Negative Impact of Climate Changes and Its Coping and Adaptation Strategies in the Lowland Areas of Ethiopia; A Systematic Review (July, 2014)

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Introduction

Climate change is a global problem with a profound impact in poor countries of eastern Africa like Ethiopia whose contribution to green house gas emission is insignificant (Thompson *et al.,* 2010). The inter governmental panel on climate change (IPCC) report of 2007 indicated that Africa will be one of the hardest hit regions by the impact of climate change although its contribution to total carbon dioxide (CO_2) emissions is low (3.6 %).

Climate related hazards in Ethiopia include loss of biodiversity, rangeland degradation, disease breakout and increasing vector born disease, drought, floods, heavy rains, strong winds, frost, heat waves (high temperatures), lightning, etc. Though the historical social and economic impacts of all of these hazards is not systematically well documented the impact of the most important ones namely droughts and floods is discussed. Ethiopia is highly vulnerable to drought. Drought has been the single most important climate related natural hazard affecting the country from time to time. It occurs anywhere in the world but its damage is not severe as in Africa in general and Ethiopia in particular. Recurrent drought events in the past have resulted in huge loss of life and property as well as migration of people (Kidus, 2010).

This particular review focuses on the lowlands areas of the country which cover about 78 million hectares and accounting for about 61–65% of the total land and found below 1500 meter above sea level (masl), (Friedel *et al*., 2000). It is home for about 12-15% of the human and 26% of the livestock population (Beruk and Tafesse, 2000). The rainfall of the area ranges from 200 to 700 mm annually with length of growing period of 90 to 180 days (kidane *et al*., 2009).

Degradation of the lowland areas of natural resources as a result of flooding and the prevalence of wind due to climate disorder soils become eroded. The fertility of the soil diminishes, there by resulting in the weakening of their beneficial capacity. This causes more damage in those parts of our country exposed to desertification. The geographical distribution of such areas in Ethiopia is extensive. The irregularity of rainfall results in water shortage. The biodiversity of water resources diminishes both in quantity and quality, as, for example, the damage inflicted on fish resource as a result of the depletion of water resources. This means that a good majority of the population will be deprived of a cheap, protein-rich food source which the people themselves fish or procure for less. The sustenance of vegetation cover is directly linked to climate change. Just as much as climate change causes damage to the country's biodiversity, so also does the loss of biodiversity cause disruption in climate. Any hazard befalling the environment results in the degradation of the fauna-flora habitat. It is also the case that, because of flooding and increase in temperature, both humans and animals will migrate to other locations. Even if some of them somehow manage to hang on in the affected location, they can only do so at the expense of their members. On the other hand, it is doubtful that those people and animals who happen to inhabit mountainous areas could find suitable locations to which they can migrate (Kidus, 2010). Putting in to consideration of the above hypothesises; this review was carried out with the general objective of reviewing the impact of long-term climate change on lowland areas of Ethiopia and the specific aims of the review was ;

- To review the negative impact of climate change on the lowland areas of the country
- To review the Coping and Adaptation strategy of climate change on the lowland areas of the country
- To review Ways forward on the negative impact of climate change on the lowland areas of the country

Review of Literature

Climate Change: Negative Impact, Coping and Adaptation Strategy

Negative Impact of Climate Change

Loss of Biodiversity

The lowland areas of Ethiopia are home of wide variety of flora and fauna. Vegetation, livestock, wildlife and their products are major rangeland resources of the country. Agricultural biodiversity in Ethiopia is the basic component of sustainable production and food security in marginal areas. It is the basis for human survival. However, due to the progressive global climate change in most arid and semi arid regions predominant losses of biodiversity have been underway (Adugna**,** 2009). It also accelerates the loss of genetic and cultural diversity a result of globalization in crops as well as domestic animals. A 2.5 °C increase in global temperature will result in major losses: 20-30% of all plant and animal species assessed could be at high risk of extinction (IPCC, 2007). Ecosystems and species show a wide range of vulnerabilities to climate change, depending on the imminence of exposure to ecosystem-specific, critical thresholds, but assessments are fraught with uncertainty related to CO_2 fertilization effects etc. Local and rare breeds are at risk of being lost through the impact of climate change and disease epidemics. There are global health implications related to biodiversity loss and many of the anticipated health risks brought about by climate change will be caused by loss of genetic diversity (Kidus, 2010).

Changes in Rangeland Productivity

Rainfall, solar energy and temperature are key determinants of rangeland productivity. The effect of future climate change projections on the length of the growing period (LGP), which integrates the influence of temperature and rainfall on productivity, results in a number of potential impacts, including changes in the length of the growing season for certain agricultural activities. The combined impact of changes in temperature and rainfall will result in a decrease of LGP in much of sub-Saharan Africa and in some cases this decrease will be severe. Areas where decreases in LGP >20% are predicted consistently include large parts of southern Africa, particularly where cropping is marginal, as well as a broad swath in the Sahel. A significant reduction in LGP by 2050 was also predicted in most models for the more arid parts of Ethiopia. However, there are competing analyses that suggest a more benign future for much of the indirect effects for example will be brought about by changes in feed resources linked to the carrying capacity of rangelands, the buffering abilities of ecosystems, increased desertification processes, increased scarcity of water resources and lower production of grain. Other indirect effects will be linked to the expected potential shortage of feed due to a rapid increase in production competition between food, feed, fuel and land use systems (Thornton *et al*. 2008). Increasing temperature can have varying effects, depending on when and where they occur. Increase in temperature during the winter months can reduce the cold stress experienced by livestock remaining outside. Furthermore, warmer weather reduces the energy requirements of feeding and keeping the animals in heated facilities (FAO, 2007).

Carbon four (C4) plants possess biochemical and anatomical mechanisms to raise the intercellular carbon dioxide concentration at the site of fixation, and this reduces, and sometimes eliminates, carbon losses by photorespiration. C4 plants inhabit hot, dry environments, have very high water-use efficiency, so that there can be up to twice as much as photosynthesis per gram of water as in Carbon three (C3) plants, but C4 metabolism is inefficient in shady or cool environments. Less than 1% of earth's plant species can be classified as C4. C3 plants, account for more than 95% of earth's plant species, use rubisco to make a three-carbon compound as the first stable product of carbon fixation. C3 plants flourish in cool, wet, and cloudy climates, where light levels may be low, because the metabolic pathway is more energy efficient, and if water is plentiful, the stomata can stay open and let in more carbon dioxide. Carbon losses through photorespiration are high. Grasslands, the mix between legumes and grasses could be altered (FAO, 2007)

Changes in Quality of Plant Material

Increased temperatures increase signification of plant tissues and thus reduces the digestibility and the rates of degradation of plant species. Resultant reduction in livestock production may have impacts on food security and incomes of smallholders, pastoraist and agropastoraists of Ethiopia. Interactions between primary productivity and quality of grasslands will demand modifications in grazing systems management to attain production objectives (FAO, 2007).

Changes in Species Composition

As temperature and CO_2 levels change, optimal growth ranges for different species also change; species alter their competition dynamics, and the composition of mixed grasslands changes. For example, the proportion of browse in rangelands will increase in the future as a result of increased growth and competition of browse species due to increased CO2 levels (FAO, 2007).

Changes in Livestock Production

In pastoral and agro-pastoral systems, livestock are key assets for poor people, providing multiple economic, social, and risk management functions. The impacts that climate change will bring about are expected to exacerbate the vulnerability of livestock systems and to reinforce existing factors that are simultaneously affecting livestock production systems such as rapid population and economic growth, increased demand for food (including livestock) and products, increased conflict over scarce resources (i.e. land tenure, water, biofuels, etc). For rural communities losing livestock assets might lead to the collapse into chronic poverty with long-term effects on their livelihoods. Among the direct effects of climate change for example, there will be higher temperatures and changes in rainfall patterns, translating in an increased spread of existing vector-borne diseases and macro parasites of animals as well as the emergence and spread of new diseases. In some areas, climate change also cause new transmission models; these effects will be felt by both developed and developing countries, but developing countries will be most impacted (FAO, 2008).

Impacts on Vector-Borne Diseases

Changes in rainfall pattern may also influence expansion of vectors during wetter years, leading to large outbreaks of disease (Rift Valley Fever virus in Ethiopia). Also climate Change. Helminthes infections are greatly influenced by changes in temperature and humidity. Climate change may affect trypanosome tolerance in: could lead to loss of this adaptive trait that has developed over millennia and greater disease risk in the future. Effects via changes in crop, livestock practices on distribution and impact of malaria in many systems and schistosomiasis and lymphatic filariasis in irrigated systems increases in heat-related mortality and morbidity (Patz *et al.,* 2005).Climate variation provides favorable conditions for malaria infection. Increase in temperature provides the proper condition for the proliferation of disease-causing microbes. The breeding of disease causing microbes and their longevity is very much dependent on heat and humidity. The proliferation or depletion of epidemics varies according to the auspiciousness or otherwise of the environment in which they exist. Water pollution that comes in the aftermath of floods renders people vulnerable to waterborne diseases. In such circumstances, the productive capacities of people with weak health conditions will be compromised. And the expenses incurred in the treatment of diseases and sicknesses will affect the capacity to create assets at the individual, household and country levels (Kidus, 2010).

Impacts Related Social Factors

The major impacts threatening the dry land communities are related to the environmental, natural resource base degradation and its associated climate variability and change and its social impacts and on the livelihood of the communities. The major key and pressing problem in these areas is the ongoing natural resource degradation, which leads to soil and vegetation loss, fertility decline, water stress, drying of water resources, lakes and rivers The other major challenge on all agroecologies but particularly important in the dry land areas is the ongoing climate variability and change. This is national, regional and global problem. The social problems include low economic capacity with limited capacity for investment, unstable environment, and great risk for agricultural production and high severity of poverty. The other challenges include poor health caused by inadequate diets, contaminated water, limited infrastructure. Most importantly farmers and herders value the large livestock size (irrespective of the land and grazing capacity) resulting in overgrazing which is one of major causes of land and natural resources degradation in the dryland. Additional problems of the dryland ecology include high diseases, pest, and weed infestation on crops, low productivity of grazing lands, no improved fodder crops, inadequate water and high prevalence of livestock diseases. Thus, agricultural production and productivity is generally low. As the result, local communities are confronted with serious food security and poverty problems with limited agricultural production. The over-riding factor limiting agriculture production and productivity in the dryland areas is climate change and variability (FAO, 2008).

Vulnerability of Humans to Health Risks and Other Hazards; Floods cause damage to waterworks, sewerage and other infrastructural resources. Hazardous chemicals as well as other disease-causing things could, for example, be washed off from waste disposal depositories or sip into flood waters thereby posing potential hazard to human health. People who have been displaced due to drought or the destruction of their homes by floods stay crowded in the same shelter until they are rehabilitated. When humans, animals, as well as activities, depend on the same limited water resource, the source will be exposed to pollution and become source for waterborne diseases. In such scenarios, before one instance of exposure has been taken care of, another instance of vulnerability could be created. In circumstances like these the damage caused by the second exposure proves worse than that caused by the first. If, for instance, a person whose residential house has been destroyed by flood counts on repairing his house and hanging out in the flooded area and all this because of lack of alternatives or lack of means and another flood hits the same area, then, the person will sustain more damage than that inflicted by the first flood (Kidus, 2010).

Irregularity of Rainfall Distributions

Rainfall distributions in the lowland of the country is low in amount, erratic, with uneven distribution, frequent drought is common experience. The rainfall is also generally concentrated in a few heavy storms with high intensity. Vegetation are scattered, degraded and very spares leaving the soil uncovered, In many drylands except the valley bottom the soils have low organic matter content, highly eroded, poor in fertility, The existence of high temperature with strong wind also causes high evapotranspiration rates and limit the moisture availability, In general the ecology is fragile and the environment is unstable (Friedel *et al.* 2000).

Climate change causes more damage to lands that are more vulnerable. Water shortage can occur on wetlands as a result of irregularity of rainfall seasons, due to increase in temperature, which causes loss of moisture through evaporation. The damage caused to wetlands through evaporation means loss of grass for thatching huts, fodder for cattle, breeding ground for birds, including, also, the area's tourist attraction value (Kidus, 2010). Moisture stress caused by inadequate and erratic rainfall makes water the most important limiting factor to meet both plant and animal requirements. Moisture shortages are further aggravated by high temperatures, leading to high evapotranspiration. The permanent water supply systems existing watering points are unevenly distributed that leads for dying of Micro organisms, plants and Animals (Alemayehu, 1998).

Drought Recurrent

Another natural disaster related to climate change in the lowlands is the frequent recurrence of drought. Livestock mortality during droughts is largely attributed to severe feed shortages and outbreak of diseases. The erratic and inadequate rainfall in the rangeland leads to forage biomass restrict that is poor in quantity and quality of forage productions (Kidane, 2005). Example1 The drought that took place in the year 1973/74 in the Afar region resulted in livestock mortalities of 90%, 30%, 50%, and 30% for cattle, camels, sheep, and goats respectively due to shortage of forage production and water (Ali, 1994). Example 2. During the 1991/1992 droughts in the Borana area, the average individual household lost about 79% of its cattle, 95% of its camels, 83% of its equines and 60% of its sheep and goats due to shortage of forage production and water (Alemayehu, 1998).

Conflict over the Rangeland Resources

Intra and inter clan conflicts over rangeland resources mainly grazing land and water points especially during the dry season has contributed to the decline of the resources. This is a common feature among the pastoral areas of Afar, Somali, Boran, Gambela and South Omo. Conflict not only denies resource usage, but also cost human and livestock losses (Beruk and Tafesse, 2000).The changes in natural resource use in Afar territory have had negative implications for the pastoral mode of production and culminated in resource use conflict (Ali, 1994).

Coping and Adaptation

The magnitude and direction of climate change especially of increasing temperature has critical impact on Ethiopian agriculture and its biodiversity which requires policy implication worth thinking. Policy for environmental protection and Genetic Resources and Community Knowledge conservation and sustainable utilization need to be adopted and enforced for proper implementation of impact assessment (Adugna**,** 2009).

Ecosystem Resilience

Understanding of functional biodiversity and 'keystone' species Maintain ecosystem functions and improved management more efficient and sustainable water use Less reliance on pesticides and herbicides Less overgrazing, more sustainable extraction More sustainable production systems More robust cropping systems Conservation of water resources Increased soil organic matter Salinity mitigation (Alemayehu, 1998).

Mitigation Measures

Increased carbon sequestration reduces green house gasses emissions from farms and natural habitats. In situ conservation of adapted biodiversity, on-farm conservation and crop management is curtailing measurement. Options to reduce vulnerability to changes in pathogen distribution increased biomass production better matching of adapted germplasm to climate variability (Alemayehu, 1998;Adugna**,** 2009).

Adaptation Measures

Better targeting of germplasm to specific environments, planting drought-tolerant & early-maturing crop varieties, introduction of new adapted commercial species or variety enabling environment for sustainable production practices enhanced uptake and impacts of improved technologies, Adaptation strategies focused on vulnerable regions, improved ecosystem management for long term sustainability, seasonal changes and sowing dates water supply and irrigation systems Conservation tillage practices: planting of cover crops, organic farming and green manure crops/composting, improved climate information and informed decision making short-term prediction to refine coping strategies, educating climatic conditions, improved prediction of pest and disease infestations, increased drought preparedness Wide range of production system options, production systems adapted to climate variability, production systems sustained despite of the use of marginal-quality of water, production systems under higher soil organic matter to reduce risk crop failure from floods, drought (Alemayehu, 1998, Adugna**,** 2009).

Ways Forward

Climate change will undoubtedly have significant impacts on pastoralists, but they need to be discussed in a nuanced way, without assuming pastoralists' absolute vulnerability or intrinsic ability to adapt. There are important knowledge gaps on what forms these will take and what can be done to help pastoralists adapt to them, and how pastoralists fit into discussions of climate change mitigation. Pastoral development needs much more nuanced research into the impacts of climate change, including more specific discussion of potential biophysical impacts such as bush encroachment under CO_2 fertilization, and new patterns of animal disease. There is a need for research and programming on the dissemination of climate information and information climate impacts - to pastoralists themselves and to a range of stakeholders involved in policy-making, governance and service provision, over various timescales from seasonal to long-term. There is also a need for more in-depth research on the contribution of pastoralism (and extensive livestock production in general) to greenhouse gas emissions, and the feasibility (bio-physical, economic and institutional) of mitigation measures through carbon-sequestration. Action can be taken now to increase pastoralists' resilience to climate change. Building resilience goes hand-in-hand with good practice in pastoralist development helping pastoralists manage drought and other extreme events, fostering livelihood diversification and education, and giving pastoralists a voice through empowerment and good governance

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