Vulnerability and Adaptation to Climate Change; Implications for policy and practice in Tanzania

Sangeda Anthony Zozimus
Department of Animal, Aquaculture and Range Sciences
Sokoine University of Agriculture, P.O Box 3004, Morogoro, Tanzania

E-mail: sangedaaz@gmail.com, sangeda@sua.ac.tz

Abstract
Climate change has significant socio economic impacts in Tanzania, in particular through floods, droughts and changes in rainfall pattern. Most literature on climate change impacts and vulnerability, report the idea that countries, economic sectors, social groups and individuals differ in their degree of vulnerability to climate change. This is partly true due to the fact that changes in temperature and precipitation occur unevenly and that impacts are unevenly distributed. Drivers of vulnerability in Tanzania include both socio-economic (population and conflicts) and biophysical (infrastructure, water resources, soil erosion & land degradation, pest & diseases). It is assumed that many regions will be capable of adapting to climate change, but that poorer ones will face difficulties. It is therefore argued that the study of adaptation to climate change should begin with the study of social and economic vulnerability. In this case, vulnerability and adaptation are important issues in climate change debate. This is because always vulnerability is defined in terms of capacity to adapt, and capacity to respond to stress is a starting point for climate change impact analysis. Climate vulnerability and adaptation carry important lessons for assessing Tanzania's preparedness for human induced climate change, and an

understanding of climate variability provides important context for discussions in this study. Decreasing the vulnerability of socio-economic sectors and ecological systems to natural climate variability through a more informed choice of policies, practices and technologies will, in many cases, reduce the long-term vulnerability of these systems to climate change. Based on these issues, literature review was done to prepare this paper that provide an overview of vulnerability status and adaptation initiatives in order to inform policy and practice in the country.

***Keywords**: Vulnerability, Adaptation, Climate change, Tanzania*

Introduction

There is a common perception that the poor or marginalized communities are likely to be hit more by adverse effects of climate change, and that capacity to respond to climate change is lowest in developing countries (Santiago, 2001). This leads to a belief that vulnerability to climate change is closely related to poverty and marginalized communities who are unable to respond to climatic stress. Pastoral communities of East Africa and in particular those of Tanzania are among the list of marginalized in several aspects (Hepworth, 2010). Furthermore, particular areas including semi-arid regions of Tanzania are more severely affected by climate change than others. Generally, vulnerability and adaptation to climate change are urgent issues in these regions. Climate vulnerability and adaptation carry important lessons for assessing Tanzania's preparedness for human induced climate change, and an understanding of climate variability provides important context for discussions in this study. Decreasing the vulnerability of socio-economic sectors and ecological systems to natural climate variability through a more

informed choice of policies, practices and technologies will, in many cases, reduce the long-term vulnerability of these systems to climate change (IPCC, 2000).

Climate variability has significant socio economic impacts in Tanzania, in particular through floods, droughts and changes in rainfall pattern. Periodic floods leads to infrastructure damage, reduction of livelihood assets and food insecurity. For example, in January 2010, unusual heavy rainfall associated with El Nino caused flooding in Morogoro and Dodoma Regions which led the International Red Cross Societies to launch an emergency appeal of about US $1.6 million (Hepworth, 2010). Kilosa and its neighbor districts were particularly hit with about 50,000 people affected, 28,000 forced to vacate their homes and more than 10,000 people made homeless. Water and sanitation infrastructure and roads were badly damaged, with large areas of farmland flooded (Hepworth, 2010). Drought on the other hand was severe in some years (e.g. 2009) with pastoralist villages in Arusha and Manyara losing up to 80% of their herds (Sangeda, 2015). Drought in 2005/6 contributed to low water levels at key Hydroelectricity power stations and led to severe power shortages throughout the country and is reported to have reduced GDP growth by 1 to 2% (ECA, 2009). Erratic and unreliable rainfall, caused crop and pasture failure, exacerbated by other stresses such as land degradation causing weeds infestations and insecurity of land tenure. An indirect consequence of these climate impacts increases pressure on other natural resources such as rangelands, fisheries, wetlands and forests, which in turn increase weed infestations, encroachment and deforestation leading to increased soil erosion as people turn to charcoal, fuel wood and agricultural expansion as coping strategies.

Based on these issues, this paper has been prepared to provide an overview of the status of adaptation initiatives in the context of climate vulnerability in Tanzania though a literature review to establish and inform policy and practice in the country.

Vulnerability as a concept of climate change

The Intergovernmental Panel on Climate Change defines vulnerability as the extent to which a natural or social system is susceptible to sustaining damage from climate change, and is a function of the magnitude of climate change, the sensitivity of the system to changes in climate and the ability to adapt the system to changes in climate. Hence, a highly vulnerable system is one that is highly sensitive to modest changes in climate and one for which the ability to adapt is severely constrained (IPCC, 2000).

Most literature on climate change impacts and vulnerability, report the idea that countries, economic sectors, social groups and individuals differ in their degree of vulnerability to climate change (e.g. Bohle et al. 1994). This is partly true due to the fact that changes in temperature and precipitation will occur unevenly and that climate change impacts will be unevenly distributed. It is also due to the fact that resources and wealth are distributed unevenly. Though vulnerability differs substantially across regions, it is also recognized that even within region, impacts, adaptive capacity and vulnerability will vary (IPCC, 2001). Some authors distinguish "pre-adaptation vulnerability" from "post-adaptation vulnerability." Kelly and Adger (2000) argue that according to the IPCC (2001) approach, vulnerability depends on estimates of the potential climate change and adaptive responses. In other words, "the level of vulnerability is determined by the

adverse consequences that remain after the process of adaptation has taken place" (Kelly and Adger, 2000).

On the other hand, Blaikie et al. (1994) define vulnerability as the capacity of a person or group to anticipate, cope with, resist and recover from the impact of a natural hazard. The same authors argue that vulnerability is a measure of a person or group's exposure to the effects of a natural hazard, including the degree to which they can recover from the impact of that event. Combining the definitions by Blaikie et al., 1994; Kelly and Adger (2000) then vulnerability can generally be viewed as "*the ability or inability of individuals or social groups to respond to, in the sense of coping with, recover from or adapt to, any external stress against well-being.*"

Biophysical drivers of vulnerability

Infrastructure

In Tanzania, land based road travel is the dominant mode of transport and accounts for over 80 percent of passenger traffic and over 96 percent of freight traffic. The road network density in Tanzania is 96.5 meters per square km (or 5.0 meters per square km for paved roads). Tanzania has one of the lowest road densities in Africa, meaning that a large part of Tanzania is inaccessible (URT, 2017). On the other hand, the railway network operates erratically. For example the TAZARA Railway which operates between Dar es Salaam and Zambia faces this challenge. Inaccessibility especially in the rural areas makes travel difficult, transport become rather expensive and crop and livestock markets become too far. The magnitude of each of these problems is felt more during the long rains than in short rains. Thus transport

becomes a major driver of vulnerability to climate change in the country (URT, 2017).

Water resources

Increasing rainfall variability and prolonged drought lead to pressure on the country's available water resources. Severe and recurrent droughts in some years triggered a decrease in water flows in streams and rivers, hence shrinkage of receiving lakes, declines of water levels in satellite lakes and hydropower dams. Furthermore, some of the perennial rivers have changed to seasonal rivers and some wetlands have dried up (URT, 2007).

Thus water as a limited resource is under pressure because of climate change and variability, land degradation, over-abstraction, and encroachment of water catchments for various land uses including agriculture. This scarcity and vulnerability has negative impacts on crop production, leading to low yields over time.

Increased population in major watersheds will put pressure on water resources as a result of climate change in terms of the quantity abstracted and also siltation and sedimentation of rivers as a result of deforestation and soil erosion. Socially, the impacts of climate change on water resources are felt by the whole society regardless of gender. However, where water sources are depleted or quality compromised, women and children are the most affected due to their vulnerability.

Soil erosion and land degradation

Climate change will have two-fold effects on soil erosion on the landscape (Adhikari et.al, 2015). Direct effect of climate change is in the event of increased precipitation, in terms of amounts and

intensity which translates into high erosivity. In the event of decreased precipitation and increased temperature as a result of climate change, soil moisture content is decreased, thus the landscape becomes incapable of supporting dense vegetation that becomes sparse with time.

Therefore insufficient vegetation cover may accelerate soil erosion and its negative effects to the community. Land use change as an adaptation strategy to climate change may affect the rate at which a growing crop covers the ground and hence affect the runoff. Poor farmers who are not motivated to adopt soil conservation methods will be on high risk of losing their productive surface soil to erosion. The latter will be worsened by nutrient mining where the extraction of mineral nutrients through crop removal is higher than replenishment through fertilizers and organic matter. According to National Sample Census of Agriculture (Small Holder Agriculture Volume II) the number of households reported to have soil erosion problem was 779,563 accounting for 13% of total agricultural households involved. In coffee-banana farming systems, soil erosion is less severe than in other systems for two reasons; first is the continuous vegetation cover unlike in other systems and; second is that in coffee-banana system the in and out flows of nutrients is somewhat balanced unlike in other systems where harvesting involves pulling the whole plants with their roots such that the field does not benefit from nutrient cycling (Kaihura et al., 2001). In pastoral livelihood zone (e.g. Loliondo) and semi-arid sorghum livestock livelihood zone (e.g. Dodoma) where soil cover is virtually non-existent, soil erosion is widespread, resulting in huge gullies, thus reducing land productivity.

Pest and diseases

Warmer temperatures, wetter climates and increased carbon dioxide levels are also projected to favour increase in insect pests and fungi leading to increase in the use of pesticides and fungicides, which may negatively affects human health and the environment. The severity of crop pests or diseases and emergence of new invasive pests or diseases is also changing. For example, African army worm moth (Spodoptera exempta Walk.) (Lepidoptera: Noctuidae) outbreak follows a prolonged drought period and its lifecycle depends on the prevailing temperature. Banana Xanthomonas wilt, (BXW), a new deadly banana wilt pathogen, is thought to have emerged due to climate change and is posing a threat to banana production in coffee-banana livelihood zones. Mongi et al. (2010) reported that farmers had the perception that food security problems were caused by prevalence of crop pest and disease due to climate change in the cotton-paddy-cattle livelihood zone. FAO (2008) Climate Change and Food Security Framework document points out that meteorological conditions as a result of climate change may become favorable for some animal and plant pests and diseases and unfavorable for others, thus enabling pests and diseases to establish in new areas that were previously unsuitable. Also new animal or plant pests and diseases may emerge due to natural selection by, and adaptation to new meteorological conditions. Although the effects of climate change on animal/plant pests and pathogens species distribution, severity and frequency of incidence of pest and disease has not been well documented in Tanzania, there is a general perception that the increase of temperature or rainfall will affect pests and disease dynamics. Nonetheless, pest and diseases intensity is higher in wet and humid livelihood zones than in arid and less humid livelihoods (URT, 2017).

Socio-economic drivers of vulnerability

Population

Based on the 2002 Population and Housing Census, Tanzania was reported to have a population of about 34,569, 232, with 33,584,607 from mainland with an annual average growth rate (1988 to 2002) of 2.9% (URT, 2002). By 2012 the country had about 44.5 million people (of which 21.9 million were male and 22.6 million female) (URT, 2013). The average household size was estimated at 4.9 and the population density was estimated to be 39 persons per sq.km.

Rapid urbanization is taking place in the country. Whilst the urban population was only 4% of the national population at independence in 1961, it rose to 23% in the 2002 national population census. With this trend, it is estimated that by the year 2030, 50% of the national population will be urbanized through natural growth, inward migration and transformation of rural settlements into urban centers. History shows that over the years of pre and post-independence of many developing countries, the difference in livelihood between urban and rural areas has catalyzed rural-urban migration. Recently, climate change and other extreme weather events have caused instability in peasant farmer activities in rural areas hence aggravating rural to urban migration (URT, 2017).

One factor for gradual growth in urban areas compared to rural areas may be failure of the agricultural system, causing rural populations to migrate into urban centers in search of alternative livelihood strategies. Although total population growth rate has

been decreasing in Tanzania, there is dissimilarity between urban and rural population growth rates.

Conflicts

Many conflicts emanate from trans-boundary resource competition, either between pastoralists and crop producers or wildlife and pastoralists or crop producers. Conflicts are a result from combined effects of climate change where rangelands cannot sustain wildlife population in terms of water and forage due to droughts and high temperature or loss of habitat. Change in forage species composition, and habitat characteristics may force wild animals to seek alternatives from human settlements and hence cause conflicts. On the other hand, anthropogenic factors such as encroachment, land fragmentation and destruction may cause conflicts. For example, increased water abstraction for rice cultivation in the Katuma river system of the maize-rice farming system has been reported to cause water shortage problems for wildlife in Katavi National Park (Elisa et al., 2011).

Prolonged dry season and increased rainfall variability negatively impact on forage and water availability for livestock, compelling pastoralists to migrate to distant areas in search for water and pasture. As a result, conflicts between crop producers and pastoralists arise and sometimes with severe human casualties, for example in the sugarcane farming regions of Morogoro, Kagera and Kilimanjaro, and sisal farming regions of Morogoro, Tanga, Coast and Lindi in where pastoralists are also found (URT, 2017).

Major conflicts prone regions include districts with large herds of cattle, especially rice farming zone in the Usangu plains where large herds of livestock from elsewhere have migrated into the

area in search for the water and pasture. Since models predict that southern Tanzania is projected to receive increased precipitation than central and northern parts of the country (Mourice et al., 2016), there is a potential conflict between livestock herders and crop producers. This is because water and forage supply may not be adequate for large population of livestock as a result of influx into the southern region from other parts of the country.

The impacts of climate change in Tanzania

Climate change has led to many impacts in Tanzania. Few of these are listed in Table 1 following literature review. Climate change have impacts to the environment, health, livelihoods and economy of the Tanzanian people as shown below.

Table 1: Impacts of climate change by sectors in Tanzania

Effect Sector	Increased Temperatures	Increased Drought	Increased rainfall	Impacts
Environment	Biodiversity loss as niches are closed out; changing ecosystem dynamics and production	Additional pressure on natural resource use (forests, rangelands and fisheries)	Shift in habitats and growing seasons	Biodiversity loss, Deforestation, Land degradation, Weed infestation
Human & Animal health	Shifts in disease vector habitats/ incidence of malaria; respiratory problems	Increased risk of water related diseases; food shortage; water	Increased risk of waterborne diseases; floods/ landslide risks	Conflicts; health problems and risks; economic costs; poverty

		conflicts; famine.		
Agriculture & food security	Shifts in the viable area for cash crops; reduced maize output; higher evapotranspiration	Crop failure; reduction in grazing lands and Animal losses	Erosion, land degradation, change in crop yields/disease crop and animal diseases	Poverty, food insecurity; economic shocks; loss of incomes and livelihood options
Infrastructure & settlements	Increased evaporative losses; cooling costs/high use of energy	Significant implications for Hydroelectric power (HEP); water shortage	Flood damage to infrastructure, transport, communications and settlements.	Economic loss and growth instability; reduced reliability of HEP; migration

Source: Modified from Hepworth, 2010

Although these impacts are negative, there may also be beneficial impacts such as increased grazing area and associated pastures for livestock with increased rainfall, or opportunities to grow more profitable crops. This was evidently seen in 2019, where there was a prolonged short rains *(vuli)* in regions with bimodal rain system. Future changes in precipitation have the potential to bring amplified floods, landslides and health risks, increased soil erosion and crop damage. Flooding during wet season is associated with annual cholera outbreaks in both urban and rural settings because pit latrines are washed out with flooding of residential areas.

It is further understood that a key factor to low food productivity in Africa is low soil nutrients exacerbated by soil erosion. Soil nutrient loss across Africa is estimated at 22 kg of nitrogen, 2·5 kg of phosphorus, and 15 kg of potassium per hectare of cultivated land over the past 30 years, equivalent to loss of US$4 billion in fertilizer per year (Sanchez and Swaminathan 2005). Increased rainfall in the future is likely to amplify the waterborne diseases and problems of soil and nutrient loss. Tanzania's staple food is maize which provides a third of the nation's daily calorific intake and is grown by half of all farmers for domestic consumption. Maize could be particularly affected by climate change with studies suggesting that yields will be reduced by 20% by 2075 and much as 80% in central Tanzania (Paavola 2003). Cash crops, including coffee, tea, cotton, tobacco, cashew nuts, sisal, cloves, and pyrethrum, account for the vast majority of export earnings and they and their production systems are also vulnerable to predicted climate change (Hepworth, 2010). Fisheries provide an important livelihood, food source and income generating activity in coastal areas and adjacent to the major lakes of Victoria, Tanganyika and Lake Malawi. Although there is a need to improve understanding about how fisheries will be affected, disturbed habitats, coral bleaching, changes in nutrient cycling and increased domestic demand brought by climate change also poses risks in this sector. Beyond Tanzania reliance on water for energy and agricultural production, the mushrooming of mining activities and the new industrial manufacturing sector (*Tanzania ya Viwanda*) are almost entirely reliant on reliable water availability and HEP to support processing.

Tourism accounted for 17% of the GDP in 2007 and nearly 25% of total export earnings (Perez, 2010) and this income and the rich biodiversity and wildlife is also vulnerable, both through disruption to infrastructure, energy production and associated reputational issues and the closing out or shifting of habitats and diseases. Modified resource management, introduction of new varieties and changes in husbandry techniques may sustain crops and related industries. Interventions to build resilience within infrastructure, water management, energy production, industry, tourism and ecosystems are possible but such adaptation options need to be explored and planned for (national budgets). The impacts of climate change are likely to be significant for the future development trajectory of Tanzania and economic valuations of climate change impacts can be useful in amplifying the political priority afforded to adaptation planning. The economic costs of climate change for Tanzania have been estimated at between 1.5 to 2% of GDP by 2030, a total of $270 million each year (UNEP/ Stockholm Environmental Institute, Adapt Cost project 2009).

Adaptation to climate change

Climate change literature shows several definitions of adaptation. For example, Burton (1996) defines adaptation to climate as the process through which people reduce the adverse effects of climate on their health and well-being, and take advantage of the opportunities that their climatic environment provides. Adaptation involves adjustments to enhance the viability of social and economic activities and to reduce their vulnerability to climate, including its current variability and extreme events as well as longer-term climate change (Smit et al. 2000). The adjustments can be passive, reactive or anticipatory, as a means for

ameliorating the anticipated adverse consequences associated with climate change. Adaptability refers to the degree to which adjustments are possible in practices, processes or structures of systems to projected or actual changes of climate. Adaptation can be spontaneous or planned, and can be carried out in response to or in anticipation of change in conditions (Watson et al. 1996). In simple way, it can be explained that planned and anticipatory adaptations are undertaken by governments or NGOs as a policy initiative as opposed to those that are autonomous which normally require the most attention. Even though, several literature e.g. Fankhauser et al. (1999), shows that the distinction between autonomous and planned adaptation may be unclear in practice.

According to the IPCC (2001) Third Assessment Report, adaptation has the potential to reduce adverse impacts of climate change and to enhance beneficial impacts, but will incur costs and will not prevent all damages. Furthermore, it is argued that human and natural systems will, to some extent, adapt autonomously and that planned adaptation can supplement autonomous adaptation. However, options and incentives are greater for adaptation of human systems than for adaptation to protect natural systems (IPCC 2001).

It is further assumed that many regions and countries will be capable of adapting to climate change, but that poorer countries and regions will have difficulties in responding to climate change. These authors argue that the study of adaptation to climate change should begin with the study of social and economic vulnerability (Handmer et al. 1999). Furthermore, Blaikie et al. (1994) argue that households that have access to resources and social networks are less vulnerable. Although they may experience greater losses

(in absolute terms) than the poor, it can be argued that resource-rich households are more resilient in that they recover more quickly from a stress. These definitions of vulnerability and adaptation have implications for assessments of vulnerability. In one case, vulnerability depends on the adaptation that has taken place; in the other, vulnerability is defined in terms of capacity to adapt, and capacity to respond to stress is a starting point for impact analysis.

Adaptation strategies in Tanzania

Ability to adapt at country, community or household level is characterized and related to the assets that one has access to (financial, natural resource, human and social capital) and how well these are used (governance). Limited financial capacity, infrastructure and equipment; dependence on rain-fed agriculture, primary production and natural resource use; poverty, low income per capita, low income and livelihood diversity; HIV/Aids; insecurity and weak institutions are all key factors in amplifying Tanzania's vulnerability, lowering its resilience and its adaptive capacity to climate change. In planning interventions around climate change, it is vital to consider these underlying issues. Governance problems and institutional performance issues contribute to vulnerability in Tanzania (ECA, 2009). Based on the climate change science and broad assessment of vulnerability in Tanzania, the following (Table 2) adaptation priorities are important.

Table 2: Adaption priorities to climate change in Tanzania

Theme	Adaption priority issue
Agriculture and food security	There is a need to improve market access and inputs, economic and livelihood diversity; outreach activities to enhance management practices; adjustment to cultivars;

	enhance irrigation efficiency and/or expand irrigation area; enhanced pest and disease forecast and control; seasonal forecasting.
Water resource development and management	There is a need to increase water storage and supply; demand management; effective systems of allocation within integrated river basin management; drought and flood warning and management
Infrastructure and energy supply	There is a need to plan resilience to climate shocks and change in the country's road, transport and communications infrastructure; plan for energy security in energy mix and design, operation and maintenance of plants.
Diverse and resilient livelihoods	There is a need to build human capital (skills, education); health; technological alternatives; increase levels and sources of income; enhance equity and social capital.
Effective institutions and governance	There is a need to have institutions capable, with resources, reach and incentives to plan for and deliver these services and adaption responses, including undertaking research and development, forecasting and communications and implementing existing strategies.

Source: Modified from Hepworth, 2010

In 2007, Tanzania prepared a National Adaptation Programme of Action (NAPA) to identify immediate short-term priorities that could be addressed by the UNFCCC LDC fund for adaptation to climate change effects (URT, 2007). NAPA identified 14 priority actions as shown below.

1) Increase irrigation by using appropriate water efficient technologies to boost crop production in all areas.
2) Introduce alternative farming systems and relocation of water sources, including wells along low-lying coastal areas.
3) Develop water harvesting and storage programmes for rural communities particularly those in dry lands.

4) Launch community-based water catchment, conservation and management programmes.
5) Explore and invest in alternative clean energy sources, e.g. wind, solar, bio-diesel, etc.
6) Promote application of cogeneration in the industrial sector.
7) Conduct afforestation programmes in degraded lands, using more adaptive and faster-growing tree species.
8) Develop community forest-fire prevention plans and programmes.
9) Establish and strengthen community awareness programmes to address major preventable health hazards.
10) Implement sustainable tourism activities.
11) Enhance wildlife extension services and assistance to rural communities in managing wildlife resources.
12) Introduce water harvesting and recycling.
13) Construct artificial structures, e.g., sea walls, artificially placing sand on the beaches and coastal drains, beach management system.
14) Establish a good land tenure system and facilitate sustainable human settlements.

Unfortunately, activities related to climate knowledge and forecasting, research, mainstreaming and capacity development were not included. NAPA did not consider how climate change adaptation can be integrated into national and sector policies, plans and activities; and the projects proposed in the NAPA were not included in the sector plan and budgets by the institutions responsible for each sector.

Later in 2012, the National Climate Change Strategy (NCCS) was launched. The strategy identified several strategic interventions for each sector in Tanzania. These activities were designed to be

done by each sector through line ministries and relevant departments in local government authorities. Activities to be coordinated by National climate change focal point (NCCFP) through National climate change technical committee (NCCTC) and National climate change steering committee (NCCSC) led by VPO.

Adaptation interventions: Implications for policy and practice in Tanzania

Table 3: Adaptation strategic interventions by sectors in Tanzania

Sector/Theme	Adaptation strategic interventions
Water Resources	i. Protecting and conserving water catchments ii. Enhancing exploration and extraction of underground and other water sources iii. Facilitating and promoting water recycling and reuse iv. Promoting rain water harvesting v. Enhancing coordination of water abstraction and use vi. Promoting efficiency in water supply and use to ensure adequate and sustainable water supplies to all sectors. vii. Facilitate access to water resources viii. Enhance management of water sources to improve sanitation and hygiene ix. Promoting water treatment and storage. x. Enhancing decentralization of water sources management. xi. Conducting vulnerability assessment in water resources
Livestock	i. Promoting climate change resilient traditional and modern knowledge on sustainable pasture and range management systems. ii. Promoting development and implementation of land use plans countrywide.

	iii.	Enhancing development of livestock infrastructure and services.
Agriculture and food security	i.	Assessing crop vulnerability and suitability (cropping pattern) for different Agro-ecological zones
	ii.	Assess trade comparative advantage on traditional export crops with changing climate
	iii.	Promoting appropriate irrigation systems
	iv.	Promoting early maturing and drought tolerant crops
	v.	Enhancing agro-infrastructural (input, output, marketing, storage) systems
	vi.	Promoting appropriate indigenous knowledge practices
	vii.	Development of crop insurance strategy
	viii.	Strengthening weather forecast information sharing for farmers
	ix.	Strengthening post-harvest processes and promote value addition
	i.	Addressing soil and land degradation by promoting improved soil and land management practices/ techniques.
	ii.	Strengthen integrated pest management techniques
	iii.	Promote use of pest/disease tolerant varieties
	iv.	Strengthen early warning systems for pest surveillance
Forestry	i.	Enhancing control of forest fire, disease and pest breakout.
	ii.	Enhancing conservation of forests biodiversity and control of invasive species.

	iii.	Supporting alternative livelihood initiatives for forest dependent communities.
	iv.	Promoting establishment of woodlots.
	v.	Establishing comprehensive monitoring system for forest resources and ecosystem conditions
	vi.	Strengthening and up scaling of community based forest management best practices
	vii.	Promoting use of non-wood construction materials.
	viii.	Promoting energy efficient technologies
	ix.	Enhancing decentralization of forest management
Wildlife	i.	Enhancing protection and conservation of wildlife habitats
	ii.	Strengthening wildlife information database and management systems
	iii.	Enhancing management of emerging human-wildlife conflicts
	iv.	Promoting appropriate methods for conservation of climate change threatened species.
	v.	Enhancing involvement of local communities in wildlife conservation through Wildlife Management Areas (WMA)
	vi.	Conducting vulnerability assessment of wildlife
	vii.	Enhance controlled fire management system in wildlife habitats
Human Health	i.	Strengthening control systems related to health risks and diseases
	ii.	Ensuring availability of specialized

		trained staff and medical facilities for addressing climate-related diseases and other health risks
	iii.	Enhancing information sharing systems and cooperation with international community in addressing climate change – health related issues
	iv.	Enhancing health insurance system
Energy	i.	Promoting diversification of energy sources including non – traditional
	ii.	Supporting development and utilization of community based mini-grids
	iii.	Promoting clean coal for energy generation.
	iv.	Promoting development and use of energy efficient technologies
	v.	Promoting application of cogeneration in industrial sector.
	vi.	Promoting energy plantations to reduce pressure on catchment natural forests.
Fisheries	i.	Enhancing monitoring of fisheries habitat and species.
	ii.	Facilitating enhancement and/or development of integrated data management system in the fisheries sector
	iii.	Promoting aquaculture.
	iv.	Enhancing protection and conservation of aquatic ecosystems
	v.	Supporting alternative livelihood initiatives for fisheries community

Source: Modified from URT, 2012

Although empirical evidence shows certainty in the increases of future temperature in Tanzania, there is a huge uncertainty regarding the specific changes and impacts and the degree to which climate change is a priority when compared to other pressures such as land uses. Monitoring networks of the TMA are limited and there is limited capacity to collect and disseminate climate information. Furthermore, climate change suffers limited understanding and priority within sectors, economic institutions and the private sector.

Most climate change related activities are about mainstreaming, and hence not within the implementation responsibilities of Vice Presidents Office. Climate change is now being mainstreamed in national development planning, sector and local government plans but there has been limited funding to implement the plans and strategies.

The NAPA of 2007 includes a good description of the main problems and the National Climate Change Strategy of 2012, describes good options for adaptations and mitigation but there is still limited awareness and funding. The NAPA did not address monitoring or forecasting of climate change and its impacts, research, capacity development, information exchange, awareness-raising or mainstreaming but the national climate change strategy (NCCS) has shown the links between these aspects. Furthermore, there are weak links between institutions working with disaster management and food security, on the one hand, and entities involved in climate change, on the other. For instance, vulnerability assessments (2003) that was made in relation to food security are not used to substantiate the planning of climate activities (2007), while the results of downscaling

activities performed by research institutions are not fed into the work with food security.

Many climate change issues regarding rangeland management, water resource, forestry, renewable energy, food security, crop and soil management, support for national institutions, including TMA, and research are partly being addressed by sector regular activities. They form part of sector plans, and are coordinated between responsible ministries and their respective donors.

Several global, regional and locally-funded programmes are ongoing or planned by Tanzanian research institutions and foreign research institutions. The research covers issues such as local adaptation strategies, downscaling of climate modelling and assessment of impact on crops and markets. However, the exchange of research results between researchers and the dissemination to different user groups is very limited. NGOs are increasing their climate work, mostly as mainstreamed activities, having several fairly effective coordination forums compared to other stakeholders.

Recommendations

Based on the discussions on impacts and status of adaptation to climate change, the following recommendations are made;

i. To strengthen climate interventions in Tanzania, efforts are required to prepare a National Policy on climate change.
ii. There is a need for defining focus among responsible institutions in mainstreaming, versus specific climate activities, such as support for an expanded NAPA, support for VPO and TMA, for pilot activities and research.

iii. There is also a need to strengthen information management, from dissemination of weather forecasts to interaction around government initiatives, exchange of research results, and information-sharing to users.

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