

**Climate Change Adaptation Strategies in Ethiopia:
Major Barriers and Impacts**

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Abstract

Ethiopia is frequently known by a high degree of vulnerability to climate induced shocks in which adaptation options are highly imperative. The purpose of this study is to assess climate change vulnerability and adaptation. Definitely, it is to assess the causes of vulnerability to climate change in Ethiopia; to identify the varieties of climate change adaptation strategies practiced in Ethiopia; to find out the main barriers of climate change adaptation and impacts of climate change in Ethiopia. In this study a purely qualitative approach was followed. The data was obtained from secondary sources via published and unpublished documents. In addition, various literatures were also extensively reviewed. The analysis of the study was based on thematic analysis. The result indicates that response options to climate change are necessary to adjust the effects of climate change and commendably lessen substantial vulnerability. In Ethiopia the causes for vulnerability of climate change found to be very high dependence on rain fed agriculture; under-development of water resource and low health service coverage among others. Crop diversification; tree planting; practice of off-farm activities; soil and water conservation were also the climate change adaptation strategies commonly used in Ethiopia. In addition, the result showed that the state of natural uncertainty, technological factors and socially constructed norms as the major barriers for climate change adaptation in the country.

Keywords: Climate, Climate Change, Vulnerability, Adaptation

Introduction

Increasing fossil fuel burning and land use changes have released, and are ongoing to release, growing quantities of greenhouse gases into the Earth's atmosphere. These greenhouse gases include carbon dioxide (CO₂), methane (CH₄) and nitrogen (N₂O), and an increase in these gases has produced a growth in the amount of heat from the sun withdrawn in the Earth's atmosphere, heat that would normally be radiated back into space. Such intensification in heat has headed to the greenhouse outcome, causing in climate change. The central features of climate change are rises in average global temperature; changes in cloud cover and precipitation particularly over land; melting of ice caps and glaciers and reduced snow cover; and escalation in ocean temperatures and ocean acidity due to seawater absorbing heat and carbon dioxide from the atmosphere (UNFCCC, 2007).

The Fourth part Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007) dispelled several worries regarding climate change. Heating up of the climate system is now undeniable. It is currently apparent that global warming is commonly because of artificial

emissions of greenhouse gases (mostly CO₂). Over the last century, atmospheric concentrations of carbon dioxide grown from a pre-industrial value of 278 parts per million to 379 parts per million in 2005, and the average global temperature rose by 0.74° C. As to experts, this is the major and fastest warming development that they have been able to discern in the history of the Earth. A growing rate of warming has particularly taken place over the last 25 years, and 11 of the 12 warmest years on record have occurred in the past 12 years. The IPCC report gives detailed projections for the 21st century and these show that global warming will continue and accelerate.

Climate change is a concept of growing importance to people because of its subsequent consequences on human beings and the living environment. Climate is one of the humankind's ultimate problems of the contemporary world (Abayineh, 2018). It is debatably the highest present-day hazard to the welfare of human race. It produces severe environmental, social and economic threats to the globe (Endeshaw, 2014 and Demamu, 2018). Climate change is a global issue causing from an increase in greenhouse gas emissions linked to human activities. It is known as one of the greatest severe world threats of the day with various consequences on rudimentary human support systems such as agriculture i.e., crop and livestock production, forests, water resources, and the ecosystem (Abinet, 2010). Adaptation in the perspective of human scopes of global change commonly implies to a process, action or outcome in a system in order for the system to better cope with, manage or adjust to some changing condition, stress, hazard, risk or opportunity (Smit B. and Wandel J., 2006).

Vulnerability to climate change cannot be clarified merely by a single environmental or sociopolitical factor, but rather a combination of many factors. The intergovernmental Panel on Climate Change (IPCC) report in 2007 defined climate change vulnerability as “the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.” Others have focused on the extent to which social groups are able to adapt to a given set of environmental circumstances or stresses. Busby, Smith, Strange, and White modeled vulnerability as a confluence of factors by combining physical exposure to climate-related hazards, population density, household and community vulnerability, and governance and political violence. Based on past scholarly work and an analysis of the confluence of these factors, this report approaches vulnerability not only as the exposure to physical hazards, but also as an interactive process of the underlying physical, social, political, and cultural processes that render entire populations susceptible to the losses associated with climate change (Doty B. et al., 2011).

In Africa today, climate change is apparently shifting rainfall patterns and more recurrent or unpredictable remarkable weather events such as overflows, drought, and high temperature effect. These influences are reasons for the damage of the agricultural production ability of the region to its enormous level. Extreme climate causes like drought and flood are extremely distressing the region's agricultural productivity and society's structure of living (Endeshaw, 2014). According

to the International Panel on Climate Change (IPCC) Fourth Assessment Report of 2007 the East and Horn of Africa is projected to be one of the regions of the world most negatively affected by climate change. Environmental change in countries in the East and Horn of Africa already includes prolonged droughts, desertification, flash floods and land degradation, all of which will likely be exacerbated by climate change in the medium and long term.

Ethiopia as part of the East and Horn of Africa is frequently known by a high degree of vulnerability to climate induced shocks (Bekele et al., 2020). Climate models suggest that Ethiopia will see a further warming of 0.7°C and 2.3°C by the 2020s and between 1.4°C and 2.9°C by the 2050s. The current population (over 87 million) is growing annually by 2.6% and is expected to be more than double by 2050. The country is extremely vulnerable to the impacts of climate change. The impact may potentially hold back economic progress or reverse the gains made in development, and thus exacerbates social and economic challenges. The country's vulnerability to climate change is further increased by high levels of poverty, rapid population growth, and reliance on rain fed agriculture. In addition, high levels of environmental degradation, chronic food insecurity, frequent natural drought cycles, etc. may also be other factors that can contribute to the country's vulnerability to climate change (Belay et al., 2016 and Kifle, 2020). By 2030 the Ethiopian population is expected to be 129 million. The country's low economic growth coupled with high reliance on agriculture which is sensitive to climate change and the fast population rise exposed the state to adverse effects of climate change (Belay, 2016 and Seyoum, 2015). At present, the country is extremely vulnerable to climate change so that the country is repeatedly affected by climate-based threats for example floods and drought. Correspondingly, seven main severe droughts have seen in Ethiopia. Moreover, six major flood incidents have arisen in various places of the state in the year's interval from 1988 to 2006. Conversely, the vulnerability of populations living under different social, economic, political, institutional and environmental conditions is not similar as a result of dissimilarities in adaptive capacity, exposure, and sensitivity (Marie, M. et al., 2020). According to the World Bank Group (2010) in its investigation on economics of adaptation to climate change argued that Ethiopia is comprehensively reliant on rain-based agriculture. The geographical location and topography including low adaptive ability of the state and low level of economic development indicates an extreme vulnerability to the influences of climate change (Tewodros, 2018). Thus, climate change is among the world environmental changes probably to have detrimental impacts on natural and human systems, economies and infrastructure. Undesirable effects of climate change are predictable to worsen poverty in most developing countries including Ethiopia (Meseret, 2020).

Objective

The main objective of this manuscript was to qualitatively assess the impacts and barriers of climate change adaptation strategies in Ethiopia.

Methodology

For the purpose of this study, data was obtained from secondary sources. The secondary data was obtained or collected through published and unpublished documents. In this study various literatures were extensively reviewed. The analysis was made via thematic analysis.

Discussions and Results

Definition of Key Concepts

Climate is the average weather condition for several years indicated via variables like precipitation, temperature and wind. It is different from weather because climate belongs to long-term atmospheric conditions expressed in the combination of events like temperature, rain fall and humidity which occurs each day or week. Climate change refers to substantial and insistent change in the mean condition of the climate system ascribed directly or indirectly to human activities (these may include anthropogenic greenhouse gas emissions) which change the structure of the global atmosphere observed over long time periods.

It implies an adjustment in natural or human systems in reaction to actual or anticipated climatic stimuli or their effects, which moderates harm or exploit beneficial opportunities (IPCC TAR, 2001 a). Based on the UNFCCC Secretariat's website adaptation is conceived as a practical step to safeguard countries and societies from the expected distraction and harm that will result from effects of climate change. It implies to the degree to which a system is likely to experience harm as result of exposure to climatic hazard. It depends on the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity and its adaptive capacity (IPCC, 2001).

The Need for Adaptation

Because of global warming, the type, incidence and number of dangerous events, such as tropical cyclones (including hurricanes and typhoons), floods, droughts and heavy precipitation events, are predictable to intensify even with comparatively small average temperature rises. Changes in some types of extreme events have already been observed, for instance, increases in the frequency and intensity of heat waves and heavy precipitation events. Climate change will have wide-ranging effects on the environment, and on socio-economic and related sectors, including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity and coastal zones. Changes in rainfall pattern are likely to lead to severe water shortages and/or flooding. Melting of glaciers can cause flooding and soil erosion. Rising temperatures will cause shifts in crop growing seasons which affects food security and changes in the distribution of disease vectors putting more people at risk from diseases such as malaria and dengue fever. Temperature increases will potentially severely increase rates of extinction for many habitats and species (up to 30 per cent with a 2° C rise in temperature). Particularly affected will be coral reefs, boreal forests, and Mediterranean and mountain habitats. Increasing sea levels mean greater risk of storm surge, inundation and wave damage to coastlines, particularly in Small Island States and countries with low lying deltas. A rise in extreme events will have effects on health and lives as well as associated environmental and economic impacts (UNFCCC, 2007).

Consequently, response options to climate change are necessary to adjust the effects of climate change and commendably lessen substantial vulnerability. To do this, two major response options that are mitigation and adaptation are significant. Mitigation needs actions that are aimed at preventing or retarding the greenhouse gas emissions. Adaptation could be an attempt which is in the form of passive, reactive, or anticipatory that can respond to anticipated or genuine consequences related with climate change. Mitigation can merely sluggish down the degree of climate change and cannot avert its existence. Since mitigation actions do not safeguard lessening of comparative vulnerability of a person on an individual level, several people, particularly those in the developing countries, would be doubtful of pledging to think through mitigation options for the international advantage. But adaptation options can minimize vulnerability to a certain degree on an individual level. In addition, the constructive influence of pledging to adaptation activities by an individual or a community would have direct noticeable impacts. Consequently, adaptation to climate change is highly possible to be practiced (Uddin A., Alam M., and Rahman A., 1999). The risks of climate change are inevitable which are not merely safeguarded by the most one-sided emission minimizations as part of mitigation. Most adaptation measures have more immediate benefits than taking several decades to see changes as in emission reductions. Adaptations are easily practicable on a local or regional scale, while mitigation of climate change requires international collaboration. Many adaptations to climate change decrease the hazards linked with current climate change (Fussel H.M. and Klein R., 2006).

Adaptation is also needed and given priority because it is a crucial and a burning policy imperative and research agenda depends with the fact that mitigation strategies to decrease greenhouse gases will consume time and are often worried with complex and prolonged global negotiations. It is prioritized and needed on the view that the climate is changing and it is a condition of necessity by all countries. Presently inconsistent and risky weather conditions have enlarged in ways consistent with modeling projections, showing that climate change is already happening. Hence, even if maintenance or lessening in GHG emissions were to be attained, the climate system is already changing and the damage will be large unless investment is made on adaptation to develop adaptive capacity and decrease upcoming vulnerability to climate change. Since successful adaptations brings benefits continuous or better agricultural production, greater household incomes, boosted environmental facilities, safeguard asset base, and less vulnerability to dangerous weather events (Seyoum, 2015). But the general characteristics of mitigation and adaptation are presented in the following table which is directly adapted from Fussel, H. M., & Klein, R. (2006).

Causes of Vulnerability to Climate Conditions in Ethiopia

Rise in GHG emissions globally has added to enhanced climate change. Climate change is naturally induced, but in recent years the major cause has been anthropogenic impact (Nuru, 2020). The major cause of greenhouse gas emissions is carbon dioxide (70%), predominantly from burning of fossil fuel (petroleum) imported, while the other sources of GHG are methane and nitrous oxide caused by deforestation and agricultural activities, mainly the use of pesticides.

Ethiopia's share to global greenhouse gas emission is very minimal. However, emissions from agriculture and energy sectors doubled since 1994. These two sectors are the foremost emitters in country which accounted for 85% and 15% of the total gas emission correspondingly. This reveals the fact that livestock farming goes together with high methane emissions. The dominant position of livestock farming in Ethiopia's economy also influences the relative contribution of GHG to the total emissions. These are dominated by methane emissions, which account for 80% of the warming potential (Abirham, 2017).

The Climate Change National Adaptation Program of Action (NAPA) of Ethiopia (2007) sees the concept of vulnerability as a very complex one. Causes for vulnerability of Ethiopia to climate variability and change include very high dependence on rain fed agriculture which is very sensitive to climate variability and change, under-development of water resources, low health service coverage, high population growth rate, low economic development level, low adaptive capacity, inadequate road infrastructure in drought prone areas, weak institutions, lack of awareness, etc. Vulnerability assessment based on existing information and rapid assessments carried out under NAPA has indicated that the most vulnerable sectors to climate variability and change 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, semiarid and the dry sub-humid parts of the country are affected most by drought. In general, Ethiopia is vulnerable to the impacts of climate change because of interrelated numerous reasons: poverty, frequent droughts, high population rise, inequitable land distribution, over exploitation of natural resources, subsistence rain-fed agriculture, etc. The country is primarily vulnerable to climate change as a result of its landscape variability, low income, and bigger reliance on climate liability socio-economic sectors such as agriculture, pastoralism and natural resources (Sorhaug A.K., 2011).

Climate Change Adaptation Strategies in Ethiopia

Adaptation to altering environmental conditions is a natural part of our everyday live. Frequently, these adaptations are a response to changes which have previously occurred. Climate change is inevitable; even if we implemented the best mitigation measures such as greenhouse gas emission reductions immediately (Zebisch M. et al., 2005 and Endeshaw, 2014). Climate change adaptation strategy is a mechanism of minimizing vulnerability, strengthening resilience capacity, minimizing the severe climate induced hazards on lives and livelihoods, and bringing benefits of opportunities delivered by actual or forecasted climate change (Belay, 2016). Adapting to climate change is the system of adjusting oneself to enhance and survive from the impacts of climate change. It also includes the accommodation of extreme climate change risks and long-term resistance to it. It is a long-term strategy that humans adjust their systems of living in response to the actual rate of climate change (Endeshaw, 2014).

Based on a study conducted by (Zeray, N., & Demie, A., 2016, 2015; Getachew, 2020; Edeshaw, 2014; Abirham, 2017) and Sorhaug A.K., 2011) the following adaptation strategies were applied in different parts of Ethiopia. Crop diversification is a mechanism that pursues to avoid threats of overall crop disaster rather than increasing yields of one particular crop. It is the most frequently

practiced strategy to reduce the impacts of climate changes in Ethiopia. This strategy is safer due to the fact that if one variety fails, there are some other crop varieties that are successful. In addition, with revolving of crop varieties on the land, soil fertility will be sustained and the soil might not be exhausted. Combining crop production with pastoralism like mixed species herds, widespread and seasonally available pastures, splitting animals into discrete herds, and mobility in response to seasonal variation in pasture productivity are main mechanisms of adaptation in Ethiopia. Tree planting is used to adapt to climate changes in Ethiopia. Vulnerability to climate changes can be alleviated if off-farm activities are being practiced by the farmers. Sale of labour is also a mechanism of coping strategy by farmers in the Upper Awash Basin of Ethiopia through drought times. Customary and modern coping strategies in Ethiopia are also being practiced like increased petty commodity production. Off-farm practices may be selling of honey, clothes, or home-made products like mattresses, hot food, beverages, whips and ropes. The other adaptation mechanism commonly practiced is soil and water conservation. Most parts of Ethiopia are mountainous and the crop fields are hardly flat. Often, they are found in a hill side or in a valley side. This generates additional demand for soil and water conservation to avert the soil and rainwater from being washed away. Practicing new or suitable seed varieties is a way of climate change adaptation strategy used in Ethiopia. Even though farming systems in the country are still somewhat outdated, farmers in several parts do have the choice of practicing new, higher-yielding crop varieties. In addition, planting drought resistant plants like Enset, irrigation and diverting of water are also the adaptation strategies commonly used in Ethiopia.

Barriers of Climate Change Adaptation

The main barriers of climate change adaptation can be grouped in to three major types. The first is the opportunities of humans to live in the state of natural uncertainty that is the non-predictable ecological disturbances like earthquake, rapid increasing of sea level, rising of temperature and other sudden catastrophic events are the main barriers of climate change adaptation. The second is human actions like technological factors and limited knowledge about environmental conservation mechanisms can be taken as a barrier. Thirdly socially constructed norms that limit community's response to climate change resilience are also taken as a barrier to climate change adaptation. Groups of humans construct these social barriers of adaptation, and they might be institutions like belief systems, norms, values and others, which are called normative restrictions that prevent individuals or groups from seeking the most appropriate forms of adaptation (Edeshaw, 2014)

According to a study conducted by (Demamu, 2018; Israel, 2019; Menberu, 2014; Meseret, 2009; and Sorhaug A.K., 2011) wealth; gender of head of household; education; age; household size; access to information; access to weather forecasts; access to credit; agricultural education or training; social capital; distance to market; agro-ecological settings; climate change adaptation policies, measures, and strategies; systems in place for dissemination of information; well-functioning social systems; access to labour; irrigation potentials; equitable distribution of power; access to land; ethnicity; stable and effective institutions; access to technology and productive use are the main barriers for climate change adaptation in Ethiopia. A huge proportion of farmers in

Ethiopia, although they notice changes in temperature and rainfall, did not make any adjustments to their farming practices because of lack of access to land, lack of information on adaptation methods, and financial constraints including credit schemes.

Impacts of Climate Change in Ethiopia

Ethiopia is one of the low-income countries and highly vulnerable states extremely affected by the influences of climate change. The country stood as one of the top twelve states in the globe with regard to climate change hit list. The country has now suffered by the influence of climate vulnerability and severe events (Demamu, 2018; Abayineh, 2018 and Zeray, N., & Demie, A., 2016). Climate change impacted Ethiopia extremely for more than a decade, causing in growing agricultural losses and human pain, placing the country in a situation of critical food insecurity and water shortages. In other words, it has highly impacted crop production in Ethiopia. The volume and interval of rainfall is deteriorating and the dry period is becoming longer, which has headed to scarcity of water and pasture, spread of human and livestock diseases, and intensification of conflicts. This in turn has led to an impact on life stock production. “Years of drought and famine (1984/1985, 1994/1995, 2000/2001) are associated with very low contributions, whereas years of good climate (1982/83, 1990/91) are associated with better contributions”. This clearly indicates that climate change in Ethiopia had an impact on agricultural GDP specifically and GDP growth in general. The availability of food has come to be a main problem for millions of families in several areas of Ethiopia as a result of the recurrent drought progressions and inconsistency in rainfall. This has made an impact over food availability in the country (Zeray, N., & Demie, A., 2016).

The other impact is on the water resources which will be impacted by climate change through a reduction in river run-off, a decrease in energy production, as well as increased floods and droughts. In this case Haramaya Lake is a notable example for such an impact in Ethiopia. Warmer temperatures and differences in rainfall conditions related with climate change are now changing the spreading ways of water and vector-borne diseases in Ethiopia. Occurrence of malaria, dengue fever, and water-borne diseases such as cholera and dysentery is probable to become more rampant, while food insecurity associated to dangerous events also threatens the lives and livelihoods of millions of Ethiopians leading to higher climate change impacts on health. Climate change, comprising dangerous events such as storms, floods and continued droughts, already has marked impacts on settlements and infrastructure in Ethiopia. Temperature has increased over the country and recurrent drought and flood are the most severe problems that affected millions of the country’s populations almost every year. This perception of change in temperature and in the frequency of drought could be linked to a changing climate. Climate change may also impact the land resources of the country by exacerbating desertification and its consequences ((Abinet, 2010; Zeray, N., & Demie, A., 2016). Generally, climate change is now imposing a substantial problem to Ethiopia by affecting food security, water and energy supply, poverty reduction and sustainable development efforts, as well as by causing natural resource degradation and natural disasters. In

Ethiopia recurrent drought and frequent floods which covered a wide geographic area caused severe loss of life and property (Tesfayesus, 2011 and Zelalem, 2020).

Conclusion

Adaptation strategies are needed prioritized since mitigation strategies to decrease greenhouse gases will consume time and are often worried with complex and prolonged global negotiations. Ethiopia's share to global GHG emission is very minimal. However, emissions from agriculture and energy sectors are the foremost emitters in the country which accounted for 85% and 15% of the total gas emission correspondingly. The causes for vulnerability of Ethiopia to climate change are so plenty and diverse. Different types of climate change adaptation strategies in Ethiopia were applied but still the problem persists which indicates reassessment of the strategies which have been implemented so far. In this work the state of natural uncertainty, technological factors and socially constructed norms were the major barriers for climate change adaptation in Ethiopia. Hence, it's concluded that Ethiopia is one of the low-income countries and highly vulnerable states extremely affected by the influences of climate change.

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