

Drought and Flood Extreme Events and Management Strategies in Ethiopia

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ABSTRACT

The review was done with the aim to assess climate extreme events especially drought and flood and the responses strategies. The review shows, there were 19 drought events in the period between 1900-2002, which is roughly once in six years and affected nearly 19.7 million people while 14 flood events occurred from 1960 to 2020 of which about 11 flood events occurred after 1990. From the review, frequencies and magnitudes of both disasters are increasing year by year in Ethiopia. Besides implementing the international initiatives, the Ethiopia government developed a climate-resilient green economy strategy in 2010 to lower emissions which is the major factor of climate change. Changing planting dates and species, planting drought-tolerant crops, soil, and water conservation practices, afforestation and reforestation, crop and livelihood diversification, agroforestry practices, small scale irrigation, mixed crop production, constructing ponds, and different water harvesting structures are the most common adaptation practice implemented before and after the drought extreme incidents. Constructing dykes, water diversions, temporary and permanent movement from flood risk-prone areas are among the strategies implemented by the government and community for flood extremes. Early warning systems and traditional agro ecological knowledge are the most sources of information about the future.

Keywords: Water diversions; Harvesting; Afforestation

INTRODUCTION

Extreme event is an event that is rare at a particular place and time of year. Weather and climate extremes are an inherent part of climate and there are overwhelming evidences that the climate and its extremes are changing. Droughts, floods, hurricanes, heavy precipitation events, heat waves, cold spells, tropical and extra-tropical storms, coastal sea level surges and ocean waves are the most natural disaster risks that the nation faces in this century. Current climatic trends and projections highlight consistent tendencies of rising temperature and increasing climatic variability (IPCC, 2013b). According to IPCC, (2007) report, the probability of extreme climatic events associated with global warming is high. A recent publication by highlights, there are mounting evidence that extreme weather and climate events have been changing in regard to intensity, frequency and duration in the last few decades. There is general agreement that changes in the frequency or intensity of extreme weather and climate events would have profound impacts on both human

society and the natural environment. Recent years have seen a number of weather events cause large losses of life as well as a tremendous increase in economic losses from weather hazards. In the last four decades, the frequency of natural disasters recorded in the Emergency Events Database (EM-DAT) has increased almost three-fold, from over 1,300 events in 1975–1984 to over 3,900 in 2005–2014 [1-7]. Since 2015 up to 2019 there was 1624 natural disaster events occurred in the world. Developing countries are more vulnerable to climate change impacts. Particularly Ethiopia is one of the most vulnerable countries for climate change related disaster risks like drought, flood, heavy rain and heat waves. Climate change is expected to exacerbate variability in rainfall and temperature in Ethiopia, potentially increasing farmer exposure to climate-related hazards. Like other countries, the frequency of drought and floods in Ethiopia had shown increasing trend in the past few decades. More specifically drought occurs every 3-5 and 6-8 years in northern Ethiopia and every 8-10 years for the whole country. The 2006, floods disasters kills more than 604 people and more

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Received: 18-Mar-2022, Manuscript No. JGND-22-16297; **Editor assigned:** 21-Mar-2022, PreQC No. JGND-22-16297 (QC); **Reviewed:** 04-Apr-2022, QC No. JGND-22-16297; **Revised:** 18-May-2022, Manuscript No. JGND-22-16297 (R); **Published:** 25-May-2022, DOI: 10.35248/2167-0587.22.12.248.

Citation: Cherinet A, Tadesse C, Abebe T (2022) Drought and Flood Extreme Events and Management Strategies in Ethiopia. J Geogr Nat Disast. 12:248

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than 32,000 people became homeless in Diredawa, South Omo and in West Shewa. According to the UN Office for the Coordination of Humanitarian Affairs report, nearly 1.1 million people have been affected by floods, including over 313,000 people displaced from Afar, Amhara, Gambella, Oromia, Somali and Southern Nations, Nationalities, and People's (SNNP) regions in 2020. A study results of shown that, dry land communities, especially pastoralists are vulnerable to climate-induced stresses due to their low adaptive capacity, over dependence on climate-sensitive livelihood activities and less resilient production environments. In recent years, however, extreme climatic events attributed to drought-induced livestock mortality, food insecurity, and poverty and putting enormous pressure on the livelihoods of the pastoralists. But, it is possible to reduce adverse effects of climate change and variability by formulating effective and efficient adaptation strategies. Over the past thirty years, several initiatives at global and regional level have been adopted to tackle the adverse impacts of climate and its extreme events [8-12]. The Yokohama strategy and plan of action in 1994, Hyogo framework for action and the 2015 Sendai framework for disaster risk reduction are among the initiatives to reduce disaster risks. As a pro-active measure, the government of Ethiopia has recently developed a national policy and strategy on disaster risk management activities within the country. Community level adaptation and mitigation strategies are also widely implemented in disaster prone areas of Ethiopia. But those strategies are everywhere in fragmented way and there is a need to compile those adaptation options. Therefore this review paper present management strategies implemented by government and communities before and after those climate extreme events in Ethiopia [13-21].

LITERATURE REVIEW

Climate extreme events in Ethiopia

Ethiopia is located in the tropical climactic region of Africa, although it has a varied topography that results in different climate classifications throughout the country, ranging from the hot lowlands to cool elevated regions. Whilst a wide range of natural hazards are present in Ethiopia, including drought, floods, and earthquakes, by far the most common natural hazards in Ethiopia are droughts and floods. Most of Ethiopia is made up of arid, semi-arid or dry sub-humid areas, all of which are vulnerable to these hazards. These different hazards occur with varying frequency and severity. Some result in nationwide disasters, while the impacts of others are more localized [22-28].

Drought: Drought is a recurrent climate phenomenon which occurs in most parts of the world, with varying frequency, severity and duration. Historical drought events reveal that Ethiopia frequently faces drought and famine. In the past nine centuries there were about 30 major drought episodes. Of these drought episodes 13 of them are known to have covered the entire nation and they were reported as severe. From 1970 onwards, drought hit the country at least once in every 10 years during the last years the event is becoming even more frequent. It is now recurring every two or three years at different levels of intensity. Also noted that there were no years without at least

mild droughts in some part of the country for the period 1971-2011. Results of showed that, the frequency and severity of drought incidences for the last four decades for the Awash River Basin and the whole of Ethiopia are spatially non-uniform across the country.

Flood: Flood is one of the major natural hazards in Ethiopia which causes significant damages to lives and livelihoods in parts of the country. In Ethiopia flooding is mainly associated with heavy rainfall and the topography of the highland mountains and lowland plains with natural drainage systems formed by the principal river basins. Some literatures suggest that, the frequency and magnitude of river flood might increase due to climate change. In line with these arguments, the frequency of flash floods markedly increased all over Ethiopia in the last decade, which caused a number of fatalities and large property damage. There have been eleven major floods during the past two decades that have resulted in significant loss of life and property. Particularly the 2001-2010 there was five flood years out of ten years [29-45]. From 1991-2000 and from 2011-2020 decades there was four and three flood disaster occasions respectively. Other report by indicated that, around 257.6 hectares of farm lands with crops, soil and water conservation infrastructures across 17 kebeles, water schemes in 7 kebeles, and irrigation schemes in five kebeles were damaged with irregular flooding in rural areas of Dire Dawa.

Responses for climate extremes

Government level responses: In reduction of climate change and variability related impacts policy makers are playing an important role. Over the past thirty years, several climate change adaptations and disaster risk management initiatives at the global, regional and country level have been adopted to tackle the adverse impacts of hazards. The Yokohama strategy and plan of action in 1994, Hyogo framework for action (UNISDR, 2005) and the 2015 Sendai framework for disaster risk reduction which was developed in 2015 are among the initiatives to reduce disaster risks. Before climate changes have got prior agenda on international level, Ethiopia already approved energy policies that address climate change in 1997 and the Ethiopia Climate Resilient Green Economy Strategy (CRGE) also developed in 2010 to lower the emission which is the major factors of climate change. Strengthening adaptation action in Ethiopia requires mainstreaming climate change into the policies and plans guiding the management of vulnerable sectors, including those focused on water, agriculture, health, disaster risk management, and energy. Ethiopia is promoting the conservation, management and sustainable utilization of forests and other natural resources. There are several large projects for afforestation, reforestation, and forest management such as Participatory forest management. Even if countries are trying to limit their emission, they still face different hazards and disasters. To minimize the impact of those disasters, the government of Ethiopia has recently developed a national policy and strategy on disaster risk management activities within the country. At the higher level, the government has also signed and ratified the Rio conventions and Kyoto protocol, 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 (NAPA), twenty priority project ideas were identified that address climate change adaptation needs of the country. Productive Safety Net, WASH, SLM etc. Programs are working to limit the occurrences of extreme events as well as to reduce the impacts of the events [46-53]. The government of Ethiopia in collaboration with non-governmental organization is working on early warning and response mechanism, facilitating safety net programs, natural resource management based adaptation mechanisms, and weather index insurance mechanisms.

Community level response for drought events

Watershed management programmes: are designed to reduce the impact of rain related hazards by building natural assets and improving degraded lands in communal watershed areas. Ethiopia developed community based watershed development guideline in 2005, in which the participation of community gets due consideration for sustainable watershed development and management. Recently, the movement on watershed management is going on almost throughout the country, which was initiated by government. Soil and water conservation strategies are widely practiced in Ethiopia since around 1990. Soil and water conservation strategies are mainly used because of soil degradation and soil erosion, and because farmers due to this, want to rehabilitate their fields. Soil and water conservation structures like farmland terraces, hillside terraces, check dams, cut-off drains, gully reclamation, eyebrow basins, micro-basins, trenches are the most common strategies which are implemented by mass movements for average 60 days in a year. According to tree planting is one of the major methods used by farmers to adapt to climate changes in the Nile Basin of Ethiopia. Vegetation like trees, plants, and grass are valuable because the roots protect the soil from erosion [54-61]. Trees are valuable during floods and droughts, and many trees together might give lower temperatures in the near area, a more fresh air, and also shadow. Land husbandry techniques such as planting of multipurpose tree/shrub and grass species, seed collection and production, seedling production are widely practiced in Ethiopia. According to FAO report, the trend of plantation forest in Ethiopia shows an increasing trend from 2000-2020. Rainwater Harvesting (RWH) is also one of the most practiced techniques which is used to, collecting, storing and conserving local surface runoff for agriculture in arid and semi-arid regions.

Agriculture: Ethiopia is one of the most vulnerable countries to climate change and variability which is frequently affected by climate based hazards such as drought and floods. The impact of climate change is worrisome in Ethiopia, where its agricultural systems have largely relied on rain that has been closely associated with climate. The agriculture sector has been playing a very significant role in providing food, employment, and income to the majority of people in Ethiopia. It accounts for about 42.9% of gross domestic product, 80% of employment, and 88% of export earnings. However, climate change remains the major challenge to the development of agriculture and food security. Despite its high contribution to the overall economy, the sector is inherently sensitive to climate-related disasters like drought and is among the most vulnerable sectors to the risks and impacts of global climate change. The impact on agriculture

is manifested by increasing incidence of droughts, floods, and unpredictable rainfall and has resulted in food shortage and famine in the past and they continue to pose a serious threat to Ethiopia's development. In order to alleviate these problems, farmers have implemented as an adaptation strategies mixed crop production with pastoralism, mixed cropping, changing planting and harvesting periods, use of drought-resistant crop varieties, off-farm activity, selling of assets, irrigation and diverting of water, agroforestry practices, water harvesting, food aid and migration. In many part of Ethiopia crop diversification is practiced long years ago to avoid risks of total crop failure rather than maximizing yields of one particular crop. Crop diversification is the most commonly used method to overcome climate changes in Ethiopia [62-73]. Greater use of different crop varieties in the same season could be associated with lower expenses and ease of access by farmer. Noted that crop diversification together with soil and water conservation and water harvesting practices were commonly used drought adaptation strategies in most parts of Ethiopia.

Agroforestry: Agroforestry is the integration of trees and shrubs with crop and livestock production systems, that is, a combination of agriculture and forestry. They supplement food supplies and also serve as a buffer during periods of droughts and crop failures. In the face of climate change, combining the two in farming systems would be advantageous since their synergy optimizes mitigation and adaptation. False banana is a relatively drought resistant plant and it is a highly valuable plant in many Ethiopian communities, especially in the south. Enset provides more amount of foodstuff per unit area than most cereals in Ethiopia.

Irrigation: Use of irrigation is one of the least practiced adaptation strategies among the major adaptation methods identified in Ethiopia. Research findings by and estimates that total irrigable land potential in Ethiopia is 5.3 Mha assuming use of existing technologies, including 1.6 Mha through RWH and ground water [74-78]. The Ethiopian Irrigation Development Plan (IDP) emphasizes the development of small-scale irrigation systems through giving highest priority for capacity-building in the study, design, and implementation of irrigation projects. Increasing emphasis will also be given to the development of large and medium-scale irrigation schemes. Listed out the benefits of irrigation that includes; increase food production in arid and semi-arid regions, enhances food production, promotes economic growth and sustainable development, create employment opportunities, and improve living conditions of small-scale farmers. As a result, irrigation contributes to poverty reduction and protects the environment from degradation and pollution. Recently spate irrigation systems are practiced both in the midlands and lowlands in Ethiopian. The Ethiopian Agricultural Development Led Industrialization (ADLI) policies and its driven strategies make use of favorable conditions for the irrigation development. Most of the irrigation partners are from international communities up to localities that have significant contributions towards food security and poverty reductions at households and national levels.

Adaptation strategies on livestock production

Pastoralism and agro pastoralism are common practices in Ethiopia. Like crop production, they are climate-sensitive sectors. Pastoralists and agro-pastoralists in the dry lands such as afar in north eastern, Somali in eastern and Borana in Southern Ethiopia use different strategies to cope with the impacts of climate variability and change. Nowadays, the pastoralists in the dry lands such as Afar, Somali and Borana are decreasing the number of cattle and sheep and increasing the number of camels and goats (because of their remarkable capacity to adapt severe drought) in their herds as a strategy to improve their livelihoods and adapt to climate change. Borana pastoralists, southern Ethiopia have 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 no pastoral adaptation strategy embraced by Borana pastoralists in the last two decades of the 20th century is cereal cultivation. 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. Diversification of livestock varieties can increase drought and heat wave tolerance, and may increase livestock production when animals are exposed to temperature and precipitation stresses. In addition, this diversity of crops and livestock animals is effective in fighting against climate change-related diseases and pest outbreaks. On other hand changes in breeding strategies can help animals increase their tolerance to heat stress and diseases and improve their reproduction and growth development. Therefore, the challenge is in increasing livestock production while maintaining the valuable adaptations offered by breeding strategies, all of which will require additional research.

Flood extreme responses

Pre-disaster conditions: Early warning system and preparedness. Flood risk management consists predominantly of structural measures, the planning and implementation of which, for the most part, are the responsibilities of governments. Community perception and level of information has an eminent role for proper disaster risk reduction like flood. A study result by shown that farm households doesn't have climate information due to lack of awareness, lack of knowledge on the role and use of weather information, lack of technology, and lack of trust regarding forecasts. This shortage of information leads to be more vulnerable for the adverse impact of climate change. From their experience, people of a given locality know the type of hazards threatening their locality and can predict how and when the event occurs. Following less efficiency of structural protection works early warning becomes more central to the risk management approach. IPCC 2007 assessment report articulates

that, Traditional Ecological Knowledge/TEK/for adaptation is "an invaluable basis for developing adaptation and natural resource management strategies in response to environmental and other forms of change". TEK plays important role in short and medium-term weather forecasting. Peoples in Dire Dawa city have developed different experiences of flood hazard forecasting's by smell of flood, observing the cloud colour and direction, weather condition, and special months of a season. Assessment of flood risk mapping areas is considered as one of the most pre-disaster risk reduction mechanisms. Flood risk maps are used in flood risk management system to visualize and represent information for decision making processes. Right now there are so many flood risk mapping studies using GIS and remote sensing techniques.

After-disaster conditions: Response Region level governments developed a response plan to prompt timely mitigation, preparedness and response measures in flood affected areas of the country. The immediate lifesaving interventions: immediate search and rescue intervention, immediate provision of food aid, emergency shelter and non-food items, provision of essential drugs, hygiene and sanitation interventions, distribution of water treatment and purification chemicals, emergency distribution of seeds to the affected vulnerable farmers, increase road accessibility by using heavy machineries, relocating displaced people in to safe ground are the common activities which is done by government when flood disaster occurs. While communities in flood prone areas are developed ranges of adaptation strategies such as using flood inundation areas for less risk livelihoods, temporary move from houses, diverting flood direction, using sandbag around houses and climbing roof of houses are applied by communities in flood risk areas in Ethiopia. The survey results by shows that, temporary move during extreme flood events is the most acquainted strategy in Diredawa and Gambella. People in flood prone areas evacuate their families and properties to safe places before the occurrence of flood event. A studies by also suggested that, climbing roof of houses is one of the strategies that applied by the residents in flood prone areas of Zimbabwe. In line with this argument reported that, during evening times, when it is difficult to determine the water level, they climb the roof of their house until flood gets slow in velocity and decreases in volume. Suggests the need of engineering solutions to minimize risk of flooding include alterations to river courses and depths, artificial flood containment such as construction of wide drainage canals, dykes, and flood retention basins, dams/reservoirs for water control, increasing access to safe water supplies, proper land use and sanitary facilities.

Adaptation barriers for drought and flood events

Community perception on disaster: There is a wide spread of traditional and cultural opinions among the Ethiopians in general and rural community in particular for the causes and consequences of climate variability. The rural community believed that, climate variability and its impacts are the acts of God/Allah against human sin. Literature evidence shows that, disaster experience and risk perception of the people has great impact on flood preparedness and mitigation. A study by revealed that, risk perception influences communities' response to

disasters and their readiness and impetus to employ precautionary behaviors to lessen the associated risks. This means communities with low-risk perception could lead to inadequate coping mechanisms, the high-risk perception has been associated with adopting protective behaviors useful in supporting higher resilience. Therefore increasing the awareness and preparedness of the communities will help the community have better management skill on disaster.

Low level of information: According to, knowledge is “a fluid mix of framed experience, contextual information, values and expert insight that provides a framework for evaluating and incorporating new experiences and information”. Higher level of education is assumed to be associated with access to information on improved technologies and productivity consequences. Sendai Framework of Action gave emphasis for the value of knowledge in disaster risk reduction, and articulate it’s helpfulness to assess hazards, vulnerability, capacity and risks, monitoring, capacitate early warning system is high and also helps to better address the sub-regional framework policy and strategy. This means raising public awareness of disaster risks can influence their attitudes to be more proactive in disaster preparedness. Communities’ knowledge can be built through mass media, education, training, etc. A study done by indicates that, rural communities in Africa have a limited access to information. In line with this argument indicates that in rural areas of Ethiopia, only a few people who have access to a radio to receive weather forecasts provided by the NMA.

Poor coordination: Strong coordination and collaboration among public and private sector agencies and organizations at all levels are crucial for disaster risk management. Technological advances of early warning systems and the continuous improvement of these systems have facilitated and supported agency coordination in the management of man-made and natural disasters in the state of Hawaii. The Global Assessment Report is evidences of the increased international cooperation on DRR. Ethiopian government also established the National Disaster Risk Management Commission (NDRMC) and mainstreamed the structure up to local level. This decentralization of the programme has been an important factor in improving coordination and collaboration. The devolution of power to woreda level offers a window of opportunity to facilitate effective collaboration and strong institutional basis for implementation of disaster risk management activities. However, improved cooperation and coordination at Woreda level seem to require longer time than it was initially anticipated. Some Woreda structures have been handicapped by limited budget resources allocation, inadequate lack of trained human resources and lack of integrated disaster management plan and absence of legally accountable act. Even if there have been encouraging initial initiatives in this regard so far, they are not consistent with disaster risk management directions. Therefore, national and international cooperation shall be strengthened in accordance with the disaster risk management direction, relevant laws and directives of the country and on the basis of international, regional and sub-regional laws, directives, and agreements ratified by the country.

DISCUSSION

Little or/no budgeting: Financing is a proactive approach to disaster risk reduction which involves early detection of disaster risks and making financial resources available to take care of the needs of the affected communities during and after the disaster. The mid-term review of the Hyogo framework for action made it clear that, financing was an issue across each of its five priority areas. Lack of financing at a local level and the need for financing systems to explicitly include DRR, without which disaster risk would not be integrated into local planning and resourcing. HFA remarked that ‘financial allocations, especially at the local level, for managing response remain uneven across countries. The frequency and severity of disasters that developing countries are facing are attenuating their development. With their limited financial resource and focusing on the other development activities, governments especially at lower level wouldn’t allocate enough budgets for disaster risk reduction activities in Ethiopia. Even if there is a small budget, they use the budget for disaster response purpose.

Poor early warning system: Early warning systems are a series of organized surveillance mechanisms or actions that collect information on potential hazards in a given location, in order to trigger timely, coordinated responses. Ethiopia’s national EWS is one of the oldest EWS in Africa, prompted by the severe famine of 1973/74. Ethiopia has a range of EWS that permit the early recognition of the onset of a drought. These tools include, inter alia, the LEAP and LIAS tools, a bottom up early warning system, hotspots analyses and the Integrated Food Security Phase Classification. But Ethiopian early warning system has some major limitations. The system has been criticized for being too complex and resource intensive. Also, it requires efficient communication channels which is lacking in most parts of the country. A study done by revealed that, Ethiopian early warning system is problematic mainly in staff capacity, using generic EWS, selection of indicators, inclusion of all risk factors, quality and accessibility of message, political influence and response provision. Due to those reasons including low perfection on the prediction of possible hazards peoples are suffering more.

CONCLUSION

This review tries to describe different coping and adaptation strategies used by communities to mitigate and adapt the adverse impacts of climate change extreme events in Ethiopia. Now-a-days climate change is acknowledged as one of the most pressing threats to the development. Extreme weather events, combined with low capacity to adapt to the adverse impacts of climate change, aggravated food security risks. From the review both the frequency and magnitude of climate extreme events are increasing. To overcome these problems, farmers in Ethiopia used a range of strategies against short and long-term impacts. At government level, the Ethiopia government formulates National Disaster Risk Management Commission with the aim take the responsibility of managing disaster related risks. Different governmental and non-governmental bodies are working to improve the community’s perception, adaptive and resilient capacities in the country. The common strategies that are implemented by farmers are related to land management,

crop management, livelihood management and livestock management. Community perceptions, low level of information, low level of budgeting poor coordination, and poor early warning systems are the common adaptation barriers.

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