Journal of Resources Development and Management
ISSN 2422-8397 An International Peer-reviewed Journal
Vol.13, 2015
www.iiste.org

Indigenous Knowledge Systems for Climate Change Detection and Adaption Planning in Mountainous Areas in Tanzania

Kassim Ramadhani Mussa*[1] and Ibrahimu Chikira Mjemah[1]
[1]Department of Physical Sciences, Faculty of Science, Sokoine University of Agriculture., P.O. Box 3038, Morogoro-Tanzania

Abstract
The study was carried out to gather perceptions and experiences of the Uluguru mountains communities on climate change and its impacts, and to understand their traditional innovations in detecting climate change and coping with the impacts. It took place in three villages of Luale ward namely Luale, Masalawe and Londo in Mgeta division, Mvomero district. Participatory research methods were employed in generating the perceptions, information and experiences about climate change, its impacts and community based adaptation strategies. Climate-related hazards were identified using traditional knowledge, skills and experiences. Historical timelines developed by the local people themselves revealed an increase in the frequency of drought incidences and shifting rainfall seasons, with unprecedented wildland fires devastating the study area. Community-based coping strategies as a response to the observed climate change impacts were also identified. However, the coping strategies practised by the traditional communities are mainly oriented towards survival, not continuous, motivated by crisis, reactive, often degraded the available resource base and are usually prompted by lack of alternatives. Therefore, local communities and traditional people in general need the support of the international community to continue their role as traditional caretakers of marginal and fragile ecosystems, at the same time, building their capacities to adapt to the impacts of the current and future changes of global and local climates using more proactive approaches integrated into their indigenous knowledge base.
KEY WORDS: Climate change, Traditional communities, Indigenous knowledge

1.0 Introduction

Climate change is today considered one of the major threats for sustainable development in Tanzania and the rest of the world (IPCC, 2007). It influences health, infrastructure, settlements, food security and agriculture, forests and marine ecosystems. In the United Nations Framework Convention for Climate Change (UNFCCC), adopted in 1992, the International community agreed on mitigation and adaptation as the two basic strategies to deal with climate change. The two strategies are complimentary to each other and not substitutes (IPCC, 2001).
For poor, traditional and natural resource-dependent communities, climate change may compound existing vulnerabilities. Settlement on marginal lands (less fertile for the case of Uluguru Mountains) or unstable ones already heightens exposure to climatic hazards. Heavy dependence on ecosystem services places their welfare at the mercy of climatic conditions. Therefore, as the availability and quality of natural resources plummet, so does the security of their livelihoods. Watson (1997) pointed out that limited resources and capacities for responding to stresses such as droughts constrain the ability of poor communities to meet basic needs and move out of abject poverty.

Climate change is projected on a global scale and is a global phenomenon. However, different areas and different environments are affected very differently (Salick and Byg, 2007). The world is usually divided into broad environmental categories within which there are some climate change commonalities but also many local and regional variations. For instance, Aristotle tried to classify the climates of the earth into Temperate, Torrid, and Frigid Zones. However, the 20th century classification developed by German climatologist and amateur botanist Wladimir Koppen (1846-1940) continues to be the authoritative map of the world climates in use today and the most widely used system that classifies the world's climates into categories based on the annual and monthly averages of temperature and precipitation (Koppen, 1936).

In that regard therefore, people are likely to face different aspects of climate change depending on where they live. In most cases however, traditional and indigenous people are rarely considered in academic, policy and public discourse of climate change, despite the fact that they will be greatly impacted by impending global changes because their livelihoods largely depend on natural resources that are directly affected by climate change, and they often inhabit economically and politically marginal areas in diverse, but very flimsy ecosystems.

Recent studies (Salick and Byg, 2007; Macchi et al., 2008 and Koivurova et al., 2008) have indicated that indigenous and other traditional people are vital and active parts of many climate change studies and the integration of their knowledge and skills in designing and implementing adaptation projects in highly vulnerable countries may help to enhance the resilience of their livelihood systems to climate change impacts and the resilience of the ecosystems within which they are found. Traditional people interpret and react to climate change impacts in exceptionally creative ways, drawing on their locally available indigenous knowledge and skills which are usually combined with new technologies to find solutions, which may help societies at large to cope with the looming climate change impacts. Therefore, this implies that climate change should not be understood as a problem which is strictly amenable to scientific fixes; but it has profound roots from the indigenous and traditional communities in Tanzania and elsewhere in the world.

Furthermore, many studies have indicated that, while climate models are capable of portraying a bigger picture of climate change and provide estimates for the likely consequences of different future scenarios of human development, they are not very good at providing information about changes at the local level. In recent years, there has been an increasing realisation that traditional groups are a valuable source of this information. Most published reports on indigenous observations of climate change and variability (Macchi et al., 2008; Koivurova et al., 2008) have come from Arctic regions where the collaboration between scientists and indigenous people is strongest. However, it is not only in the Arctic regions where traditional people are observing climate changes. In Africa and in Tanzania in particular, traditional people are observing climate change and they have already started devising the local coping strategies, although at the policy level their efforts to fight climate change are not recognized and not documented yet.

Therefore, the detection of climate change using indigenous knowledge is an essential input when designing the national policies, strategies, plans and programmes for addressing vulnerability to climate change impacts. It is against this background that this study sought to utilize indigenous knowledge and skills of the Luguru communities in the Western slopes of the Uluguru Mountains, Morogoro-Tanzania, to detect and reconstruct climate change, analysing key hazards and their ensuing impacts and how they have been coping with the already existing climate change impacts.

1.1 Study objectives

1.1.1 Overall objective

This study aimed at understanding the local perceptions of climate change, its impacts and the local coping strategies using locally available knowledge and skills. However, the study was guided by the following specific objectives

(a) To explore various traditional innovations applied by the mountainous, forest-dependent communities in detecting onset of seasons as well as detecting climate change and variability

(b) To reconstruct the past and present changes in rainfall trend using indigenous knowledge, memories and narrative analysis.

(c) To identify and weigh up major hazards which constrain their livelihood strategies and identify key traditional coping strategies.

2.0 Study Methodology

2.1 Description of the study area

This study was conducted in Mvomero district, Morogoro region, covering 3 villages of Luale ward namely Luale, Londo and Masalawe in Mgeta Division. Mgeta division lies in the Western slopes of the Uluguru Mountains, which is part the Eastern Arc Mountain ranges comprised of Uluguru, Usambara and Udzungwa mountains. The Uluguru mountains lie immediately South of Morogoro town in Tanzania between latitude 7° and 8°S and longitude 37°-38° E, about 190 km from Dar es Salaam, the commercial city of Tanzania as shown in Figure 1.

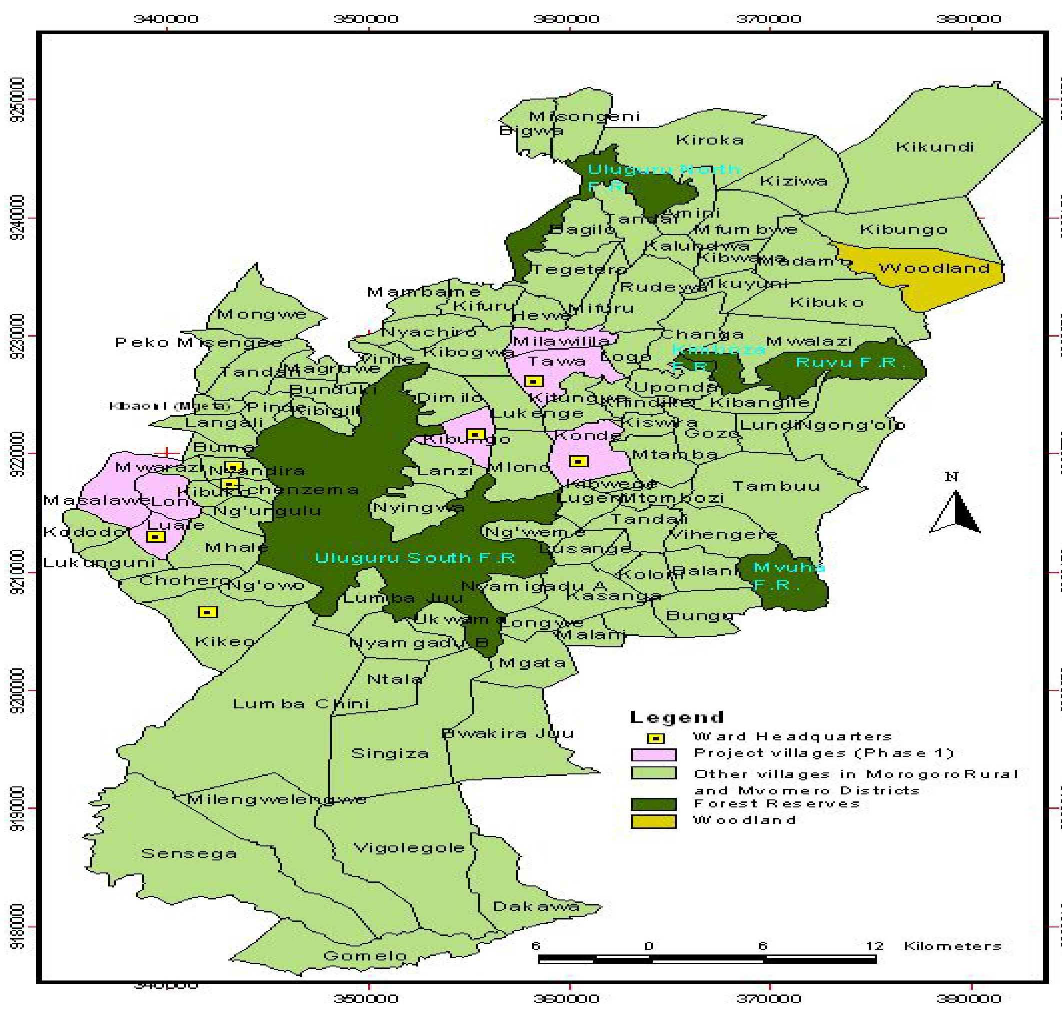

Figure 1: Part of map of Tanzania showing the location of the Uluguru Mountains

Different socio-economic activities are carried out around the forest, agriculture being the major one, which is mostly carried out at a subsistence level to produce both food and cash crops. The topography of the Uluguru Mountains is not very friendly to mechanized agriculture and there is a very acute shortage of land. Even then, the available land has significantly lost its natural fertility, resulting into poor crop production. The main crops grown in the Uluguru Mountains include cabbages, maize, peas, bananas, cassava and cocoyam. Tree crops include deciduous fruits like peaches, plums pears and apple; and forest trees like Eucalyptus spp, Cupressua lusitanica, Grevillea robusta and Acacia mearnsii (Senkondo, 1992).

2.2 Climate of the study area

Climatically, the Uluguru Mountains capture moisture passing inland from the Indian Ocean and the east-facing slopes of the Uluguru Mountains have more of its rainfall influenced by the Indian Ocean circulations than the east-facing slopes. The estimated rainfall is 1200 mm per annum in the Eastern slopes, while it is well above 2000mm per annum in the western slopes. The Uluguru Mountains receive two rainfall seasons per year, the long rains which start in March through May and the short rains which commence in October through December. The mean annual temperature in the area is about 24.3°C, with a maximum of 26.5°C in December and a minimum of 21.1°C in July (Lyamuya et al., 1994). Nevertheless, Jens et al. (1993) argued that the mean annual temperature can go down to19.5°C in certain years, with a maximum of 22°C in December and a minimum of 17° C in July. However, this is an evidence of small scale change in the climate of areas such as the Eastern Arc Mountains which might be due to the effect of anthropogenic alteration of the habitat on those mountains specifically through deforestation.

2.3 Why the Western slopes of Uluguru Mountains?

Having a much higher annual rainfall amount than its Eastern counterpart, less climate change-related research has been directed in this particular area. In addition, the theoretical information available in the literature, that the Western part of the mountains will suffer less than the Eastern part from climate change impacts (URT, 2005) called for non conventional approaches of detecting climate change and variability since the IPCC models and other scientific tools had reassured the scientific community that the study area is one of those parts of Tanzania which will benefit from the changing climate (e.g. increase rainfall). So, this study tried to explore a discrepancy between theoretical assumptions fed into global circulation models and the situation on the ground.

2.4 Methods and tools

This study employed participatory research methods and tools in generating qualitative and quantitative information about climate change, its impacts and community-based adaptation strategies. Primary information was acquired using focus group discussions (FGDs), key informant interviews and narrative analysis from farmers, elderly people and other livelihood groups. The FGDs and key informant interviews were used in carrying out resource mapping in order to reveal the key livelihood resources which are both, important for traditional people's livelihoods and are also vulnerable to climate change impacts. Further to this, a focus group discussion was used in developing a vulnerability matrix, which explored the vulnerability of major livelihood resources to climate change impacts. Two transect walks were carried out, not only to complement the focus group discussions but also to triangulate most of the information collected during the focus group discussions. Pair-wise matrix ranking was used to characterize and weigh up key hazards in the study area, ultimately determining the relative position and importance of climate-related hazards to the livelihood systems of these mountainous communities.

A narrative analysis enabled the development of a historical timeline which identified major climatic events and frequency of occurrences, using traditional knowledge and skills. Phenological markers, most used by traditional people for detecting the onset, the die-away and divergence of rainfall seasons were identified and documented. These were purely based on indigenous knowledge whereby a list of traditional weather indicators was developed in the first place, and the markers related to rainfall season prediction were identified and the participants were asked to describe the mechanisms with which the markers are used for weather forecasting, particularly the onset, recession and the quality of a particular season in terms of rainfall amount.

3.0 Results and discussion

3.1 Traditional innovations for detecting onset of seasons and climate change

The mountainous communities in the study area have outstanding phenological markers that signal the onset, recession and change of seasons. These ranged from the disappearance of some tree species, appearance of certain insects and noises of some amphibians. With climate change, many of these phenological events are occurring earlier or may be decoupled from the season or weather that they used to indicate. Despite the fact that there are so many markers of weather, climate, climate change and variability, only three phenological markers which pertain to onset, recession and quality of rainfall season are discussed in this paper.

(a) The disappearance of Fig mulberry tree (Ficus religiosa) and climate change in the Uluguru Mountains

First and foremost, the disappearance of Fig mulberry tree (Ficus religiosa), (Mkuyu in Swahili as well as the vernacular language of the Luguru people), which is a water-loving tree has been used as a signal of lessening seasonal rainfall. While in the past the area was endowed with numerous trees of that kind, nowadays, the trees are hardly seen around, and in some places they have been disappearing at an alarming rate, being a precursor of dwindling ground and surface water. The discussion with the local people, particularly the elderly revealed that in almost all the places where streams have dried up, the Fig mulberry tree no longer exists, thus being a good indicator of water scarcity. Whether or not the trees can re-emerge naturally as soon as water becomes plenty needs a thorough research, as this could not fetch reasonable answers from the local people.

(b) Red ants (Formica obscuriventris) and weather prediction by traditional Luguru people

Another important indicator for signalling decreasing precipitation are the red ants, Formica obscuriventris. In the first place, the appearance of red ants in a particular year not only indicates imminent rainfall onset as discussed by Chang'a et al (2010), but in the Western slopes of Uluguru Mountains this also signifies a prospect for good season, with bumper harvest. When flying ants are seen during rainy season, it is a sign of having more rainfall in the year. According to the interviewed people, under the changing climate, red ants have been as sporadic as the rainfall itself. Since their appearance is correlated to good rain season, conversely, their disappearance reflects decreasing rainfall.

(c) The sounds of frogs and the onset of rainfall season

When frogs start shouting, it indicates near rainfall onset. When the intensity of the noise increases, this tells the people of Uluguru Mountains that there will be more rainfall in the coming rainy season. To the traditional people in the Uluguru Mountains in Tanzania, there is a high correlation between the intensity of the noises frogs make and the intensity of the expected rainfall. In this regard therefore, to the traditional people, frogs are good bio-indicators of onset of rainfall and the quality of the rainfall season. That being the case, dwindling seasons can as well be traced using frogs. Whether every species of frogs can be used for that purpose (i.e. weather forecasting) or there is a varying degree of precision of prediction depending on a type of species of frogs needs a thorough study.

3.2 Indigenous knowledge for rainfall reconstruction

Models and records of precipitation mainly focus on changing amounts of precipitation with climate change and are less accurate than temperature models (Salick and Byg, 2007). In contrast, local people emphasize changes in the regularity, length, intensity, and timing of precipitation as described earlier on in sub-section 3.1. According to the reactions from the elderly segment of the local population in the study area, precipitation used to occur in clearly delimited seasons of rain in the years before 1960. However, from mid 1960s through 2010, rainfall seasons have reportedly become less distinct (as portrayed by various phenological markers) or occur at different times. In other areas where precipitation used to be regular, now there may be distinct dry periods and more intense rainfall in shorter periods of time.

A historical timeline carried out using a focus group discussion revealed an increasing trend of drought in the study area (Fig. 2) from early 1960s to the year 2010, whereby, using their locally available knowledge, memorable events and phenological markers like disappearance of Fig mulberry trees, local people could show that rainfall amount has been decreasing, with consequent crop losses. Severe droughts were experienced in 1968, 1988, 2006 and around 2007-2008. Conversely, 1970, 1980 to 1984 and 1997 to1998 were rainfall-laden years. The 1997/1998 season in Tanzania is a remarkable one since this is when the most severe El-Nino rainfall came into the mention of many Tanzanians, both the elites and those using indigenous knowledge systems.

These findings disagree with what is reported in the Tanzanian Initial Communication Report to the United Nations Framework Convention on Climate Change (UNFCCC) and The National Adaptation Plan of Action (NAPA) of 2007 which clearly 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% under the changing climate (URT, 2005). The Western slopes of the Uluguru Mountains, being one of the bimodal regions in Tanzania were expected to experience an increase in rainfall by around 5-45% as per the model predictions. The situation on the ground shows a much faster decrease in rainfall. This shows clearly that local knowledge, apart from complementing the scientific knowledge, can altogether be used for checking the validity and accuracy of the information provided by climate models.

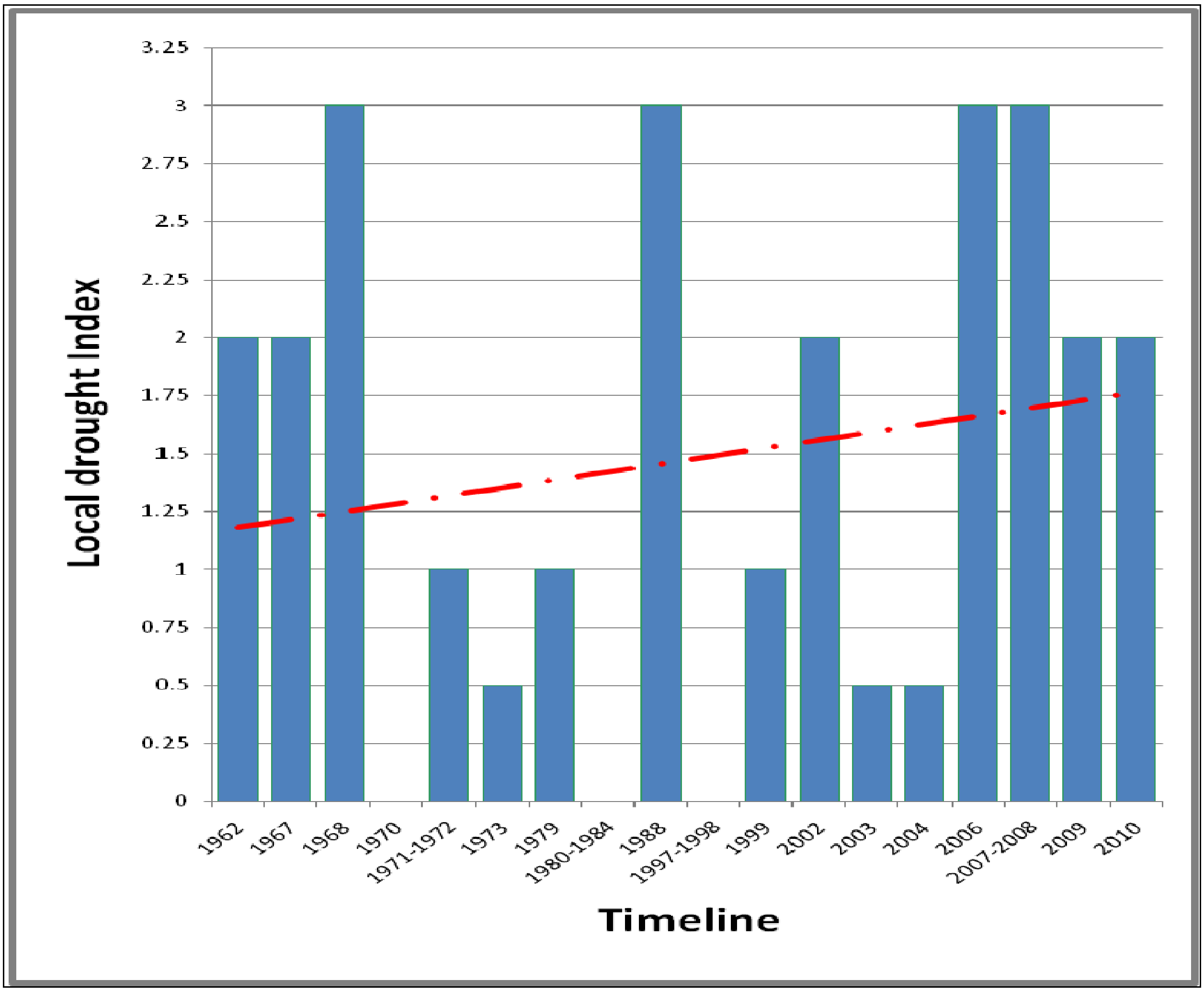

Figure 2: Historical timeline showing an increasing drought incident in the western slopes of Uluguru Mountains

KEY: Decision criteria

3.0: 75% to 100s% crop loss (Bad year)
2.0: 50% to <75% crop loss (Poor harvest)
1.0: 25% to < 50% crop loss (Average harvest)
0.5: < 25% crop loss (good harvest)
0: Wet year with bumper harvest

3.3 Seasonal rainfall variations from local people's perspective

Apart from a historical reconstruction of rainfall trend, late onset and an early withdrawal of rainfall were described using seasonal calendar analysis approach, where local communities were asked to recount if there are any observed differences in the timing of rainfall seasons as compared to 10/20/30 years ago. One of the most important questions asked to the local community members during focus group discussions and key informant interviews was, "Are there any trends or changes in the frequency and magnitude of rainfall over time?" Thereafter, a local drought index was developed to depict months which have been receiving rainfall above normal and those receiving way far below normal. A comparison was made between the years before the 1970s and the years after 19970s as depicted in Figure 3. According to the local people's perceptions, rainfall seasons followed a normal trend up to the end of the 1970s where anomalies in rainfall seasons started to manifest in the area. Therefore, it was reported that the months of March, April and May (MAM) were usually the long-rain months and October November and December (OND) being the short rain season. However, rainfall seasons have recently been observed to set on in late March or early April and withdraw in the early days of May. In addition, the same has been happening to the short rains, whereby instead of setting on in October, the rains have been starting in November (as shown by the red line graph in Fig. 3).

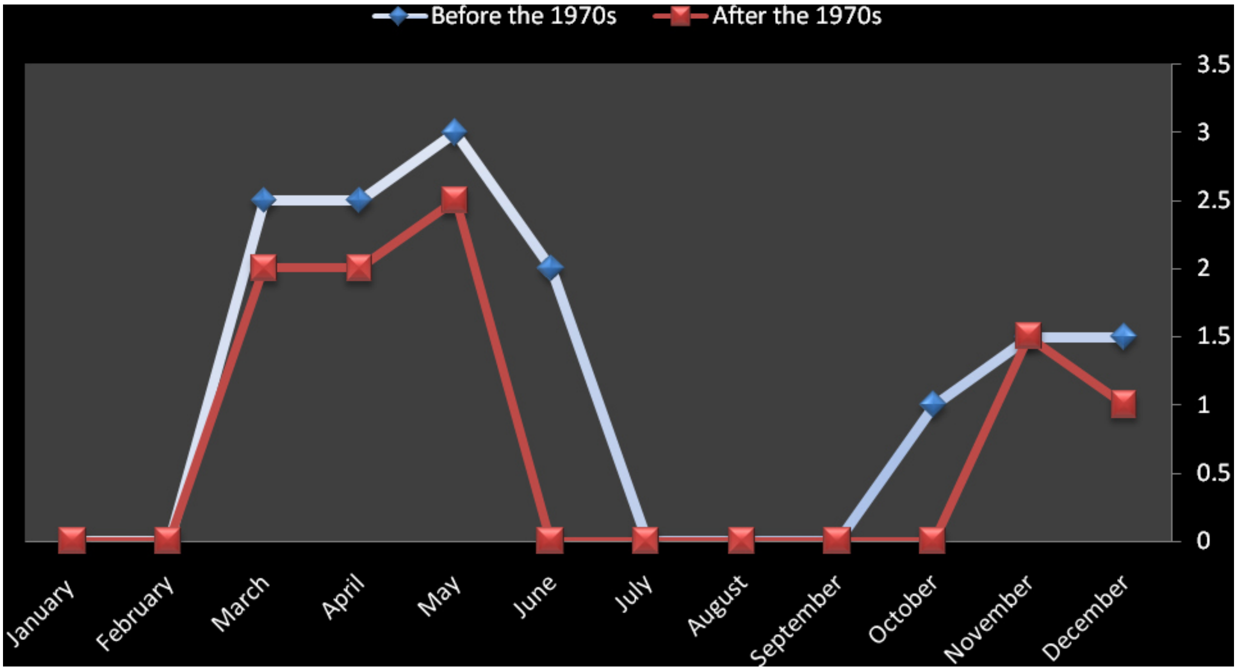

Figure 3: Seasonal rainfall variation before and after the 1970s
KEY:

3: Wet month (Above normal) **2:** Average precipitation
1: Below normal precipitation **0:** Dry month

3.4 Climate hazards, impacts and traditional coping strategies

Major hazards impacting the mountainous areas were identified using a key informant interview, followed by a focus group discussion. After identifying key hazards, a pair-wise ranking method was used to identify the hazards that highly impact their livelihoods. It was therefore realized that climate-related hazards are on the lead, indicating therefore that climate change and variability is a problem of greatest concern in the study area. Drought (27%) as shown in Fig. 4 was identified as the most problematic of all hazards, followed by wildland fires (25%). While carrying out the pair-wise ranking of hazards, traditional people could ostensibly link drought and wildland fires, adding that these two hazards are intertwined, naming drought as the causative agent of rampant wildland fires. The percentages represent the frequency which corresponds to the number of times the hazard has appeared in the pair-wise matrix, using a consensus-oriented discussion by the local community members.

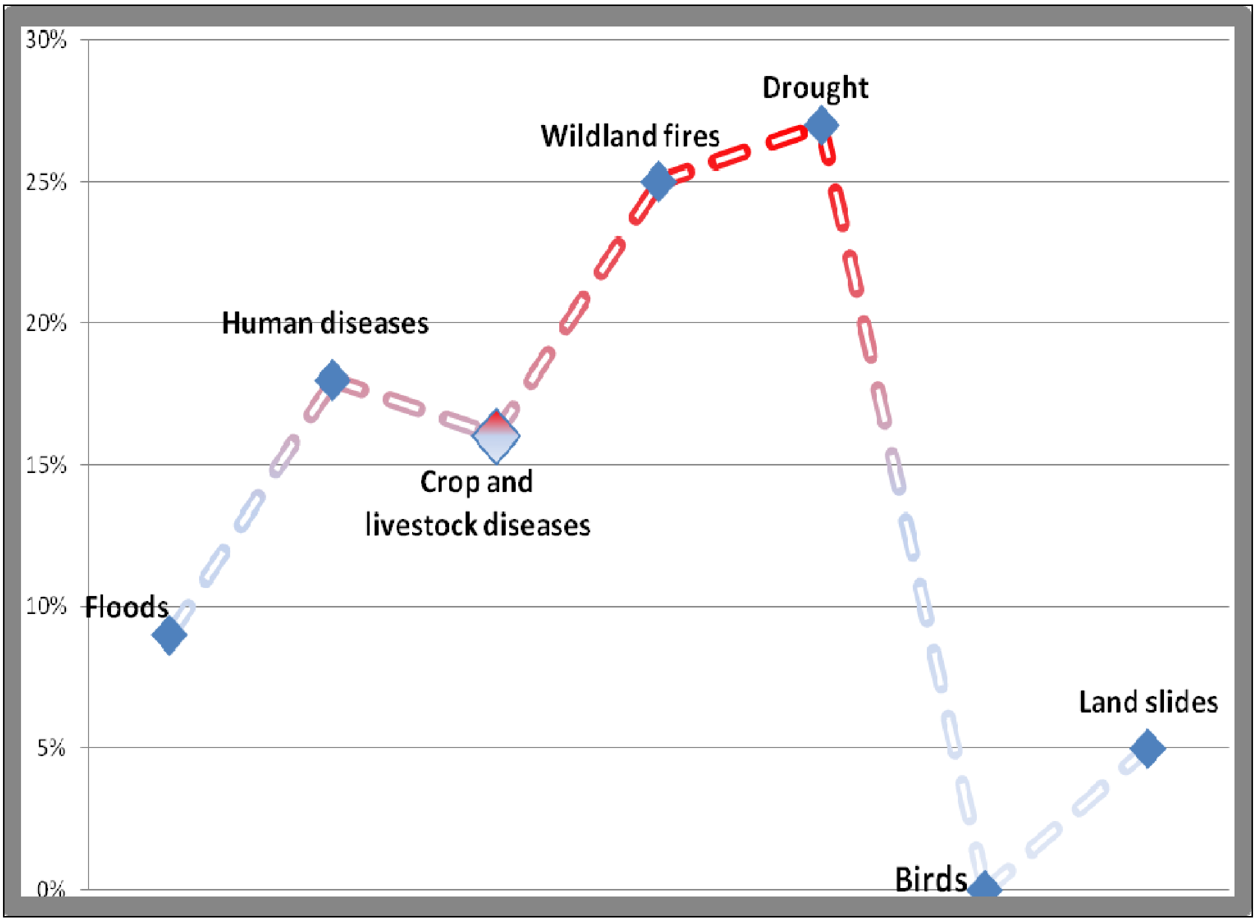

Figure 4: Major livelihood hazards in the study area.

Being a climate related hazard, drought has been accompanied by food insecurity since these communities heavily rely on a rain-fed farming system. On the other hand, wildland fires have been devastating to the cash and food crops, causing massive food shortages. Human, crop and livestock diseases have to a lesser extent been felt; some linked to climate change and some being there since time immemorial.

In reaction to drought, wildland fires and their accompanying impacts, the local communities have devised several community-based coping mechanisms. For instance, during acute hunger, men would migrate to other places in search for casual labour, living women and children behind. Other commonly practised coping strategies include, but not limited to hunting of wild rats and turn them into a meal while waiting for harvests. Nevertheless, rats are unpopular animals in Tanzania, thus turning them into food is the last choice a community would make. Furthermore, micro irrigation schemes have been observed to pick up to complement crop water requirements as a response to rainfall shortages.

In addition to micro-irrigation, terracing is also being scaled up as yet another soil moisture conservation technique. Though it has been there in the past but there has been an increased adoption in recent years when drought became more pronounced because of realization that terraces conserve moisture. However, some of the coping strategies practised by the traditional communities are mainly oriented towards survival, very reactive (e.g. the migration of men in the family in such of casual labour), may degrade the resource base and are usually prompted by lack of alternatives. Rat eating for instance is actually a survival mechanism during prolonged dry spells. Rat hunting in several occasions has reportedly led to rampant wildland fires, destroying forests and some perennial crops surviving dry conditions.

4.0 Conclusion

There is more reliance of indigenous knowledge for weather forecast and climate-related disaster prediction than on conventional weather forecast methods in the Uluguru Mountains. Thus, it was realized that local people's perception on climate change is not far too different from the scientific community's perception. Their indigenous knowledge gives them as much information on the change of climatic variables as does the Global Circulation Models (GCMs) and other scientific tools in the developed world and some other places of the country where media coverage is reliable. Therefore, indigenous knowledge is equally important in climate change studies in areas where the coverage of conventional weather forecasting is limited. Any interventions on climate change impacts, adaptation and mitigation should take on board indigenous and traditional knowledge on climate change detection and adaptation.

However, despite all the effort by the traditional people to cope with the observed climate change impacts in the Uluguru Mountains, it is very likely that the projected climate changes will exceed any previously experienced changes and their traditional coping mechanisms may therefore not in themselves be sufficient to deal with the ensuing climate change impacts. Therefore, it is obvious that local communities in Tanzania where climate change is already manifesting its impacts need the support of the international community (developed countries) to continue their role as traditional caretakers of marginal and fragile ecosystems, at the same time, building their capacities to adapt to the impacts of the current and future changes of global and local climates using more proactive approaches integrated into their indigenous knowledge base.

References

Chang'a, L. B., Yanda, P. Z. and. Ngana, J. (2010). Indigenous knowledge in seasonal rainfall prediction in Tanzania: A case of the South-western Highland of Tanzania. Journal of Geography and Regional Planning Vol. 3(4): 66-72.

Intergovernmental Panel on Climate Change (IPCC). 2001. Climate Change 2001: Impacts, Adaptation, and Vulnerability. Cambridge: Cambridge University Press.

Intergovernmental Panel on Climate Change (IPCC). (2007). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996 pp.

Jens O. S. and Hansen, L. A. (1993). Report on the Biodiversity Survey Royal Society for the Bird Life, UK.

Lyamuya, V.E., Noah, L.G., Kilasara, M., Kilenga, I.J. and Burgess, N.D. (1994). Socio- Economic and Land Use Factors Affecting the Degradation of the Uluguru Mountains Catchment In Po'cs, T. 1974. Bioclimatic Studies in the Uluguru Mountains, I. Acta Botanica Academiae Scientarium, Hungariae 20:115-135.

Ko¨ppen, W., (1936): Das geographisca System der Klimate. Handbuch der Klimatologie, W. K o¨ppen and G. Geiger, Eds., Vol. 1, C. Gebr. Borntraeger, 1–44.

Koivurova, T; Tervo, H; Stepien, A. (2008). Indigenous Peoples in the Arctic. A Background Paper. Arctic TRANSFORM 4 September 2008. pp33.

Macchi, M; Oviedo, G; Gotheil, Katharine Cross, K; Boedhihartono, A; Wolfangel, C; and Howell, M (2008). Indigenous and Traditional Peoples and Climate Change: IUCN Issues Paper March 2008. pp66.

Salick, J. and Byg, A. (eds.) (2007). Indigenous Peoples and Climate Change: A Tyndall Centre Publication. Tyndall Centre for Climate Change Research, Oxford May 2007 pp32.

Senkondo, E. M.M. (1992). Farming systems analysis of alternative agro-forestry systems in Tanzania. The case of Uluguru Mountains Area Morogoro. Dissertation for the Award of MSc. Degree at the Agricultural University of Norway (AUN).

United Republic of Tanzania (URT) (2005): Tanzania Meteorological Agency (TMA) Annual Report. Government Printer, Dar es Salaam. Tanzania.

Watson, R. T. (1997). Summary for Policymakers. The Regional Impacts of Climate Change: An Assessment of Vulnerability. A Special Report of IPCC Working Group II. Cambridge: Cambridge University Press.