are being made to mainstream potential response measures for reducing the resulting impacts. At the higher level, the governments has signed and ratified all the Rio Conventions, namely the United Nations Framework Convention on Climate Change and its Protocol, the Bio-diversity Convention and the Conventions to Combat Desertification. After these conventions, through the National Adaptation Plan of Action, twenty priority project ideas were identified that address immediate climate change adaptation needs of the country (Kidane *et al*., 2009). More specifically, the government of Ethiopia has set adaptation measures in agriculture, roads, and hydropower. The following adaptation options are considered: 1) increase irrigated area, 2) increase research and development for agriculture, 3) Modify plans for expansion of hydroelectric power (volume or timing of investment) and 4) Build climate resistant road infrastructure (e.g. increase the capacity of roads and bridges to withstand greater heat and precipitation). Potential adaptation policy adjustments in the hydroelectric sector include altering the scale and timing of planned projects as well as constraining downstream flow and irrigation flow. Ethiopia has embarked on a very extensive hydro-power development program, including major dams on the Blue Nile, Atbara, and Gibe Rivers. Some of these dams are planned as cascades of dams in series and some as dams on parallel rivers. The cost of additional capital to keep up with the Ethiopian base-energy generation plan is assumed to be the cost of adaptation in the energy sector (Robinson *et al*., 2013). The government has also set policies to adapt climate change in terms of agricultural intensification. However, some argue that there should be a stronger emphasis on ecosystem-based adaptation, rather than agricultural intensification (Leulseged *et al*., 2013).

The Federal Democratic Republic of Ethiopia has put in place policies, strategies and programmes that enhance the adaptive capacity and reduce the vulnerability of the country to climate variability and in 2012 the Climate Resilient Green Economy (CRGE) initiative was launched to protect the country from the adverse effects of climate change and to build a green economy that will help realize its ambition of reaching middle income country status before 2025. The CRGE initiative builds on the NAPA of Ethiopia, being implemented under the auspices of the Ministry of Water Resources and the National Meteorological Agency (Burnett, 2013). Adaptation measures are also employed at different levels of the country.

For example, the Ethiopians, who live in the high lands, are engaged in mass actively in the combat against climate change. This fight against climate change is indicated by the people's involvement in soil and water conservation practices, which helps to maintain the existing climate as well as to accommodate favorable climate to the country, intending on minimizing the negative impacts of it (Flintan *et al*. 2011). While, the most common coping strategies in agricultural, agro-pastoral and pastoral site of the Oromia and Somali regions are pastoral migration, asset diversification, food aid, and supply side and demand side interventions with regard to water. There are a number of coping mechanisms, adopted especially by the poor and middle wealth groups, including forced labour migration, sale of assets, killing calves and travelling far distances to collect water that do not

facilitate adaptation (Leulseged, 2010). In parallel, in Borana pastoralists, southern Ethiopia two major categories of adaptation choices, adjustment in pastoral practices, and shifts to non pastoral livelihoods are recently embraced. The adjustment responses are increased mobility, more adoption of drought-tolerant livestock species, increasing resort to purchased hay, competitive individual household land grabs for strategic private range enclosures for the double purpose of cereal cultivation, and fodder production. While, the most non-pastoral adaptation strategy embraced by Borana pastoralists in the last two decades of the 20th century is cereal cultivation. The pastoralist massive rush to the act of having private enclosures for cereal cultivation largely began in the mid-1990s and perhaps culminated in the first decade of this century. Farming was originally adopted by shock victims and the destitute. Climate-induced recurrent pressures later made it a common experiment among Borana pastoralists primarily to avoid livestock selling required for supplementary cereal purchases in the widely pressing circumstances of declining milk yields (Wassie and Fekadu, 2014). Similarly, in West-Arsi zone of Ethiopia, the local coping mechanisms that are used to reduce the impacts of climate change are saving, diversification, wood sell, mobility, social interconnectedness and credits. There are also institutional coping strategies such as emergency aid, credit services, safety net, water distribution, awareness rising on saving and use of technology (Abate, 2009).

2.2 Climate change mitigation measures

There is much concern that the increasing concentration of greenhouse gases in general, and carbon dioxide in particular contributes to global warming by trapping long-wave radiation reflected from the earth's surface. Over the past 150 years, the amount of carbon in the atmosphere has increased by 30%. Most scientists believe there is a direct relationship between increased levels of carbon dioxide in the atmosphere and rising global temperatures (Stavins and Richards, 2005).

One proposed method to reduce atmospheric carbon dioxide is to increase the global storage of carbon in soils. Though, soil carbon storage is a win–win strategy. It mitigates climate change by offsetting anthropogenic emissions; improves the environment, especially the quality of natural waters; enhances soil quality; improves agronomic productivity; and advances food security (FAO, 2005; Lal, 2009; Adesodun and Odejim, 2010; Kumar *et al*., 2009). Soils store 1502 Gt carbon (Jobbagy and Jackson, 2000), an amount that is two times greater than the amount found in the atmospheric carbon pool (Battle *et al*., 2000; Lal, 2004). In addition to carbon storage, the turnover time of organic carbon is important in understanding the role of soils in the global carbon cycle. Thus, soil carbon sequestration through changes in land use and management is one of the important strategies to mitigate the global greenhouse effect. Important land uses and practices with the potential to sequester soil organic carbon include conversion of cropland to pastoral and forest lands, conventional tillage to conservation tillage or no-tillage, and no manure use to regular addition of manure. However, food security needs for the world teeming population make conversion of cropland to forestland unsustainable. Therefore, increased food demands call for management of croplands to ensure food security and at the same time enhanced soil organic carbon sink within the soil to minimized atmospheric emission of CO2 (Adesodun and Odejimi, 2010). In this case, afforestation and conservation programs have been made in the last three decades (Badege, 2001). In addition to this there was a huge areal closure activity in the northern parts of the country for the purpose of rehabilitating degraded lands which have their own role in increasing soil carbon stock.

The second mechanisms for reducing the emission of green house gases are using lower emitting energy sources. A pilot project to distribute energy-efficient cook stoves was identified as a voluntary offset project that would reduce greenhouse gas emissions, household pollution, and deforestation in the Metekel Zone in the Benishangul-Gumz Regional State in Ethiopia. Voluntary emission reduction (VER) projects present companies, governments and organizations with an opportunity to purchase carbon credits. The developers of this project, Carbon Positive Trading (CPT) and The Learning Paper, believed that energy-efficient stoves were an ideal way of meeting the criteria for a voluntary carbon offset project in Ethiopia (Negusu, 2011). Similar to this area, energy saving stoves was also introduced in different parts of the country before a decade ago.

The other mechanism to mitigate climate change worldwide is carbon trading. The current carbon trading is one of the critical practices in the country to mitigate climate change. The Humbo natural regeneration (reforestation) project proposed by World Vision has already been endorsed by Ethiopia's in December 2006 is one example for carbon trading in the country (Negusu, 2011).

3. Conclusion

Being a country having agriculture based economy; Ethiopia is highly vulnerable to the impacts of climate change. In response to this, both adaptation and mitigation measures are implementing in different parts of the country in different sectors. Some of the adaptation measures undertaking includes increase irrigated area, increase research and development for agriculture, modify plans for expansion of hydroelectric power, and build climate resistant road infrastructure. The government has also set policies for adapting climate change in terms of agricultural intensification. While, generation of power from hydroelectric dams and wind are additional mechanisms for adaptation for climate change and at the same time for mitigation climate change. The current

carbon trading is also another way of mitigating climate change through afforestation and reforestation practice.

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