PhD Research Proposal

Submitted to Growth and Employment Platform

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Title: Understanding Pathways to Increasing Resilience in a Changing Climate among Pastoral Societies of Northern Tanzania
1.0 Background to the problem

There is high level of certainty in the assertion that climate change is a result of global warming that have significantly been caused by increased emission of carbon dioxide (CO$_2$), methane (CH$_4$), nitrous oxide (N$_2$O) and other greenhouse gases (Collier et al., 2008). The evidence, based on direct measurements, is irrefutable that the concentrations of these greenhouse gases have increased substantially over the last 40 years, and continue to increase today (McBean et al., 2001). It is concluded by the Intergovernmental Panel on Climate Change (IPCC) (2007) that more than 90% of the current global warming is a result of greenhouse gases emissions from anthropogenic activities including fossil fuels burning for industrial manufacturing and other consumption as well as land use practices. Whereas the world has warmed by an average of 0.76°C since pre-industrial times, the global average temperatures are expected to further increase by 1.8°C to 4°C if no mitigation action is taken (Yanda and Mubaya, 2011; IPCC, 2007d). For example, based on its analysis of global observations of the climate system, the IPCC concluded that ‘warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.’ (IPCC, 2007a: 5)

The consequences of this climatic alteration are starting to become more visible as climatic conditions and ecosystems begin to change (Yanda and Mubaya, 2011). Given these emission rates, a 2°C rise in temperature is highly probable and possibly inevitable (Stern, 2006). As a result of this trajectory, social and ecological systems are at greater risk of adverse effects including but not restricted to: decreased cereal productivity and coastal flooding in low latitudes; animal and plant species extinction threats and annihilation of marine ecosystems particularly coral bleaching (Yanda and Mubaya, 2011; IPCC, 2007b). Apparently, recent extreme weather events on the globe pose a threat of increased sensitivity to potential dramatic socioeconomic impacts for all countries (Yanda and Mubaya, 2011).

The characterization of African climate is largely dominated by droughts and floods. Given the observed and projected climate change impacts, chances are Africa will be affected more severely than other regions (ibid.) This is due to greater vulnerability of Africa’s economy, such as crop production, livestock keeping and tourism, to climatic variation, geographic exposure and low incomes (Collier et al., 2008; Yanda and Mubaya, 2011). Though Africa is expected to bare the largest burden of climate change impacts, it is in fact the least responsible for global carbon emissions (Collier et al., 2008; Deressa and Hassan, 2009). To this end, whereas most efforts to curb climate change impacts in developed countries are concentrated on carbon emission reduction, developing countries and particularly African are occupied with adaptation of production to a changing climate. Henceforth, developed countries are yet to witness the adverse consequences of global warming. In Africa however, many of the adverse impacts are
already at play (Collier et al., 2008). One of the socioeconomic sectors that will bear the heaviest burden is the pastoral system given its sensitivity to extreme weather.

In East Africa, these changes will have serious implications for water resources, food security, and the spread of disease, the productivity of natural resources, sea-level rise, and desertification *ibid*. Holmgren and Oberg (2006) argue that, people at high risk in times of climatic change are those living on floodplains, coastal areas, mountains as well as those having no means of adapting to changes. As the largest, most populous, and poorest country in East Africa, argue Ehrhart and Twena (2006), Tanzania is likely to feel the impacts of climate change more than most. Diverse climatic conditions, corresponding to the country’s varied topology, mean that national trends are likely to mask considerable variation at the sub-national level. Whereas annual mean temperatures are expected to rise by 3–5°C and average daily temperatures by 2–4°C by 2075 (VPO 2003), rainfall predictions are less certain. Indeed, major discrepancies remain between climate models. However, the most commonly used projection for Tanzania foresees annual rainfall increasing by 10 per cent overall (Agrawala et al., 2003; IPCC 2001).

Pastoral livestock herders, who subsist wholly or in part upon their animals, can make efficient use of available resources in Arid and Semi Arid Land (ASAL) by using livestock to convert grasses and browse into animal protein to be consumed by people (Pratt and Gwynne 1977; Dyson-Hudson 1980; Lamprey 1983). Livestock serve many roles in pastoral society: as both the means and outcomes of production, as sources and objects of labour, as values, and as social, cultural and capital goods (Galaty and Johnson 1990). Arid and semi-arid lands cover nearly two-thirds of the African continent. The majority of African livestock and more than 50 million people who are dependent on livestock and dry land agriculture reside in these dry zones. Climate variability is characteristic of all dry lands, but in Africa it is particularly potent. The precipitation variability for instance influences ecosystem dynamics and thus exerts a major influence on human lifestyles and land use patterns (Galvin et al., 2001).

The IPCC models for East Africa for example, show an increase in temperature of up to 2–4°C by the 2080s, with more intense rain predicted to fall in the short rains (October–December) over much of Kenya, Uganda, and northern Tanzania as soon as the 2020s, and becoming more pronounced in the following decades. Pastoralists could benefit as more rainfall could result in more dry-season pasture and longer access to wet-season pasture. It could also result in less frequent drought, which may mean more time for people to rebuild their assets between lean times. However, there are also significant negative consequences including loss of livestock through heat stress, loss of land to agricultural encroachment as the rise in rainfall raises the productive potential of arid areas, an increase in frequency of flooding, and the spread of human and livestock diseases that thrive during the wet season (Oxfam, 2008).
As previously noted, pastoralists depend directly and indirectly on the products of their livestock, so they have developed multiple coping mechanisms to deal with drought. These include keeping diverse species of livestock, movements of species-specific and production-specific livestock herds over large areas, emigration out of the pastoral system until the perturbation passes, economic diversity, and even allocating seasonal and drought-induced nutritional stress among those community members better able to cope with it (Galvin, 1988; 1992, Galvin et al., 1994). However, these strategies have become constrained especially in the present century due to two main factors; an increasing human population along with a stable or declining livestock population and a decreasing land use area (Little and Brokensha 1987, Grandin 1988, Galvin 1992, Fratkin 1997).

In this respect, massive food shortages are projected for sub-Saharan Africa in the next quarter century based on current rates of population expansion and food production; the result has been further increases in livestock and agricultural intensification in arid and semiarid lands. Thus, with increasing population pressure on a declining and highly variable resource base, human vulnerability to drought and floods has increased. Pastoralists and agro-pastoralists have, in the past, adapted very well to climate variability. However these populations have become vulnerable to climate variability in large part because their strategies for coping with climate variability have become constrained (Galvin, 2001). Therefore, as climate variations ranging from short term droughts to long-term climate shifts occur, the ability of people to maintain their livelihoods in their traditional lands using traditional methods is likely to be impacted, particularly when these fluctuations are layered with other livelihood stresses (Lynn 2010a; 2010b).

2.0 Statement of the research problem
The observed alteration of the global climate system traced to about two centuries ago is attributed to both natural processes and anthropogenic activities. It should also be noted that, the later is what has actually led to vast modifications of the climate system leading to adverse consequences to the earth’s ecological and social systems (IPCC, 2007b; Tschakert et al., 2008; Yanda and Mubaya, 2011). With mounting evidence for climate change impacts, their consequences and implications are confined to local and international concern (Risbey, 2008; Blennow and Perrson, 2009; IPCC, 2007; Grundmann, 2007). The concern builds from a premise that those impacts, both positive and negative, are evident through unevenly distributed complex mixture (Yanda and Mubaya, 2011).

Evidence suggests that those societies carrying the heaviest burden due to impacts of climate variability and change are surprisingly the least responsible for greenhouse emissions, land use change and have least capacity to adapt. In that regard, Africa is cited to be hit severely by these impacts because of sensitivity of its core economies; crop cultivation, livestock keeping and tourism, to mention but a few. It is however noted
that the impacts vary widely across the continent with some areas, like East Africa, getting wetter while others, particularly southern Africa becoming even drier and hotter (Collier et al., 2008). Whereas it is still challenging to predict current and future impacts of climate change with such diverse streams, it is clear that livelihoods of poor and marginal societies particularly of Africa have a high propensity of experiencing significant shift following dwindling of their environment and availability of resources they depend for their sustenance (Assan and Kumar, 2009).

In a Tanzanian context, climate change poses a combination of impacts resulting from both extreme wet and/or dry conditions. For instance, while the interior part of the country is noted to experience higher temperatures and reduced rainfall; northeast, southeast and the Lake Victoria basin are less exposed to droughts but rather more frequent and severe flooding (Yanda and Mubaya, 2011). In this respect, local community livelihoods are under threat of being adversely impacted. One typical scenario is the semi-arid lands where availability of water for dry-land and integrated cropping as well as other uses including domestic use and for livestock is currently threatened by excessive drought. In addition to that, the impacts of climate change on livestock are also felt from an increased severity and frequency of drought. Deterioration of pastures during droughts and periods of overgrazing have resulted in poor health and death of livestock impacting food and livelihood of herders (Challinor et al., 2007).

Experience show that arid and semi-arid areas of Tanzania where most pastoral societies dwell have been repeatedly affected by rainfall scarcity and associated drought. It also has been assumed that (Hatibu, 2007 as cited in Yanda and Mubaya, 2011) most devastating floods are caused by heavy rains which occur after long periods of drought. As climate projections indicate that Eastern Africa will get wetter, these areas face even more dramatic flood events. It is not clear from these projections however whether hotter periods in the area will dwindle. For instance, Hatibu (ibid.) note that despite the overall low amount of rain in the semi-arid areas, sometimes it falls in intense storms that often lead to flooding. This trend has attracted several scholars to consider flooding in Tanzania as a seasonal phenomenon occurring in localised areas.

It has been noted that though climate change is a global phenomenon, its impacts and magnitude vary across multiple levels and scales from a household through national to regional and global standpoint. Most climatic projections and studies have deliberated on how regions are and/or will be impacted. Sufficient information from all these levels is a prerequisite for instituting viable adaptations mechanisms. This is due to the fact that different individuals, households, nations and regions have different capacities to contain this challenge given their level of economy, geographical setup, and knowledge to mention but a few. It is on the basis of these premises that this study seeks to explore ways through which the resilience of pastoral system in a changing climate can be enhanced.
3.0 Objectives
Generally, the study aims at understanding pathways to increasing resilience in a changing climate among pastoral societies of northern Tanzania. Specifically, the study objectives are to:

i. determine patterns and trend of climate variability and change in the study area;
ii. assess vulnerability and impacts of climate variability and change on pastoral system;
iii. determine resilience status of pastoral system to climate variability and change impacts;
iv. evaluate institutional role and capacity in enhancing pastoral system’s resilience to climate variability and change impacts.

3.1 Research questions
The proposed study will be guided by the following questions:

i. what are the pattern and trend of climate variability and change in the study area?
ii. what are the vulnerability and impacts of climate variability and change on pastoral system?
iii. what is the resilience status of pastoral system to climate variability and change impacts?
iv. what is the institutional role and capacity in enhancing pastoral system’s resilience to climate variability and change impacts?

4.0 Significance of the study
The study is expected to contribute scientific knowledge on the resilience of pastoral system to adverse impacts of climate variability and change especially in a wavering policy and socio-economic environment. Also, the study will set a stage for an understanding of local strategies and innovations employed by local people in coping and adapting to impacts of climate change and variability for plausible policy intervention. Likewise, this knowledge will provide insights to the third academic focus area of the “Growth and Employment Platform”; uncertainty, shocks and rural livelihoods on how poor rural households cope with and/or adapt to shocks. Specifically, the government of Tanzania is currently implementing the MDGs through phase two of the National Strategy for Growth and Reduction of Poverty (NSGRP) famously known as MKUKUTA whose goal four under cluster two aims at, among other things, ensuring sustainability of the environment and climate change adaptation and mitigation. The proposed study therefore, stands to provide significant policy recommendations that will contribute to the attainment of the goal.

5.0 Literature review
5.1 Theoretical framework
The proposed study will be guided by “Adaptive Cycles” theory (Chapin et al., 2009). It is noted by the theorists that all systems undergo disturbances such as fire in a forest system, war, economic recessions, change of leadership systems and/or philosophy, or manufacturing plant’s closure which cause large scale rapid changes in key system properties (ibid.). With this understanding, ensuring long-term stability of systems rests upon changes that occur at times of crucial phases of cycles of long-term change (ibid.). Adaptive cycles therefore, offer a framework for descriptions of the role of disturbances in social and ecological systems (Holling, 1986). What these cycles basically represent are disruption, reorganisation, and renewal of the system (Holling, 1986; Walker et al., 2004).

Chapin et al., (2009) use a forest ecosystem analogy to describe the key phases of adaptive cycles and how the theory can be used to describe disturbances that a given system undergoes. The authors note that an initiation of the cycle in the forest ecosystem, hereby referred to as “release phase” may be by a stand-replacing wildfire which brings about such rapid change among most properties of the forest system as death of trees, decline in productivity, increase in runoff to stream as well as compromised public faith in fire management. “The phase occurs in a matter of hours to days and radically reduces the structural complexity of the system” (ibid.)

What follows a release is a relatively brief (months to years) of “renewal phase”. Using the same forest ecosystem analogy, this phase entails-after the disturbance-seedling establishment and possibly formulation of new policies for managing the forest. During this phase, a number of things are expected to happen: the species and policies established might be similar to those present before the disturbance. Not only that, this is a point in time when there is relatively less resistance to the establishment of new suite of species and/or policies emerging from surrounding landscape (ibid.). These innovations may bring about a system that is different from the pre-fire one thus undergoing what this theory terms as “regime shift”

The forest goes through a “growth phase” after a preceding brief window of opportunity for change (ibid.) The growth phase may take a span of several decades given incorporation of environmental resources into living organisms, and regularisation of policies. “At this stage the forest is relatively insensitive to potential agents of disturbance” (ibid.) The authors further note that persistent changes in the forest’s nature compel both managers and the public to accept changing conditions and regulations as a reasonable pattern.

“Conservation phase” is what completes the adaptive cycles following accomplishment of the steady state by the forest thence exhibiting more specialised and complex interactions amongst the system’s components (ibid.). The constant state of the forest leads policy makers to formulate management rules that will ensure this constancy is
maintained. This is aimed at providing predictable patterns of for instance, recreation, hunting, and forest harvest. Enhanced interconnectedness among social and ecological components renders the forest more vulnerable to any factor(s) acting as an agent of disruption of the balance achieved at this stage of the cycles. Such factors may include: “fire, drought, changes in management goals, or shift in the local economy” (ibid.). If such changes are significantly large, a new release phase of the adaptive cycles could be triggered.

Adoption of the forest ecosystem analogy by Chapin et al. basically provides a more realistic approach of describing the theory. The theory therefore can be adopted to describe adaptive cycles of any social and/or ecological system. Gunderson et al., (1995 as cited in Chapin et al., 2009:17) stresses that “the most surprising thing about adaptive cycles is perhaps that, the sequence of the phases-release, renewal, growth, and conservation-can be used as a way of thinking about many types of social-ecological systems, including lakes, businesses, governments, national economies, and cultures, although the sequence of phases is not always the same”.

From management point of view, the most crucial lesson from studies of adaptive cycles establish social-ecological systems to be typically vulnerable thus “likely to change to a new state in response to a stress or disturbance” (Holling and Meffe, 1996; Walker and Salt, 2006). It is further postulated that “systems create their own vulnerabilities in the conservation phase where they spend most of their time” (ibid.). It is in this stage where managers often strive to bring down constant changes in ecological processes so that minor perturbations are contained to enhance accomplishments of management targets (ibid.) Stressing the importance of effective use of the theory in natural resource management, Chapin et al., (2009:17) notes that “recognition of these changing properties of a system through the lens of adaptive cycle suggests that effective long-term management and policy-making must be highly flexible and adaptive, looking for windows of opportunity for constructive policy shifts”.

5.2 Conceptual framework
The study in proposition adopts a framework by Agnew and Woodhouse, (2010) in their work on understanding responses to climate change in water resource management. The framework is however modified to fit into and guide this study. It is organised in two levels in a sense that the primary level variables determine resilience and/or lack of in a pastoral system. These include human activity, environmental outputs, climate change, and impacts on pastoral systems. The secondary level focuses on management issues that aim at enhancing resilience of a pastoral system to climate change and variability impacts including climate change adaptation and mitigation, these are determined by environmental processes at play and hazard and vulnerability of a given pastoral system.
The framework can be approached from any of the key four aspects which form the primary level of the framework: human activity, environmental outputs, climate change, and impacts on pastoral system. The observed global atmospheric CO\textsubscript{2} concentration have scientifically been attributed to anthropogenic (human) activities mainly fossil fuel burning for manufacturing, transportation, and energy sectors to mention but a few. Not only that, CO\textsubscript{2} emissions has also been associated with dramatic increase of human caused land use changes particularly forest degradation and deforestation for farming expansion, commercial logging etc. Its contribution to CO\textsubscript{2} concentration however is not as significant as that from fossil fuel burning. Greenhouse effect which is a result of concentration of atmospheric greenhouse gases represents one of the key environmental outputs following emission increase. It is this effect that literature note to be a cause of global warming. The resulting temperature increase is proven to alter global climate systems including precipitation, ocean circulations, and wind systems. Due to these climatic alterations, ecosystems sustainability has been compromised and so are the services they provide. Human systems (particularly pastoralists) and their livelihoods (livestock herding) therefore, are at greater risk of climate variability and change hazards like droughts, floods, heat waves, and sea-level rise.

Following the observed climate change impacts on pastoral system, the most immediate action is for the system to cope and eventually adapt to impacts. This can involve different players ranging from herders themselves who devise coping and adaptive strategies to national and international adaptation initiatives. Apart from adaptation, efforts have also been directed on mitigation of climate change by reducing emission of GHGs and other human activities that contribute to their concentration. Environmental outputs, in this case GHGs concentrations, that depict changes in the climate system such as altered precipitation or temperature regimes largely depend on the effectiveness of GHGs mitigation measures. Should the business as usual model prevail the resulting environmental processes including precipitation changes, drought and floods, temperature rise and sea-level rise are what we interpret as climate change.
Figure 1: Conceptual framework for understanding resilience to climate change among pastoral system
Source: Modified from Agnew and Woodhouse (2010)

5.3 Pattern and trend of climate variability and change
Many scientists have concluded that earth’s temperature will have increased by several degrees over the present century due to the increase in greenhouse gas concentrations in the atmosphere (Smith and Lenhart, 1996; Houghton et al. 1992, NAS 1992, Wigley and Raper 1992, Mitchell et al. 1995). Based on the Intergovernmental Panel on Climate Change, IPCC (2001a) observations, the rate and duration of warming during the twentieth century are unprecedented for the past thousand years. Since the end of the nineteenth century, the global average surface temperature has increased by about 0.6 °C, with the 1990s likely being the warmest decade in the instrumental record since 1861. Increases in maximum temperatures, numbers of hot days, and the heat index have been observed over nearly all lands during the second half of the twentieth century (IPCC 2001a). While some uncertainties remain, the IPCC (ibid.) concluded that collective evidence suggests that the observed warming over the past fifty years can be mostly attributed to human activities (that is the human-induced changes in atmospheric greenhouse gas concentrations and aerosols). The warming trend in the global average surface temperature is expected to continue, with increases projected to be in the range of 1.4 to 5.8 °C by 2100 in comparison to 1990.

Based on several decades of research, there is now a reasonable scientific understanding of several parts of the African climate system, including southern Africa, the Sahel and to a lesser extent East Africa (Washington, et al., 2004). With a decadal temperature increase of 0.05°C, climatic changes observation on Africa indicates a warming of 0.7°C over the 20th century (Hulme et al., 2001; IPCC, 2001d). For East Africa, this warming has been associated with increase in precipitation in some parts. Further projections on climate change for Africa (ibid.) indicates a warming ranging from 0.2°C (low scenario) to more than 0.5°C (high scenario) per decade. These impacts will bring about a 5-20% increase in precipitation from December-February (wet months) and 5-10% decrease in precipitation from June-August (dry months).
To this end, the mean temperatures for Tanzania, as noted by the Initial National Communications, are also projected to increase throughout the country particularly during the cool months by 3.5°C, while annual temperatures will increase between 2.1°C in the North Eastern parts and 4°C in the Central and Western parts of the country (URT, 2003). These changes will affect the coping strategies of the local communities for various sectors. Predictions further show that areas with bimodal rainfall pattern will experience increased rainfall of 5% – 45% and those with unimodal rainfall pattern will experience decreased rainfall of 5% – 15%.

The rainfall pattern on the other hand has become increasingly unpredictable (URT, 2007). For instance, the analysis of total annual rainfall for 21 meteorological stations in selected regions of Tanzania indicated that there is a decreasing trend for over 13 stations (61.9%) whereas an increasing rainfall trend was observed over 7 stations (33.33%) and 1 station had almost a constant pattern. The most affected stations were Pemba, Zanzibar, Moshi and Arusha. One common feature of the rainfall pattern however, is a greater variability in cycles (ibid).

5.4 Climate change vulnerability and impacts
Over 40% of the earth’s land surface is dry lands, encompassing arid, semiarid, and dry sub humid climatic zones that are home to approximately 2.5 billion people (Millennium Ecosystem Assessment 2005). Livelihood sustainability in these regions is threatened by a complex and interrelated range of social, economic, political, and environmental changes that present significant challenges to researchers, policy makers, and, above all, rural land users (Reynolds et al., 2007).

Dynamic, often termed non equilibrium, ecological, and environmental change models (e.g., Dougill et al. 1999, Joubert et al. 2008) suggest that climate change-induced drought events may exacerbate this problem, pushing dry land systems to cross biophysical thresholds, causing a long-term drop in agricultural productivity. The scientific consensus with regard to future climate change is that the proportion of dry land areas affected by droughts is likely to increase (IPCC 2007a). Sub-Saharan African dry lands have been highlighted as particularly vulnerable because of their low adaptive capacity and sensitivity to the projected changes (Callaway 2004, IPCC 2007b).

A recent situation analysis conducted in agriculturally less favoured and high potential areas of Tanzania and Malawi (Majule et al., 2007a and b) have indicated that pasture and water availability are increasingly becoming scarce in many areas due to changes in rainfall patterns and decreasing rainfall amount. Apart from that, evidence suggests that during high rainfall periods, Ndigana become a serious problem and rift valley disease is most prevalence following El Nino in central parts of Tanzania (Majule et al., 2007b).
Livelihoods of the majority of people living in rural areas of Tanzania depend on agriculture and other natural resources, particularly forest products, to obtain food and income (URT, 1997; Majule et al., 2007a). In many Sub-Saharan African (SSA) countries, smallholder agriculture underpins most rural livelihoods and national economies, and worsening poverty and increasing food insecurity is closely linked to low and/or declining levels of agricultural productivity. In the medium term, appropriate means of enhancing agricultural growth and productivity are key components to a viable and widely applicable poverty reduction strategy (Thirtle et al., 2001). A re-appreciation of this has renewed interest by African governments (NEPAD, 2003) and development agencies in increasing agricultural productivity. Already vulnerable to highly variable climatic and soil conditions, accelerating climate change and declining soil fertility poses a further significant challenge to improving agricultural productivity in SSA (Devereux and Edwards, 2004).

Tanzanian agriculture is mainly subsistence in nature and to a large extent depends on rainfall as well as natural soil fertility which have been reportedly declining over years (Majule et al., 1997). Similarly, climatic conditions play a major role in influencing crop pests thus an increase of humidity due high precipitation creates conducive environment for fungus generation with significant reduction in crop production. A good example is with cashew nut production in Tanzania which is significantly affected by a fungal disease known as Powdery Mildew (ibid.). Increased precipitation is also projected to propel the leaching of nutrients, removal of topsoil through erosion, impaired nutrients transformation under water logging conditions affecting plant development and eventually dwindling crop yields. Due to these anticipated changes, it is predicted that coffee for instance will most likely be grown successfully where rainfall would increase with cotton growing areas shrinking. These changes will also affect grain production. Maize yield for example, is expected to decline by about 33 percent over the entire country (Initial National Communications-URT, 2003).

Rainfall is a dominant driver of ASAL land cover and constrains human land-use (Ellis and Galvin, 1994). Temporal rainfall patterns influence the balance of crop cultivation and pastoral land-use, as well as the degree of integration of these two land-uses. Whereas a unimodal rainfall regime favours agriculture due to a more concentrated and predictable growing season, a bimodal pattern of rainfall in ASAL, such as that found in Tanzanian rangelands, favours pastures, woody plants, and pastoral land-use (ibid.). In most African semi-arid savannahs, rainfall is highly variable and a major determinant of inter-annual variability of crop and livestock yields (Mace 1993; Ellis and Galvin 1994).

In connection to that, the majority of African livestock and more than 50 million people who are dependent on livestock and dry land agriculture reside in dry zones. Climate variability is characteristic of all dry lands, but in Africa it is particularly potent. This precipitation variability influences ecosystem dynamics and thus exerts a major
influence on human lifestyles and land use patterns. Pastoralists and agro-pastoralists have, in the past, adapted very well to climate variability. While the early Maasai of Tanzania and southern Kenya did cultivate at times in addition to herding livestock, a series of droughts in the eighteenth and nineteenth centuries reinforced specialized Maasai livestock herding under the difficult conditions (Lamprey 1983; Homewood and Rodgers 1984). However these populations have recently become vulnerable to climate variability in large part because their strategies for coping with climate variability have become constrained (Kathleen et al., 2001).

5.5 Resilience and adaptation to climate variability and change impacts

The concept of resilience—the ability to respond to environmental shocks—is attributed to the ecologist C. S. Holling (1973). It is defined by the IPCC (2007a: 880) as “[t]he ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change.” It has been found useful in work on climate change because it recognizes that the same climate change might produce different impacts due to variations in the stability and vulnerability of different social or ecological systems. Pelling’s (2011: 42) recent review establishes that resilience “is not simply synonymous with adaptation.” This is illustrated by an example where (short-term) risk management can lead to (longer-term) institutional inertia, which highlights the need to understand the “social processes shaping resilience” (ibid: 43).

Adger (2003) stresses on resilience concept by arguing that the resilience of social-ecological systems is determined by the magnitude of the perturbations that they can absorb and still retain their overall function; the degree to which the system is capable of self-organisation; and the degree to which capacity can be built for learning and adaptation. The agenda implied by resilience actually challenges some widely held tenets about stability and resistance to change that are implicit in how sustainability is formulated in environmental and social policy arenas around the world. Adger (ibid.) further notes that promoting resilience means changing, in particular the nature of decision-making to recognise the benefits of autonomy and new forms of governance in promoting social goals, self-organisation, and the capacity to adapt. Promoting resilience is concerned with the knowledge required to facilitate robust governance systems that can cope with environmental changes and social, demographic and democratic transitions (ibid.). Therefore, Adger cautions that adaptation to global environmental change is likely to be punctuated by examples of system collapse unless resilience is recognised as a central goal of sustainable development. Success in environmental policy should be redefined by how it promotes and facilitates resilience, and by how it promotes legitimate, broad-based development that allows individuals and societies to cope with risk and adapt to changing circumstances over time.
In many cases, adaptation activities are more local (that is district, regional or national) issues rather than international (Paavola et al., 2005; Parry et al., 2005). This is because different communities in different geographical locations and scales are exposed to different levels of vulnerability and possess varying adaptive capacities, thus they tend to be impacted differently, and thereby exhibiting different adaptation needs (Ndesanjo, 2009). Moreover, Majule et al., (2008) notes that adaptive capacity to climate change varies within communities due to various factors including variation on wealth among social groups, age, gender and sex. A number of adaptations especially during extreme events, further notes Majule et al., have been developed by different socio-economic groups: the poor people sell labour in rich people farms, engaging in non-farm income generating activities such as brick and charcoal making, reducing the number of meals from two to one per day; the middle adapt by engaging in non-farm income generating activities, food vending, and resorting to cheap marriages; and the rich tend to hide food to discourage the rest of the community from begging food.

A good case of pastoral system adaptation and eventual resilience is put across by Bolling’s (2003) work on pastoral populations from Kenya: the *Pokot* and Northern Namibia: the *Himba*. Bolling expounds that both populations have developed a number of strategies to cope with shortfalls in food production. These include: herd diversification to contain different impacts of drought on grass and bush land; intensified sharing of food; networks of livestock sharing through livestock loans and gifts during good times to create networks of obligations; institutionalised resource protection through indigenous knowledge approach; extended spatial mobility and rituals; as well as reliance on food-aid. He further notes that while the immediate management of disasters is necessary to prevent human mortality and excessive loss of livestock, institutionalised buffering mechanisms lower vulnerability. Immediate responses to a crisis are aimed at enhancing personal well-being. Buffering mechanisms take another approach: individual benefits are given up to create security as a common good. Pasture protection for instance is a good case. Herders give up opportunities to exploit virgin grazing for the common good of a regulated and predictable range management.

Along the same argument, Lynn (2010b) findings among Maasai pastoralists in Tanzania, which do not differ widely from those of Bolling (2003), indicate that this society traditionally reduce risk from spatial-temporal variations in resource availability through a multitude of adaptations. These include; livestock movements and migrations to track forage and water availability, herd diversification to multiple species (spreads risk across species), and social programs such as stock associations and wealth re-distribution from wealthy to poor. In that regard, Maasai pastoralists of Tanzania for instance, keep a mixture of cattle, goats and sheep. These complementary herd species allow livestock to take maximum advantage of available resources in different ecological niches, similarly to wild species assemblages (Swift et al., 1996). Mixed herds also ensure that the herd owner is buffered against species-specific disease outbreaks.
The ratio of species herded depends on cultural preferences, environmental parameters and the personal choices of the herders themselves (Cooke, 2007). In years following drought, the proportion of livestock held in the small stock (sheep and goat) herd will increase because small stock reproduce at 2-4 times the rate of cattle, one to four offspring per year as opposed to one birth every year and a half to two years for cattle (Lynn, 2010b; Dahl and Hjort 1976; de Leeuw et al., 1991), so they are particularly useful and important after droughts and other disasters. Goats are frequently sold for cash, given as gifts, or slaughtered for food or ceremony because the amount of money and food generated by a single goat is optimal for day to day transactions.

5.6 Institutional role in climate change resilience and adaptive capacity enhancement

Over the years most of the efforts to curb climate change have been concentrated on mitigation especially reduction of GHGs through cutting down use of fossil fuels and sequestering carbon by emphasising on reduced deforestation and increasing afforestation (Ndesanjo, 2009). Watson et al., (1996) and Kates (1997) suggest that the reason for this lies in the existence of two distinct schools of thought about climate change, both of which have chosen not to encourage adaptation research. On the one hand, Kates identifies the “preventionist” school, which argues that the ongoing increase of atmospheric greenhouse-gas concentrations could be catastrophic and that drastic action is required to reduce emissions. Preventionists fear that increased emphasis on adaptation will weaken society’s willingness to reduce emissions and thus delay or diminish mitigation efforts. On the other hand, one finds what Kates refers to as the “adaptationist” school, which sees no need to focus on either adaptation or mitigation. Adaptationists argue that both natural and human systems have a long history of adapting naturally to changing circumstances and that active adaptation would constitute interference with these systems, bringing with it high social costs.

Similarly, Klein (2000) argues that another reason why scientists and policymakers paid little attention to adaptation until recently is that the understanding of the process and mechanisms along which adaptation to climate change occurs is still limited, while uncertainties concerning the location and magnitude of impacts remain considerable. Adaptation is intricately linked with non-climatic developments and takes place in a dynamic societal context. Therefore, the identification and implementation of appropriate adaptation options, that is, options that are economically efficient, technically feasible, environmentally sound, culturally compatible and socially equitable, is fraught with difficulties. In the recent years however, a significant number of countries especially from a developing world with support from a few developed countries have embarked on massive adaptation programmes nullifying what Kates, (1997) hypothesised.
Expounding on this aspect, Klein (2004) clarifies that adaptation is undertaken by governments on behalf of society, sometimes in anticipation of change, but, again in response to individual events. At any level, adaptation proceeds through two main steps: facilitation and implementation (ibid.). Whereas the former involves raising awareness, removing barriers and making funds available for adaptive strategies, the later involves making physical operational changes in practice and behaviour. Adaptation to climate change can therefore be reactive or proactive (anticipatory) (Paavola and Adger, 2005; Parry et al., 2005). Reactive adaptation responds by reacting to the present impacts of climate change with for example, the provision of food aid after disaster, relocation or reconstruction of infrastructure after flood damage or migration to a new locality. Proactive adaptation, on the other hand, seeks to avoid the risks and impacts of climate change before they happen for instance diversification of crops and change of agricultural patterns, designing and building higher floor levels or suspended timber floors and land zoning. While disaster response and rehabilitation is essential to save lives and livelihoods, as far as the two approaches are concerned, the past 20 years have seen the recognition of the role of risk reduction and preparedness (Ndesanjo, 2009; Abramovitz, 2001; Camilleri et al., 2001; Pavoola and Adger, 2005).

Institutional memory of past climate events and traditional knowledge have, to the present, dominated adaptation experiences among local communities in Tanzania. Among farmers for instance, the increasing unpredictability of rainfall season in East Africa has led to more people having to adapt simple modern technologies such as use oxen ploughs as opposed to traditional approaches. Ploughing land using oxen is much faster than hand and this speed allows maximum use of the shortened, often intermittent rainy period for crop production. However, the poorest households can rarely afford to plough using oxen and the wealthier owners prepare their own fields first (Nelson and Stathers, 2009).

In Tanzania the mandate of climate change adaptation falls under the Vice President’s office through the National Adaptation Programme of Action (NAPA). NAPA’s mission is to identify immediate and urgent Climate Change Adaptation Actions that are robust enough to lead to long-term sustainable development in a changing climate. NAPA also seeks to identify climate change adaptation activities that most effectively reduce the risks that a changing climate poses to sustainable development (URT, 2007). It should however be noted that the Government of Tanzania still face potential threats on feasible implementation of NAPA. Apart from limited internal capacity to fund adaptation activities, other threats include: extreme poverty of the most vulnerable groups; poor infrastructure, especially poor rural roads making it difficult to access rural areas, hence difficulties in delivering farm inputs and accessing markets; limited credit opportunities for rural communities to allow family households easily access farm inputs; the impact of HIV/AIDS creating a major drain on family energy, cash and food; poor health conditions of resource-poor rural communities, and limited analytical capability of local
personnel to effectively analyze the threats and potential impacts of climate change, so as to develop viable adaptation solutions (ibid.).

As a result of little capacity by the governments to feasibly implement climate change adaptation, the burden is left to local communities, households and/or individuals. Experience from CARE food security projects in Mwanza shows that in responding to recurrent unfavourable rain seasons, pastoral communities are forced to sell part of their herds as a coping mechanism. The effect is felt at the household level, in the form of reduced nutritional intake among household members. In some other communities, men sale charcoal and women are forced to sell firewood. It is valid to say that local communities need help to adapt to climate change, as these coping strategies may lead them to becoming more vulnerable not only to changes in the natural resource base but to food and nutritional insecurity (CARE, 2006 as cited in Yanda and Mubaya, 2011)

6.0 Methodology
6.1 Study area
The study will be undertaken in selected villages in two regions located in northern Tanzania; Arusha and Tanga. Two districts will be earmarked for the studies which are Simanjiro and Handeni. Simanjiro has repeatedly been hit by droughts in recent years leading to loss of large number of livestock due to pasture and water scarcity. To countercheck this pastoralists usually resort to transhumance which involves moving their herd to other areas with promising pasture and water availability. It has been learnt that Handeni district in Tanga makes one of the most preferred destination for pastoralist in search of pasture and water (personal communications). Undertaking the study in these two context will provide a clearer picture of how pastoral systems cope and or/adapt to the ongoing impacts of climate variability and change. The two areas have been selected due to these premises.

6.2 Research design
The study will adopt both descriptive and explanatory research designs. As the former allows for description of a given phenomenon, the latter will allow test of relationships. Together with that, an explanatory study enables the study to formally seek answers to problems by answering the question “why” as opposed to questions such as “what”, “where”, “when” which are answered by a descriptive approach. Finally, this combination of designs will enable the study to describe relationship(s) among variables (Singleton and Strants, 2005; Babbie, 2010). Further, the study will incorporate both quantitative and qualitative research by collecting data for both. See a section on data collection techniques for further details.

6.3 Sampling
The proposed study intends to use both probability and non-probability sampling techniques. On the one hand, the defining property of probability sampling according
Singleton and Strans, (2005) is that “every possible combination of cases has an equal chance of being included in the sample. Following acquisitions of the village population from village register, simple random sampling will be used to identify sample for household survey. On the other hand, purposive sampling will be used to determine a sample for in depth key informant interviews and focus group discussions (FGD). This non-probability sampling technique allows the investigator to rely on his/her expert judgement to determine representative units (ibid.). The study proposes to engage a total of 300 households, 150 from each study site, for household survey. Sample size for participatory data collection will be determined by the nature of stakeholders related to the study. Ideally, these will involve the elderly due to their long term experience in the study site, local government officials, ministry of livestock development and fisheries, grassroots Community Based Organisations (CBOs) and non-governmental organisations working with pastoral societies.

6.4 Data collection techniques
Data collection techniques will vary according to objectives and their respective requirements as described below:

**Activity:** Determining patterns and trend of climate variability and change in the study area

**Methods:** The study proposes to look at two key climate variables namely rainfall (precipitation) and temperatures. These two variables have been chosen as they primarily influence the availability of pasture and water for livestock among pastoral systems. To determine the trend of such variables, data of the same between thirty years ago and now will be obtained from the Tanzania Meteorological Agency (TMA) and subjected to trend analyses using Microsoft Excel software. The IPCC (2007b) defines climate in a wider sense is the state, including a statistical description, of the climate system particularly precipitation, temperature and wind. The classical period of time is 30 years, as defined by the World Meteorological Organization (WMO). It is against this criterion that the study seeks to use climate data collected over the past thirty years.

**Activity:** Assessing vulnerability of and impacts on pastoral system by climate variability and change:

**Methods:** In addressing the second objective the study will employ a combination of participatory approaches (Songok et al., 2011). Focus group discussions (FGDs) and in depth interviews with purposively selected key informant will be undertaken. Group discussions are said to build up collective and creative enthusiasm, which leads to sharing familiarising new ideas and concepts with an outsider who then familiarise with them (Chambers, 1992). Key informant interviews likewise, will enable the study to obtain climate information from people with long term experience on the area as well as expert knowledge thus counterchecking the credibility of data from other sources. Also,
questionnaire surveys will be undertaken with randomly selected pastoral households. This task will be guided a modified three dimensional Generic vulnerability framework by Fraser et al., (2011). To this end, two aspects will be considered when assessing vulnerability including: (1) a micro assessment of the pastoral system (livestock, pasture, water) in study site(s) in order to determine the system’s ability to maintain productivity and/or rebound following climatic perturbation; and (2) assessment of livelihood assets vulnerability among surveyed households to determine their ability to adapt.

**Activity:** Determining resilience status of pastoral system to climatic perturbations in northern Tanzania:

**Methods:** The study in addressing the third objective will employ the Resilience Alliance (2007) social-ecological systems (SESs) assessment guidelines in determining the pastoral system’s resilience status. This is step by step guide that can be applied in different context while assessing SESs resilience. Three key aspects will be considered to attain this, namely the study population; herd; and the environment that support the two. Based on the Resilience Alliance guidelines, specific questions/items to draw information on this objective will be incorporated into the household questionnaire as well as FGD and in depth interviews guides.

**Activity:** Evaluating institutional capacity and role in enhancing pastoral system’s resilience to climatic perturbations in northern Tanzania:

**Methods:** In this study, an institution(s) will be perceived at different levels starting from a family (household) through local authorities to national governing bodies both public and private. To address this objective, the study will adopt a Social Network Analysis (SNA) approach. The method has been adopted from Stein et al., (2011) on water governance in Mkindo catchment-Tanzania. A network approach entails a formal observation of social networks both individually and collectively as a set of actors connected through a single or multiple relationships. It is these actors and their network ties that define network data to be analysed using SNA (Marin and Wellman, 2010; Borgatti et al., 2009). Therefore, the actors will consist of local and central government agencies as well as organizations ranging from community based (CBOs) to national ones dealing with pastoral societies. Households will not be included as visiting each individual in the network will be unfeasible. Generation of network data will be through semi-structured interviews, group discussions and organizational survey (Stein et al., 2011).

### 6.5 Data analysis plan

Quantitative data from household survey will be subjected to descriptive statistics where measures of central tendency particularly frequencies will be determined. In order to compare the relations among variables cross tabulations will be used. The study will use Statistical Package for Social Sciences (SPSS) software to analyse survey data.
Qualitative data will be analysed and presented based on pre-determined themes, categories, and patterns into which data from the field will be collapsed.

7.0 References


Hanneman, R.A., and M, Riddle, (2003). Introduction to Social Network Methods, University of California, Riverside, California


Holmgren, K., and H. Öberg., (2006). Climate Change in Southern and Eastern Africa During the Past Millennium and its Implications for Societal Development,
ENVIRONMENT, DEVELOPMENT AND SUSTAINABILITY, Volume 8, Number 1, 185-195, Springer


Klein, R.J.T., (2004). “Approaches, Methods and Tools for Climate Change”, Keynote Lecture to the In Session Workshop on Impacts of, and Vulnerability to Climate Change, 21st Session of the UNFCCC Subsidiary Body for Scientific and Technological Advice, Buenos Aires, 8 December 2004


Climate Change and Variability: Local Perceptions, Vulnerability Current and Future Adaptation Strategies, Tanzania Situational Analysis


Mcbean, G., A. Weaver, and N, Roulet., (2001). The Science of Climate Change, What do we know? ISUMA


Swift, M.J., A-M.N. Izac and M. van Noordwij (1996), Biodiversity and ecosystem services in agricultural landscapes: Are we asking the right questions?


United Republic of Tanzania (URT) (2007). National Adaptation Programme of Action (NAPA), Dar es Salaam, Vice President’s Office

URT, (2003). Initial National Communication under the United Nations Framework Convention on Climate Change (UNFCCC), Vice President’s Office, Dar es Salaam, Tanzania

URT, (1997). National Environmental Policy, Dar es Salaam, Vice President’s Office


# Draft Time Plan

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<td>Proposal write-up and presentation</td>
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<td>2</td>
<td>Literature review</td>
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