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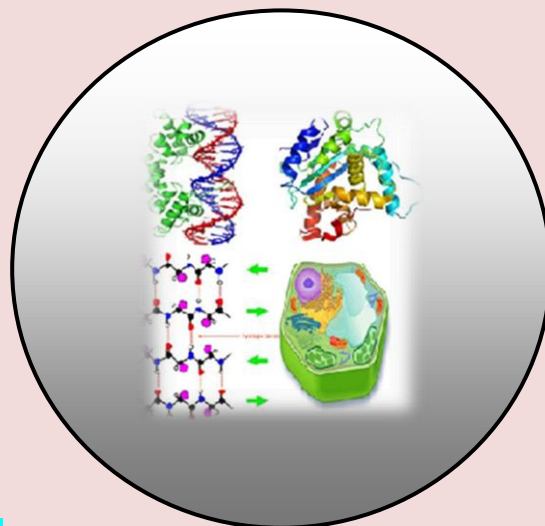
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Review on Climate Change Impact and Adaptation Strategy in Ethiopia

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ABSTRACT

Climate change will have wide-ranging effects on the environment, and on socioeconomic and related sectors, including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity and coastal zones. Changes in rainfall patterns 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. To overcome problem occurred with climate change, there are many options and opportunities to adapt. Adapting to climate variability and change is an issue of climate risk management, where an organization seeks to reduce any potential threats, and make the most of any opportunities that may arise as a result of climate change. This risk management entails developing and implementing adaptation strategies and actions. However, adaptation is a complex, highly context specific, multifaceted issue. Aspects of adapting to climate change range from having or developing an awareness of the need for adaptation, and understanding the adaptation issue at hand, planning strategies and actions for dealing with these issues, implementing them, and then monitoring and reviewing their performance, as well as the risks themselves, as they change over time.

Keywords: Vulnerability, Extreme Event, Effect and Weather.

INTRODUCTION

The impacts of climate change such as rising global average temperature and changes in precipitation are undeniably clear with impacts already affecting ecosystems, biodiversity and human systems throughout the world. Future impacts are projected to worsen as the temperature continues to rise and as precipitation becomes more unpredictable (Kotir, 2010). At the same time, there has been an increase in the number of publications on the implications of climate change and consequential weather extreme events such as erosion processes, drought, marine flooding, and storm surges among others.

Over the years, studies on climate change principally assessed impacts and adaptation, based on climate change scenarios, using only quantitative climatic data and models. However, a successful understanding of climate change will not necessarily be limited to values of climate parameters; it will also encompass variability and associated extreme weather events, and the understanding of these by local farmers who are being affected. Therefore, there is a need for an in-depth study, to examine farmers' understanding of extreme weather events, their significant impacts on crop and livestock production, and their strategies for adaptation. Communicating scientific findings to farmers and incorporating their understandings will be very useful in implementing and monitoring strategies which would improve the crop yield not only in Africa but in the other part of tropical regions (Ayanlade *et al.*, 2017). There are many options and opportunities to adapt. Adaptation is a continuous process of awareness and understanding, planning, implementation, and monitoring and review (Moser and Ekstrom, 2010). It ranges from technological options such as increased sea defenses or flood-proof houses on stilts, to behavior change at the individual level, such as reducing water use in times of drought and using insecticide-sprayed mosquito nets. Other strategies include early warning systems for extreme events, better water management, and improved risk management, various insurance options and biodiversity conservation (UNFCCC, 2007). A wide variety of adaptation options has been proposed as having the potential to reduce vulnerability to risks related to climate change (Smit and Skinner, 2002). Mean that adaptation is processes through which societies make themselves better able to cope with an uncertain future and entails taking the right measures to reduce the negative effects of climate change (or exploit the positive ones) by making the appropriate adjustments and changes. Generally the objective of this review is mostly aim to review related articles to understand the climate change impact and adaptation strategy.

Climate Change

Climate change is defined as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over a comparable time period (UNFCCC, 1997). Climate change involves not only global warming, but also other physical changes such as precipitation, the intensity and frequency of storms and the occurrence of droughts and floods. As well, the widespread melting of the ice sheets, which would imply a large sea level rise, and changes in the thermohaline circulation (THC)³ - the global density-driven circulation of the oceans - which would amplify climate change, are considered as two of the main irreversible risks associated with climate change (Jamet and Morlot, 2009).

Climate Change Impact

Impact on Agriculture

Agriculture is an economic activity that is highly dependent upon weather and climate in order to produce the food and fiber necessary to sustain human life (Yohannes, 2016). While there will be positive and negative impacts with large uncertainty, most studies show that climate change for agriculture at global level is more harm than good (IPCC, 2012). Currently, many tropical diseases of crops, severe pest attacks and weeds are common and contribute to a reduction in yields of crops. Crops that are excellent competitors under stable environmental conditions often cannot survive when their habitat is altered by rapid change. Instead parasitic species such as weeds, rodents, insects, bacteria and viruses will quickly reproduce and colonize the disturbed environment. The buildups of these organisms have an adverse effect on crop yields and food supply (Alawa *et al.*, 2014).

According to (Megersa *et al.*, 2014) climate change and variability can severely constrain the productivity of pastoral herds by reducing water availability, forage production and quality, and hence the carrying capacity of rangelands. In particular, the risk of heavy livestock losses suffered during recurrent severe droughts associated with climate change and variability presents one of the most serious threats to pastoral livestock keepers. These were associated with a similar underlying trend in precipitation with recurrent droughts causing a substantial reduction in the cattle population. Climate change also has an impact on irrigation farm. If climate change reduces water supplies and increases water demand, water may become scarce. Farmers may well find that they cannot pay for or obtain the water they would need to irrigate. Farmers may be forced to switch from irrigated to rain-fed acreage (Mendelsohn, 2008).

Sea levels rise

Climate change can lead to a significant rise in sea level and catastrophic events with implications on migration and the capital stock (Jamet and Morlot, 2009). Because warming causes the ocean to expand and snow and glacial ice to melt, one real threat is a rise in sea level. There may be some compensation through increased snowfall on top of the major ice sheets so that they could increase in height even as they melt around the edges. Example: Greenland and Antarctica. Sea level is observed to be rising by 1 to 2 mm/year, and this rate should increase, so that there are prospects for about a 50-cm rise in sea level by 2100, but the main impacts are not likely to be felt until the 22nd century (Trenberth *et al.*, 2000). According to (Jamet and Morlot, 2009) an increase in temperature by 1.5°C relative to pre-industrial levels would initiate the melting of the Greenland ice sheet that could lead to a 7m sea-level rise and coral bleaching.

Extreme Events

The way in which an organization may be affected by changes in climate is not only through direct changes in climate variables such as temperature and precipitation, but also changes in extreme weather events, such as heat waves, droughts, storms, flooding and wildfires (Bowyer *et al.*, 2014). Increasing frequency and intensity of extreme events particularly: – droughts during the summer month and El Nino events, increase in extreme rainfall and winds associated with tropical cyclones in East Asia, Southeast Asia and South Asia, intense rainfall events causing landslides and severe floods, heat waves/hot spells in summer of longer duration, more intense and more frequent, particularly in East Asia (UNFCCC, 2007). According to Trenberth *et al.* (2000) El Nino events are associated with much larger-scale changes across most of the Pacific Ocean. These changes in turn alter weather patterns around the globe through changes in the atmospheric circulation. The major floods in the summer of 1993 in the upper Mississippi River basin were partly caused by El Niño.

Impacts on Marine and Terrestrial Ecosystems

In less developed countries, the daily struggle for essential goods make dependency more real, despite the lack of knowledge, organization and/or financial resources to deal with the problems imposed on ecosystems by climate and anthropogenic changes (Anastácio and Pereira, 2017). Climate change is an added stress to already threatened habitats, ecosystems and species in Africa, and is likely to trigger species migration and lead to habitat reduction. Ultimately, the climate-related impacts on one species may have cascading effects on other species within an ecosystem. In such case, it 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 patterns are likely to lead to severe water shortages and/or flooding. Melting of glaciers can cause flooding and soil erosion.

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 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). Generally climate change has an impacts on ecologically by shifting of vegetation types and associated impacts on biodiversity; change in forest density and agricultural production; expansion of arid land; decline in water quantity and quality; and stresses from pests, diseases, and wildfire (Alavalapati *et al.*, 2011).

Impacts on Rural Community

Important characteristics of rural society make it vulnerable to climate change impacts and affect how the risks and costs may be distributed among different regions. The Salient social impacts may include changes in employment, equity, risk distribution, and human health, and relocations of populations. Economic impacts include increased risk and uncertainty of forest or agricultural production, alteration in productivity for crops and forest products, reduction in supply of ecosystem goods and services, increased cost of utilities and services, and altered energy needs (Alavalapati *et al.*, 2011). It will also affect human health through both direct and indirect pathways. Direct impacts will result from increased exposure to temperature (heat waves, winter cold) and other extreme weather events (floods, cyclones, storm surges, droughts) and increased production of air pollutants and aeroallergens such as spores and molds (USGCRP, 2009). 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 (UNFCCC, 2007).

Adaptation Strategy

Improving Agricultural practice

An exogenous technological change which justified by a long history of crop improvements over time as a result of agricultural research (new varieties) and enhanced crop inputs; global crop yields are expected to improve by 1% per year (Herrero *et al.*, 2010). The adoption of appropriate tillage operations such as zero or minimum tillage can sequester soil organic carbon and reduce its release to the atmosphere to add to the existing stock of gases. In addition, it further check soil erosion and associated dangers thereby conserving soil nutrients for greater yields of crops which would in turn address the food insecurity of the nation (Alawa *et al.*, 2014). Soil water balance is important for the water management and water use strategy. It is necessary to know how much water can be used in each irrigation area and the river basin, when the water is available and how much water can be stored for use in the drought period, quantify variability of water resources over a long-term basis and associated links with energy and biodiversity (Kang *et al.*, 2009).

Adaptation integration into policy: The Role of Government

According to Alawa *et al.* (2014), there is every need for government to be actively involved in the mitigation and adaptation to global climate change in design and implementation of good overall development policies and programs, increased investment in agricultural productivity, reinvigoration of national research and extension programs, improvement of global data collection, dissemination and analysis, lending support for community-based climate change adaptation strategies and funding of climate change adaptation program. Generally, as they report, given the current uncertainty about the location and specific effects of climate change, good development policies and programs are among the best climate change adaptation investments.

Productivity enhancements that increase farmers' resilience in the face of climate change pressures will likely have similar poverty-reducing effects. Rural infrastructure is essential if farmers are to take advantage of improved crop varieties and management techniques. Higher yields and more cropped areas require maintaining and increasing the density of rural road networks to increase access to markets and reduce transaction costs. Investments in irrigation infrastructure are also needed, especially to improve the efficiency of water use. Policies should be positioned to encourage extension agent those actively work with communities in that specifically address climate change adaptation, which include disseminating local cultivars of drought resistant crop varieties, teaching improved management systems and gathering information to facilitate national research work. In addition to this, farmer organizations can be effective information-sharing mechanism and have potentials to provide cost effective links between government efforts and farmer activities.

Table 1. Type and examples of adaptation options at different level in agriculture.

Adaptation	Examples	Implementation
Technological development	<ul style="list-style-type: none"> • crop development • Weather and climate information systems • Resource management innovations 	<ul style="list-style-type: none"> • public and private investment in new crop varieties and hybrids to increase tolerance to heat and water stress or other relevant adverse condition • public and private investments in monthly and seasonal forecasting, and early warning systems • public and private investment in water management innovations to address moisture deficiencies and risk of drought and changing seasonality of precipitation
Technological adoptions	<ul style="list-style-type: none"> • Farm production innovations • Land use changes • Irrigation • Timing of operations 	<ul style="list-style-type: none"> • Diversification of crop type and varieties including crop substitution. Diversifying livestock types and breeds and changing seasonality of feedlot practices • changing location of crop and livestock production and fallow rotations to address economic risk associated with climate change • Implement on-farm irrigation practices to avoid recurrent drought risk • changing timing of operations to address changing duration of growing seasons and associated changes in temperature and moisture

Source: Adapted from Smit and Skinner (2002).

Funding for national statistical program should be increased so that they can fulfill the task of monitoring global change. International development agencies and national government should work to ensure that technical, financial and capacity-building support reaches local communities. They should also encourage community participation in national adaptation planning processes.

While national adaptation policies and strategies are important, the implementation of these strategies at the local level will be the ultimate test of the effectiveness of the adaptation. National budgetary allocation for climate change adaptation and other disasters should be substantially increased to cope with the challenges whenever they occur (Alawa *et al.*, 2014).

Capacity-building, education and training and public awareness

Community based adaptation strategies can help rural communities to strengthen their capacity to cope with disasters and improve their livelihoods (Alawa *et al.*, 2014). The probabilities of perception of climate change are greater for those who have higher educational attainment compared to less-educated or illiterate farmers. It is apparent that educated farmers have more knowledge, ability to understand and respond to expected changes, able to forecast future scenarios and have greater access to information and opportunities than others. These issues lead to the farmers who perceive more about climate change (Uddin *et al.*, 2017).

Local coping strategies

The impact assessment of climate change on agriculture in Asia and agricultural exports in the United States (US), farmer's adaptation measures through crop diversification and investing irrigation in coping with extreme weather events in China, and finances in mitigation of and adaptation to climate change for sustainable agricultural development (Kun, 2014). Subsequent analyses of adaptation reveal that farmers in Africa and South America make very many important adaptations in response to climate (Mendelsohn, 2008). In Africa rural farmers have been practicing a range of agricultural techniques as coping strategies and tactics to enable sustainable food production and deal with extreme events. These include intercropping and crop diversification; use of home gardens, diversification of herds and incomes, such as the introduction of sheep in place of goats in the Bara province in Western Sudan, pruning and fertilizing to double tree densities and prevent soil erosion in semi-arid areas, e.g. Senegal, Burkina Faso, Madagascar and Zimbabwe; manipulation of land use leading to land use conversion, e.g. a shift from livestock farming to game farming in Southern Africa; water conservation techniques to cope with arid conditions such as the Zia technique in Burkina Faso: farmers dig pits in the soil to collect organic material carried by the wind during the dry season, at the start of the rainy season farmers add organic matter from animals which attracts termite activity resulting in termite tunnels that can collect rain deep enough that it doesn't evaporate and thus increasing soil fertility (UNFCCC, 2007).

Reducing the sensitivity and altering the exposure

Reducing the sensitivity of an affected system, which can be achieved, for example, by investing flood defenses or increasing reservoir storage capacity; or insuring that infrastructure in flood-prone areas are constructed to allow flooding; while altering the exposure of a system to the effect of climate change can be achieved, for example, by investing in hazard preparedness and early warnings, such as seasonal forecasts and other anticipatory actions (Wreford *et al.*, 2010).

Increasing the resilience

Increasing the resilience of social and ecological system can be achieved through generic actions aim to conserve resources, but also include specific measures to enable specific populations to recover from loss (Tompkins and Adger, 2004). This indicates that, when social and environmental conditions are able to cop up with uncertainty, the impact will be minimized. Even this helps to increase climate change adaptation strategies by itself.

CONCLUSION

The impacts of climate change such as rising global average temperature and changes in precipitation are undeniably clear with impacts already affecting ecosystems, biodiversity and human systems throughout the world. Future impacts are projected to worsen as the temperature continues to rise and as precipitation becomes more unpredictable. Although climate change may result in some benefits such as extended growing season or more moderate temperature in some areas, the overall effects are likely to be harmful. Societies, cultures and economies in the world's history have successfully developed by mastering their abilities to adapt to climatic conditions. Against the very unfavorable economic scenarios of the last decades, farmers around the world have been struggling to maintain their income by continuously trying to increase yields in their production systems. But these higher productive systems have often become more vulnerable to climate variability and climate change. These existing pressures demand the development and implementation of methodologies to address issues of vulnerability to climate for assisting farmers and policy makers of different sectors to further develop their adaptive capacity with improved planning and better management decisions. Adapting to climate variability and change is an issue of climate risk management, where an organization seeks to reduce any potential threats, and make the most of any opportunities that may arise as a result of climate change. This risk management entails developing and implementing adaptation strategies and actions. Adaptation is however, a complex, highly context specific, multifaceted issue. Aspects of adapting to climate change range from having or developing an awareness of the need for adaptation, and understanding the adaptation issue at hand, planning strategies and actions for dealing with these issues, implementing them, and then monitoring and reviewing their performance, as well as the risks themselves, as they change over time.

RECOMMENDATION

- ✓ Sustainable development cultures in most sector those amplify climate change by adding causes to climate change should be given priority and agriculture should not be seen as "business as usual".
- ✓ Government should be proactive in their policies to be ready for ecological challenges that occur mostly unplanned.
- ✓ Ecological funds should be raised as the magnitude of ecological disasters is usually not certain and difficult to control.
- ✓ Create stronger links between global policy and local-level realities and innovations.
- ✓ Ensure that climate change policies are informed by the voices of the women and men who deal with the consequences of climate change every day.
- ✓ Developed economies should assist developing countries, especially African countries, adequately to combat the climate change menace in order to help achieve the sustainable development especially in Africa.
- ✓ Government and development partners should do more to help farmers adapt to changes in the climate to help sustain social livelihood.

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