Lessons Learnt on Forestry as an Instrument to Reduce Impacts of Climate Change in Tanzania: A Review

Emmanuel Patroba Mhache
The Open University of Tanzania,
Faculty of Arts and Social Sciences,
Department of Geography,
P.O. Box 23409, Dar es Salaam.
E-mail: ngorora@yahoo.com

Abstract: *This paper presents the role and contribution of forest in controlling climate change in Tanzania and globally. Apart from climate change control, forests contribute to the survival of the human being; they provide shelter for wildlife and food for people, fodder to livestock, water, medicinal plants and fuel as well as other indirect benefits. Indirect benefits include regulating climate, attracting rainfall, soil erosion control and provide shade. Despite these benefits, evidence shows that some of the most adverse effects of climate change are in developing countries, where populations are most vulnerable and least likely to easily adapt to climate change. However, climate change will continue affecting the development efforts in developing countries. Climate change is happening and is increasingly affecting the poor depending on nature for their survival. The negative effects of climate change are compounded by widespread poverty, diseases and population increase. These effects are obvious to Tanzania in particular. Literature has shown that climate change would double the demand for food; water and livestock forage within the next 30 years. Tanzanian is advised to use forest resources sustainably, protect forests and plant trees as they are very important for human life. Above all, forest is an important sink for removing carbon dioxide from the atmosphere. Forests or vegetations absorb carbon dioxide in the atmosphere and release oxygen to the atmosphere.*

Key words: Forestry, Climate change, Vulnerability, Tanzania

INTRODUCTION

Tanzania came into existence in 1964 after Tanganyika and Zanzibar were united. Tanzania is the largest country in East Africa, covering an area of 945,200 km^2, 60,000 km^2 of which is inland water. Tanzania lies close to the equator in the East coast of Africa between parallel 1^0S and 12^0S and meridians 30^0E and 40^0E. It is located along the Indian Ocean. By being close to the equator, the climate variations in temperature are not extreme. The country area includes water bodies, forests, woodlands and mountainous landscapes (Kihiyo, 1998). Forest is one of the major and important natural resources in the country which contributes to the human welfare and protection of natural systems.

Universally, forests play a great part in regulating climate, slowing soil erosion, controlling flow of water, and storing it as well as regulating its flow into rivers and lakes (Sharma, *et al.* 1994). Like other developing countries, Tanzania forests play a

very important role in the survival of human being. It provides building materials; food, fodder, medicinal herbs, fuelwood and it is a source of water. Moreover, forests sustain human being culturally, spiritually and has religious value (Burgess and Clarke, 2000). Above all, forests are important sinks for removing carbon dioxide from the atmosphere (Sharma *et al.* 1994; Lugo and Brown, 1992). Under the Kyoto Protocol, forestry is permitted as a sink measure under the Clean Development Mechanism (CDM), but only in the form of 'afforestation' and 'reforestation' (Skutsch, 2003).

CLIMATE CHANGE AND ITS IMPACTS TO TANZANIA

Climate change is one of the most significant global challenges facing human society in the 21st century. Different studies have shown that some of the most adverse effects of climate change are experienced in developing countries, where human beings are most vulnerable and least likely to adapt to climate change. However, climate change is affecting the development process in most developing countries. Changes in temperature, water supply and its quality have a negative impact on agricultural production, human settlement, forestry and on wild animals (IPCC, 2001a, and b). According to the IPCC (2001a), Africa including Tanzania will suffer the most from the impacts of climate change. Among others, climate change will impede the achievement of Millennium Development Goals (MDGs).

Climate is the state of the atmosphere over a long period of time around 30 to 35 years. Getis *et al.* (2000) defined climate as a description of typical weather conditions in an area over a long period of time. Climate is thus defined as a weather condition recorded over thirty years. The world's climate varies naturally from one place to another. Climate change is happening and will increasingly affect the poor (*ibid*). The Inter-Government Panel on Climate Change (IPCC) has concluded that human activities are altering climate system and will continue to do so in many years to come (IPCC, 2001a). This variation has an impact on environment, properties, people's life and economic development. In this case, climate change must be an integral part of the long term sustainable development for African nations. Levels of carbon dioxide and other green house gases in the atmosphere have risen steeply since the industrial revolution (*ibid*). Studies show that in Tanzania mean annual temperatures and average daily temperatures will rise by between 2^0C to 4^0C by 2075 as a direct consequence of climate change (URT, 2003). Interestingly, the interior parts of the country are projected to face higher temperature increases than coastal areas (Mwandosya *et al.* 1998).

Over the past century, surface temperatures have increased and associated impacts on physical and biological systems are increasingly being observed. The continent of Africa is warmer than it was 100 years ago (Hulme *et al.* 2000). Concentrations of carbon in the atmosphere have increased because of the use of fossil fuels, deforestation and other human activities. These activities include clearing of land by fire and practicing shifting cultivation. In 2002, it was estimated that deforestation rate in Tanzania was about 91,272 hectares per annum (Shemsanga *et al*. 2010). The FAO (2009) estimated that deforestation in Tanzania was at 412,000 ha per annum between 1990 and 2005. This is equivalent to 1.1% of the country's total forest area (i*bid*). However, climate change is considered to be one of the most serious threats

to sustainable development, with adverse impacts on the environment, human health and food security and impact of climate change on natural resources and man made features.

The environment

The increase in temperature leads to the melting of ice on top of mountains resulting in rising of sea levels, disruption of the water cycle and disappearance of some animal and plant species and submerging of islands. Computer simulations of the climate indicated that global temperatures will rise as atmospheric concentrations of carbon dioxide increase (Enger and Smith, 2000).

Human health

Climate change is likely to affect transmission of vector borne diseases such as malaria, skin rashes, cholera and many others (Paavola, 2003). There is an increase of diseases like malaria in highlands due to temperature increase (URT, 2003; 2007). Also the increase of rainfall would attract vector bone diseases and activated its survival.

Food security

Nearly half of the world's population (2.9 billion people) lives on less than $2 per day (World Bank, 2001). About 800 million people are malnourished (Watson, 2001) due to the impact of climate on food production. Frequent crop failures due to extreme drought would lead to food shortage. These impacts on people's livelihoods are severe in the tropics and sub tropics, particularly in Africa because many poor small holder farmers depend on agriculture and have few alternatives (IPCC, 2001b). Other events like flooding might lead to destruction of crop growth as a result people will abandon agriculture and engage in other non-farming activities like charcoal making which contribute to global warming.

Impact of climate change on natural resources and man made infrastructure

Some species have disappeared completely due to climate change while others have come into existence. The other impact is on physical infrastructure especially road networks, such that some of the roads are not passable during the rain season. In addition, infrastructures like roads are also swept away by floods which complicate the transportation of agricultural produce and farm inputs to market places and farming areas respectively. There is destruction of road networks due to heavy rains. There is destruction of infrastructure on the coast and sea water intrusion in boreholes. This is applicable to those areas along the sea or oceans.

EFFECTS OF CLIMATE CHANGE IN TANZANIA

In recent years, Tanzania has witnessed a number of climate related disasters namely, flooding, droughts, widespread crop failures, livestock deaths and intensification of climate sensitive diseases among others (Shemsanga *et al*. 2010). However, there are different impacts of climate change in Tanzania; these impacts have been witnessed in other countries and also globally.

Heavy rainfall and frequent droughts

- Heavy rainfall and hurricanes have threatened human life and properties.

- Warming of sea-surface temperatures have caused bleaching of coral reef in Tanzanian waters and therefore impacting on socio-economic activities of coastal communities.
- Frequent occurrence of droughts has caused and resulted into:
  - Serious water shortages,
  - Attendant power outages,
  - Land degradation, low crop yield and increased livestock deaths;
  - Frequent forest fires.

The drought in 2003 has slowed economic growth and had a negative impact on food production and consumption in many districts in Tanzania. Drought affects most rural areas because farming and animal keeping are the main activities practiced in rural areas. All these activities depend on climate, if there is change in rainfall pattern and shortage of water for irrigation, all these activities would be affected resulting in food shortage.

Moreover, frequent floods and heavy rains destroy infrastructure, buildings and other belongings especially in floodplains. In Dar es Salaam flood-plains are populated by poor households. Thus, two-thirds of Dar es Salaam's population of over two million people live in flood-prone areas (UNEP, 2002). Moreover, global warming, flooding and rainfall change increase the spread and incidence of insect-borne diseases such as malaria and water borne diseases. Droughts have negative impacts on settlements, requiring more time for water collection and resulting in reduced water use. This impairs hygiene and contributes to the spreading and increased incidence of all contagious diseases (IPCC, 2001a).

Spread of diseases

Climate change have an impact on human health in different ways. It is documented that climate variability plays a central role in the geographical distribution and reproduction of vectors responsible for a number of diseases in Tanzania (URT, 2007). However, warmer temperatures increase the risk of mortality from heat stress (Enger and Smith, 2000). A warmer climate has expanded the range of carriers of malaria to highland areas like Lushoto, Amani, Rungwe, Njombe and Muleba. Diseases that thrive in warmer climates include malaria, dengue and yellow fevers, encephalitis, and cholera, are likely to spread due to the expansion of the ranges of mosquitoes and other disease-carrying organisms and increased rates of transmission (Enger and Smith, 2000). This could result in 50 million to 80 million additional malaria cases per year worldwide by 2100 (Enger and Smith, 2000).

Melting of ice cap of Mt. Kilimanjaro

Kilimanjaro Mountain has been sustaining large number of inhabitants and is a source of water for large population living close to the mountain. According to Agrawal *et al.* (1995), the most obvious indication of climate change is glacial retreat observed on Mount Kilimanjaro. About a third of Mt. Kilimanjaro ice field has disappeared in just 12 years and 82% of it has vanished since it was first photographed in 1912. It is projected that if current trends of increasing temperatures persist, the glacier may disappear entirely by 2020 (Thompson *et al*.

2002; URT, 2007). If this situation happens there will be considerable implications for the local ecosystem within and on the mountain slopes which provides critical water supplies and supports the livelihoods of over a million local inhabitants on the slopes of the mountain (Agrawal *et al.* 1995).

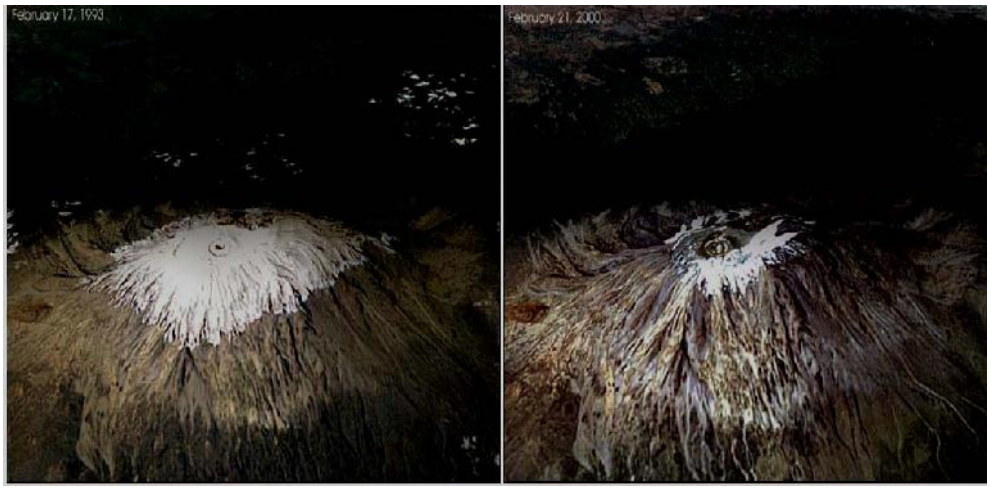

Figure 1: Showing loss of ice cap on Mt. Kilimanjaro between 1993 and 2000 (Source: URT, 2007)

Disruption of the water cycle

Among the most fundamental effects of climate change include disruption of the water cycle. Drought and floods; water quality and water quantity are the areas of particular concern. Disruption of the water cycle will produce severe droughts in some places and floods in other areas. Damage from the drought in the southern plain of the United States in 1996 was estimated at $4 billion and the 1993 Mississippi river flood damage at $10 billion. Tanzania experienced *La Nina* related drought in 1999/2001 and *El Nino* related floods in 1997/98 which caused great damage to life, environment and properties (Nganga, 2006). *La Nina* and *El Nino* are considered to be evidence of the impact of climate change.

Changing forests and natural areas

Tanzania is among the richest countries in biodiversity (UNEP, 2002; URT, 2007); her forests are under major threat of deforestation from both anthropogenic activities and climate change. Among the main anthropogenic activities responsible for deforestation include overgrazing, high demands of wood for energy, wildfires and over-exploitation of wood resources for commercial purposes and clearing for agriculture and settlement. Climate change could dramatically alter the geographic distribution of vegetation types. However, because of climate variability, the bulks of forests in Tanzania are set to be shifted to drier ecosystems (URT, 2003). Climate variability is increasing the occurrence and severity of wild fires (Hemp, 2005) that in turn is affecting the distribution of species, changes in land-cover, reducing the forest size and subsequently drying up of streams and rivers (Paavola, 2003). The named activities have been contributing a significant amount of CO_2 in the atmosphere while increasingly reducing carbon sinks (URT, 2007).

Challenges to agriculture and food supply

The impacts of climate change on agriculture may add significantly to the challenges of reducing poverty in Africa (Jones and Thornton, 2003) and in Tanzania in particular. In Tanzania climate change imposes worst impact through interference with food security to the growing population (Shemsanga *et al*. 2010). Climate change strongly affects crop yields as pointed out by Enger and Smith (2000). A CO_2 concentration of 550 ppm is likely to increase crop yields in some areas by as much as 30 percent to 40 percent, but it will decrease yields in other places by similar amounts, even for the same crops (*ibid*). A warmer climate would reduce flexibility in crop distribution and increase irrigation demands.

The impacts of climate variability on agricultural sector in Tanzania include shifting in agro-ecological zones, prolonged dry episodes, and unpredictability in rainfall and uncertainty in crop patterns. Climate change also increases weed competition with crops for moisture, nutrients and light, as well as ecological changes for pests and diseases (Paavola, 2003; URT, 2007). Farmers in some rural areas in Tanzania have changed most of their cropping practices due to changes in rainfall pattern and amount (Lema and Majule, 2009).

Case study

I had a discussion with my grandfather and grandmother. The conversation started as a joke. I asked them what is climate. With their little knowledge they have, they said that is weather condition of a place. I proceed asking them if they recognize any changes of climate since 1970s up to now. Response was that there are many changes. During those days rain was heavy, it was raining for some days without stopping i.e. non-stop and we used to get heavy crop harvest. Now some of the springs and wells have dried and trees around wells are no longer there. Some species which were used for food, fodder, medicine and fruits are not available. All these became extinct and have disappeared because of climate change. In 1960, most parts of Mount Kilimanjaro was covered by ice, but if you look on the mountain cap now only very small portion with ice/snow is left.

"My grandfather and grandmother", I called. What do you think is the cause of climate change? They all laugh. Then they said that, there are many causes such as increase in population which has forced people to cultivate on marginal areas and cutting many trees for construction of their houses and for fuel wood. Other causes include cutting trees to get land for settlement and outbreak of fire in different part of Tanzania. For example recently we have experienced outbreak of fire around Mount Kilimanjaro and in the forests such as in Morogoro, to mention a few. Most areas are left bare without plants or vegetations. Outbreak of fire is caused by different reasons. One cause is the people collecting honey or wax in the forest and left fire uncontrolled; when wind blows there is fire outbreaks and it spread all over the forest.

The other cause of fire is the people doing lumbering or making timber in the forest. They used to prepare food in the forest, when they leave the forest they forget to extinguish or put off the fire as a result fire spread in the forest and burn large areas until people come and put off the fire. Last but not least are those who go in the forest to cut grass and collect firewood. Some of them are cigarette smokers, when they finish smoking they leave last part of the cigarette (butt) lighting. The last cause of fire is nature; it is a natural occurrence without known cause. It is the act of God.

What do you think needs to be done to control this situation? To control outbreak of fire in the forests, my grandmother advised, rural people or any one using forest should make sure that all fires made in the forest is extinguished or put off before leaving the forest. Those smoking cigarettes should make sure that they extinguish the last part of the cigarette before throwing it away. They lastly suggested planting of trees especially Luciana and grevilea which can be used as a fodder and for timber making.

I concluded discussion by thanking my respondents saying that, tree planting, the use of forest rationally and carbon trade contribute much to reducing carbon dioxide in the atmosphere and as a result control climate change. If all these are done we would not see the changes of climate we see and experience today.

ROLE OF FORESTS AS A CARBON SINKS

Forests are carbon dioxide sinks. Both natural and plantation forests are important in controlling and regulating climate. Forests absorb carbon dioxide and release oxygen which is then used by animals and human beings. Through photosynthesis, plants absorb carbon dioxide from the atmosphere, store the carbon in the form of sugars, starch and cellulose and release oxygen into the atmosphere. However, the carbon is stored in the leaves, roots and bark. Lastly, a young forest, composed of growing trees, absorb carbon and acts as a sink. With depletion of forests all these roles of forests are not possible (Sharma *et al.* 1994).

FORESTRY AS INSTRUMENT IN THE REDUCTION OF GREEN-HOUSE GASES

Globally, forests store 70% of terrestrial fixed carbon (FAO, 2009). For this case forests are very important in ensuring that green house gases are removed from the atmosphere. Non-Government Organisations (NGOs), governments, communities and people all over the world should be encouraged to conserve the remaining forests and plant trees wherever there is a place and chance to do so. This strategy will help to reduce the impact of climate change.

Despite the fact that Tanzanian forests and woodlands contribute significantly to removing carbon from the air as they grow, the quantity of carbon that is currently stored in these forests is yet to be established. However, it is apparent that, deforestation and forest degradation contributes significantly to climate change as does fossil fuel use. It is until when drivers and the root causes of deforestation are properly addressed deforestation will continue to contribute to climate change. There must be massive tree planting efforts and use machines and cooking stoves which are not producing Green House Gases.

The danger is that, many people including policy and decision makers fail to appreciate that forest destruction is caused by incredibly wide variety of political, economic and other factors outside the forest sector. These factors need to be harmonized to contribute to sustainable and rational use of the remaining forests. Politicians, economists and others, should work together in order to control and avoid deforestation and conflicts with regard to forest use.

MAJOR CONSTRAINT FOR THE FOREST SECTOR TO PARTICIPATE IN CARBON TRADING

Inadequate awareness about carbon trading coupled with lack of technical capacity in both the private and non-government actors and the public institutions in Tanzania are the main constraints for participation in carbon trading both within CDM and in the voluntary schemes.

CONCLUSION AND RECOMMENDATIONS

Climate change is already affecting Tanzania both economically and socially. This paper concludes that rural dwellers in Tanzania are vulnerable to climate change. Most rural dwellers depend on rain fed farming. This farming type is affected by changes in rainfall patterns and amount. Conclusively, climate change will further reduce access to drinking water, negatively affect the health of the poor people, and pose a threat to food security in many countries in Africa, Asia and Latin America. In some areas where livelihood choices are limited, decreasing crop yields and loss of landmass in coastal areas, migration might be the only solution to climate change. However, many natural processes and several anthropogenic factors lead to climate change. Since human being have no control over the natural forces such as solar output, volcanic eruptions, but do have control of many of the anthropogenic forces such as greenhouse gas emissions and land use cover changes, it is only prudent for us to begin to consider ways in which the future impacts of anthropogenic forces can be reduced or controlled.

Addressing climate change requires more than local efforts as it recognizes no national boundaries (IPPC, 2001). However, in order for Tanzania to contribute in reducing Green House Gas (GHG) through forestry, it is recommended to do the following:

- Capacity building in terms of having a critical mass of government institutions and non-government actors that can venture into carbon trade is critical importance. Reduced rate of desertification through enhanced growth of natural vegetation can lead to reduced impact of climate change for pastoralists and farmers.

- Initiation of carbon trading in Tanzania would reduce the impact of climate in the country, the trade should bring sustainable development, help to alleviate poverty to local communities such as those participating in Forest Management, create clean technology of sustainable wood-fuel production among many others.

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