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Research Article

Review of Potential Impact of Climate Change on Natural Resource and Livelihood of Farmers in Highland of Ethopia

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INTRODUCTION

Background and Justification of the Review

Climate change refers to a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decade or more (IPCC,2007). Global climate change is the hottest environmental issue today and will continue in the future because of its devastative impacts in different ways (Temsegen etal., 2014). It is caused by both natural factors 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 in the globe (Temsegen etal., 2014).

Africa has been identified as one of the parts of the world most vulnerable to the impacts of climate change, the continent is already suffering from food insecurity and malnutrition (IPCC, 2014). Some studies in Africa highlighted that about 23 million people in 11 African countries are affected by acute food insecurities and facing malnutrition (IPCC,2007). In SubSaharan Africa, more than 60% of the economically active population and their dependents rely on agriculture and natural resource extraction for their livelihoods, although the share of agriculture in GDP is decreasing, the share of agriculture in employment is still high but it is sensitive to climate change (Mahendra, 2011).

The climate of Ethiopia is characterized by showing high variability annually, seasonally and geographically. Especially the amount and seasonal distribution of precipitation are varying annually and difficult to predict, while the temporal distribution of rainfall during the growing season is an important factor influencing crop yield and forest product (Evangelista et al., 2013; Tadege, 2007). Rains can be delayed by several weeks or stop during critical germination periods, leading to short- and long-term droughts with crop failures, food shortages and famines, when occurring during the dry season, rainfall can facilitate the spread of diseases on crops, forest and livestock (Evangelista et al., 2013). Livelihoods of farmers in Ethiopia is highly influenced by these climatic conditions and has a long history of coping with extreme weather events, increasing temperature and higher variability in rainfall will influence Ethiopia‟s agriculture is expected to worsen the existing conditions, which could.

Highlands of Ethiopia is vulnerable to climatic variability owing to its low adaptive capacity: this can be explained by the low level of socio-economic development, high population growth, inadequate infrastructure, lack of institutional capacity and high dependence on climate sensitive, natural resource-based activities (NMA, 2007). Like any other developing countries, Ethiopia has two independent options to respond to climate change mitigation and adaptation, given the low level of industry sector, mitigation would not suit to Ethiopia for it deters the growth spurs that has registered in the last few years: instead, adaptation measures such as use of different crop varieties, tree planting, soil conservation, early and late planting, and use of irrigation should be taken by farmers to adapt to climate change (Temesgen etal., 2008).Therefore, the objective of this paper is to review the impact of climate change on natural resource and livelihood of farmers in Ethiopia.

LITRATURE REVIEW

Climate Change and Variability in Highlands of Ethiopia

Impact of Climate Change on Agriculture

Agriculture is the most important sector in sub-Saharan Africa, but it is predicted to be negatively impacted by climate change. It is clear that climate change will bring about substantial welfare losses especially for smallholders whose main source of livelihood derives from agriculture (Paulos Asrat & Belay Simane, 2018). Changes in climate extremes are already having impacts on social, economic and natural systems, and future changes associated with continued warming will present additional challenges (Karl et al., 2008).

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Using the single-index approach, the study results indicate that the combined riskiness of crop portfolios at a household level responds negatively to annual rainfall variability, while seasonal rainfall variability has less consistent impact. Farmers are more likely to select less risky crops with less return, even when intercrop interactions are taken into account (Bezabih, Di Falco, & Yesuf, 2011).

The intensity of tropical cyclones (Knutson, McBride, Chan, & Emanuel, 2010) and frequency of heavy precipitation events are very likely to increase over many areas during the twenty-first century, with consequences for the risk of floods. At the same time, the proportions of arid lands are projected to increase, in addition to a tendency for drying during summer, especially in the subtropics, low and mid latitudes (Bates, Kundzewicz, Wu, & Palutikof, 2008). The vulnerability of these sensitive regions to impacts of hydrometeorological disasters, in terms of loss of assets and economic value, has increased dramatically over the past few decades despite ongoing efforts in several sectors including agriculture (Mills, 2005).

Climate change causes 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. Changes in rainfall pattern are also likely to lead to severe water shortages and/or flooding. Rising temperatures also 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. Temperature increases will potentially severely increase rates of extinction for many habitats and species (UNFCCC, 2007).

Climate change causes the frequency and severity of weather events. Some indirect effect of climate change includes, changes in soil moisture, land and water condition, change in frequency of fire and pest infect, and the distribution of diseases. The potential for a system to sustain adverse impact on agriculture is determined by its capacity to adapt to the changes. Higher temperatures, reduced rainfall, and increased rainfall variability reduce crop productivity that would be affected food security in low income and agriculture-based economies. Thus, the impact of climate change is detrimental to countries that depend on agriculture as the main livelihood (Edwards-Jones, Plassmann, & Harris, 2009).

According to study of Deressa (2006) for Ethiopia, by using Heckman sample selection model both increasing temperature and decreasing precipitation are damaging Ethiopian agriculture. According to FAO (2011), climate change has strong impact on the agricultural sectors and forestry by modifying or degrading productive capacities and by directly and indirectly increasing the risks associated with production.

Impact on Soil Organic Matter and Soil Quality

Projected climate change may affect soil moisture and temperature regimes. At the ecosystem level, the soil affects vegetation through its influence on water availability, elemental cycling, and soil temperature regime. Changes in soil moisture and temperature regimes can affect species composition in the ecosystem. These changes may affect the soil organic carbon pool and soil physical properties because of the changes in biomass (detritus material, above ground and below ground biomass) returned to the soil. The effect of climate change may be different in tropical, temperate, and boreal regions. Projected increase in temperature and decrease in effective rainfall may decrease the net primary productivity (NPP) in many tropical regions, but increase it in the boreal forest regions (Lal, Follett, Stewart, & Kimble, 2007).

According to Tripkovic (2014), the following threats were identified that influenced by climate change. Firstly, "Soil erosion by wind and rain affects both the productivity of soils but also water quality and aquatic ecosystems. Second, Compaction of soil reduces agricultural productivity and water infiltration, and increases flood risk through higher levels of runoff. Finally, the loss of soil organic matter reduces soil quality, affecting the supply of nutrients and making it more difficult for plants to grow, and increases emissions to the atmosphere."

Impacts on Groundwater Availability

In most cases, groundwater supplies are directly linked to surface water and rainfall, with groundwater recharging through soil infiltration. When surface water sources become insufficient due to decreased replenishment and/or increased evaporation rates, groundwater exploitation increases. However, groundwater recharge rates generally are insufficient to meet sustainable demand, leading to decreased water quality and increased pumping depths (and associated increased costs) (Bukantis & Rimkus, 2005). The water resources sector will be affected by climate change through a decrease in river run-off, a decrease in energy production, as well as increased floods and droughts.

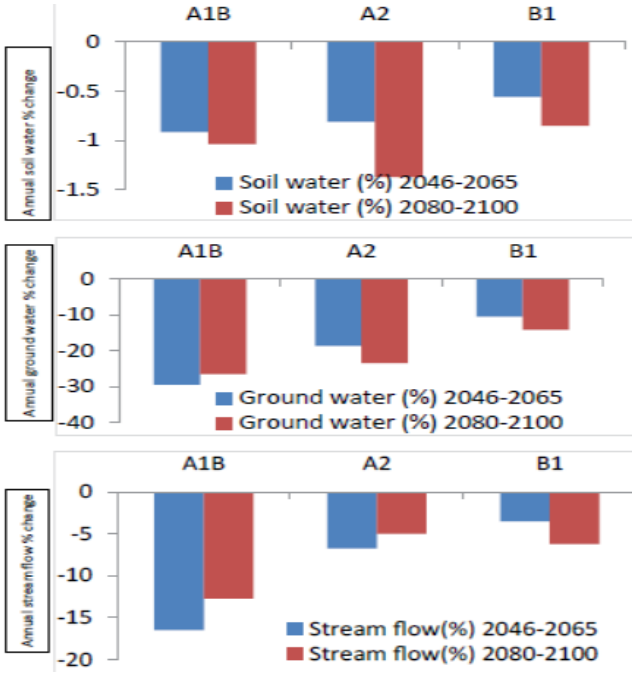

Figure 1: Projected annual percent change in soil water, ground water and stream flow due to changes in climate by 2046-2065 and 2080-2100 periods in the Northern Highlands of Ethiopia source : (Setegn, et al.,2011).

Ponds are drying up quickly after the end of the rains during the dry season due to increased evaporation resulting from increased temperature (Woldeamlak etal., 2015). Similarly, the Borana pastoralists indicated that they face a critical water shortage due to climate change. They indicated that there is critical shortage of rainfall (unreliable, less intensity and duration), and hence ponds do not fill to their capacity and dry out fast, streams and rivers disappeared and boreholes dried out (Zelalem etal., 2009). Dependent on availability (volume stored or recharged in the aquifer), access (springs, wells or boreholes) and demand (linked to livelihoods strategies). In most areas, the key determinants of water security will continue to be related to access rather than availability (USAID, 2015). While quantifying the relationship between climate change and groundwater availability is complicated, what is clear is that changes in rainfall and evaporation translate directly to changes in surface water infiltration and groundwater recharge rates (MacDonald et al., 2001).

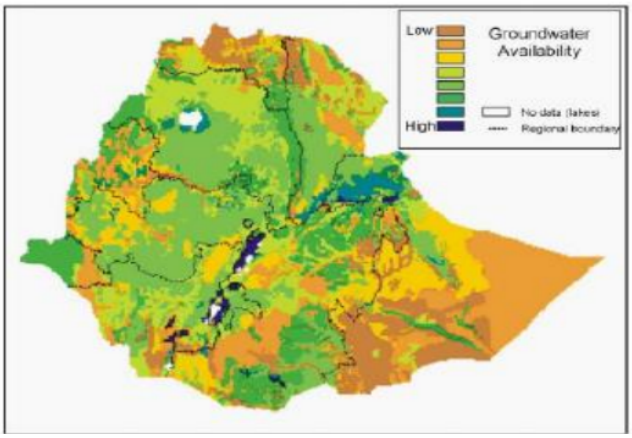

Figure 2: Map showing the estimated distribution of groundwater availability in Ethiopia source : (MacDonald etal., 2001).

Impact of Climate Change on Biodiversity

The vegetation of Ethiopia comprises over 7000 species out of which over 475 are endemic to the country It also harbors divers fauna including 240 species of mammals and 845 species of birds ,of which 22 species of mammals and 24 species of birds are endemic (setegn ,2016). Biodiversity is an important resource having a dual purpose of utilization; consumptive use (food, fiber, fuel, shelter, medicine and wild life trade) and non-consumptive use (ecosystem services and economically important tourism industry). Given the heavy dependence of Ethiopia on natural resources, many communities are vulnerable to the biodiversity loss that could result additionally due to climate change. The use of fire as a management tool for slash-and-burn agriculture and other purposes results in at least a third of the savanna being burned every year (IPCC, 2001).

Impacts on Livestock Production

While the direct effects of heat stress on livestock have not been studied broadly, warming is expected to alter the feed intake, mortality, growth, reproduction, maintenance, and production of animals. Collectively, these effects are expected to have a negative impact on livestock productivity (Thornton et al., 2009 cited in EACC). Chickens are predominantly vulnerable to climate change because they can only tolerate narrow ranges of temperatures beyond which reproduction and growth are negatively affected. Further, increases in temperature caused by climate change can be exacerbated within enclosed poultry housing systems (Zeray & Demie, 2016).

Impact of Climate Change on Rural Livelihoods

The major and almost the exclusive livelihood activities of the rural Ethiopia are crop production, livestock rearing, natural resource extraction, and only less than small percentage engaged in off-farm activities (WFP,2015). Livelihoods in Ethiopia are highly complex due to the varied differences in topography, rainfall patterns, and population density. Despite the complexity of livelihood systems in Ethiopia, it is possible to understand risks and vulnerabilities by focusing on three main livelihood zone types: cropping (mostly located in the northern and western parts of the country), pastoral (mostly located in the eastern and southeastern parts of the country), and agro pastoral (mostly located at the margin between the two) (WFP,2015).

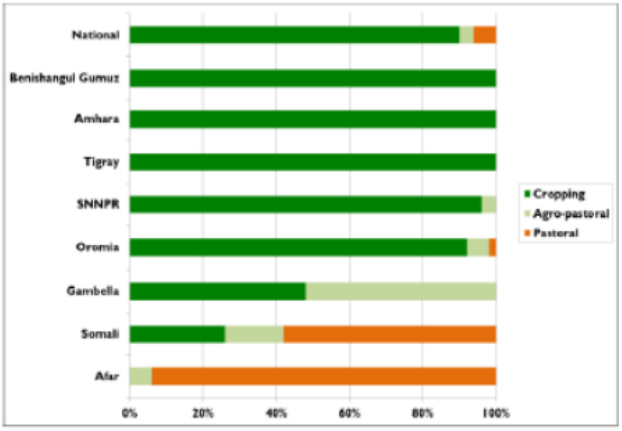

Figure 3: Proportion of crop cultivation, agro-pastoral, and pastoral populations by region. (Source: CSA, 2012).

The graph describes major livelihoods in Ethiopia pastoralists account for 6 per cent of the total population, agro pastoralist"s account for 5 per cent, and cultivators account for over 89 per cent. In both Afar and Somali, the majority of people are pastoralists. In Gambella, agro pastoralism and livestock rising account for approximately half of households" livelihood activities. Research in northeastern Ethiopia shows that some pastoralists have shifted to agro- 20 pastoralism – this trend can be explained by the impact of climate-related shocks (drought resulting in lack of stock feeding), economic factors (increase in poverty rates) and demographic pressures (rapid population growth) (Tolossa, 2008). The sensitivities of the major livelihood systems, as well as the major climate-related hazards is indicated below.

CONCLUSION AND RECOMMENDATION

Conclusion

The Highlands of Ethiopia is one of the most vulnerable parts to climate variability and changes due, its high dependence on rain-fed agriculture and natural resources. The country is indeed rated as among the most vulnerable to climate change as a result of its low adaptive capacity. Emissions from agriculture and energy sectors are two sectors which are major emitters in Ethiopia which accounting for 85% and 15% of the total gas emission respectively. Climate change negatively affecting soil water balance, ground water and subsequently stream flow and Ponds are drying up quickly after the end of the rains during the dry season due to increased evaporation resulting from increased temperature. Given the heavy dependence of Ethiopia on natural resources, many communities are vulnerable to the biodiversity loss .Change in the climatic condition results in increasing the fire risk of the forest because when there is drier conditions will increase the risk of fire, making forest fires more frequent and intense, resulting in degradation and create conditions that are more favorable for invasive species.

One of the major expected effects of climate change on crop production in Ethiopia is relocation of suitable area of production for different crops, plant species are forced to relocate growing areas to remain within optimal thermal zone as species relocate habitat area, there may be net gain or loss of area of adaptation and production. Similar to crop production, the impact of climate change and variability in the livestock production is generally negative. Heat stress and its impact on seasonal water availability have a variety of detrimental effects on livestock, with significant effects on milk production and reproduction in dairy cows, and swine fertility.

The government of Ethiopia has set adaptation measures like increase irrigated area, increase research and development for agriculture, Modify plans for expansion of hydroelectric power (volume or timing of investment) And Build climate resistant road infrastructure. There are also a lot of techniques which helps to reduce the concentration of carbon di oxide including

Recommendation

With the ever increasing weather unreliability, strong dependence on climate sensitive sector and continued water deficit, the involvement of institution on Early warning system, information management, community-based disaster preparedness, and humanitarian actions are going to be critically essential to substantiate enabling environment for climate change adaptation and these are becoming under implementation particularly in drought prone and vulnerable areas of the country.

The vulnerability of mid and lowlands is a grave concern in future and intervention is needed to address water shortage, e.g. irrigation and scaling up traditional water harvesting.

Using effective level of fertilizer input under increasing land scarcity, improving the efficiency of inorganic fertilizer and promoting sustainable cropping practices is crucial to reduce social vulnerability. Since livestock rearing and crop production are inseparable activities in Ethiopia, use of organic fertilizer should also considered since it provides a comparative advantage for the country due to its ease availability, less cost, better yield, better long-term restoration of soil fertility and moisture.

Alleviate landlessness and unemployment by enhancing the micro-financing efficiency, creating employment opportunities and sustainable and well-studied resettlement programs Sustainable on-land diversification should be promoted to cope with the future likely climate change impacts.

Promotion of development programs and addressing vulnerable groups through development of better proxy indicators of societal vulnerability, addressing them from short and long term perspectives.

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