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ADAPTIVE CAPACITY TO CLIMATE CHANGE OF PASTORALISTS IN KILOSA DISTRICT, TANZANIA

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ABSTRACT

A study was conducted to investigate the adaptive capacity of pastoralists in Kilosa district to climate change. Specifically, the study assessed the trend and impact of climate change in the area, adaptive elements of pastoral communities against climate change and determined the contribution of state agencies in enhancing pastoral system's resilience to climate variability in the district. Data were collected using household questionnaire survey, focus group discussions, key informant interviews and field observation. The data was analysed using Excel and SPSS computer software programs. Results revealed that in the period 1972-1974, there was a significant shift of rainfall in the study area from bi-modal to unimodal. This trend has been consistent with climate change scenarios in recent decades of lower rainfall and more severe droughts. Most pastoralists were aware of climate change impacts namely water scarcity, increase of livestock diseases and increased distance to grazing lands. The capacity of pastoralists to adapt to climate change stress depends largely on the number of livestock. Pastoralists owning more livestock are more likely to adapt to climate change. This study recommends that the community should diversify to other sustainable economic activities rather than relying on livestock only while climatic conditions are not favourable for this economic activity. The Government should put more effort on supporting pastoralists in their adaptive strategies as well as make regular review of policies to favour adaptation measures.

Key words: Pastoralists, climate change, adaptive capacity, Kilosa.

BACKGROUND INFORMATION

Climate change refers to a systematic change in the key dimensions of climate including average temperature, wind and rainfall patterns over a longer period of time (IPCC 2001). Climate change is rapidly emerging as one of the most serious global problems affecting many sectors that lead world development with undesirable impacts on environment, human health, food security, economic activities, natural resources and physical infrastructure (Magombo *et al.* 2012; IPCC 2007). The negative consequences of climate change in Africa are already happening in terms of prevalence of frequent floods, droughts and shift in agricultural practices including pastoral systems facing limited adapting capacity (Collier *et al.* 2008). In response to all the associated stresses of climate change, numerous adaptive measures are taken by all affected parties depending on locality and the extent of impact.

Significant attention has been devoted to the indicators of adaptive capacity, which are characteristic of regions, countries and communities that influence their propensity or ability to adapt to the impact of the climate change. Smit and Pilifosova (2001) state that "these determinants of adaptive capacity relate to the economic, social, institutional, and technological conditions that facilitate or constrain the development and deployment of adaptive measures. Adger (1999) asserted that countries with limited economic resources, poor

information and skills, poor infrastructure, unstable or weak institutions, inequitable empowerment, access to resources and low levels of technology have low capacity to adapt and are therefore highly vulnerable.

One of the Sustainable Development Goals (SDGs) namely Climate Action proposes strengthening the resilience and adaptive capacity to climate related hazards and natural disasters (UN 2015). Considerable work on adaptive capacity has been done after the publication of the International Panel for Climate Change (IPCC) Third Assessment Report in 2007, which identified adaptive capacity as an element of vulnerability (IPCC 2007). A number of studies (Haddad 2005; Adger and Vincent 2005; Brooks *et al*. 2005; Adger *et al*. 2004; Yohe and Tol 2002) have concentrated on climate change adaptation at different dimensions, its risks, relation to developing countries, and coping capacity.

However, most of these studies have focused on the adaptive capacity at national level while only a few (Jakobsen 2011; Nelson *et al*. 2010; Gbetibouo and Ringler 2009) have focused on the sub-national level. Some studies have revealed a need of having access to climate data and its complexity in availing specific information as a challenge to research (Thornton *et al*. 2010; Irish Aid 2015). National level assessments base on macro-economic modelling and may have relatively modest climate information relevant for local use such as Kilosa (Mendelsohn *et al*. 2000).

Historically, pastoralists have been marginalized socially, politically and economically. Sørensen (2006) analysed the colonial and postcolonial states of pastoralists and hunter-gatherers. In Tanzania, pastoralism suffers from the effects of settlement, conservation, encroachment on their traditional pasture lands, lack of infrastructure, unfavourable market mechanisms which result in difficulties in marketing their products (DANIDA 1995; Benjaminsen *et al*. 2009).

At any level, adaptation proceeds through two main steps: facilitation and implementation (Klein 2014.). Whereas the former involves raising awareness, removing barriers and making funds available for adaptive strategies, the latter involves making physical operational changes in practice and behaviour. Klein (2004) argues that the main reason why scientists and policy makers 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. According to IUCN (2008), there has been little recognition of the reservoir of knowledge underlying coping strategies and adaptive capacity of local communities. This argument can be verified from the fourth report of the IPCC (2007) which does not recognize ongoing local community adaptation to climate change.

It is thus imperative to understand the actual dynamics of climate change impact and adaptive capacity at the lowest levels of households (Deressa *et al*. 2008) contrary to the top-down policy approaches (Ford and Smith 2004). Information in this case is useful for policy makers and gives bases for the efforts towards adapting to climate change. The government of Tanzania is currently implementing the SDGs through phase two of the National Five-Year Development Plan (FYDP II) whose period of implementation is 2016/17-2020/21 (URT 2016). Goal four of the Plan is on natural resources management, environment and climate change. This clause emphasizes on sustainability of the environment and climate change adaptation and mitigation in consideration of proper livestock management practises (*Ibid*).

While adaptation depends greatly on the adaptive capacity or adaptability of the affected system, region, or community to cope with the impact and risks of climate change, this capacity in turn depends on the

socio-economic characteristics of the community or system in question. According to IFPRI (2007), access to credit and extension services, awareness of climate change as well as access to market information (input and output markets) are some of the important determinants of household level adaptation.

Empirical research by Cutter (1995), Denton (2002), Enarson et al (2002) and Enarson (1998) has shown that entitlements to elements of adaptive capacity are differentiated socially along the lines of age, ethnicity, class, gender and religion. According to Agarwal (1992) cited in Tipilda and Kristjanson (2008), female and male livestock keepers typically face different opportunities and constraints in managing livestock. The variation also extends to means of adapting to climate change factored by poor access to markets, availability of extension services and technical information, periodic drought and disease, resource uses, policies that favour larger scale producers or external markets, and weak institutions.

Various studies, for example Bryan *et al*. (2009) a study in South Africa and Ethiopia where Finan and Nelson (2001) indicated that people with good social and economic status are highly capable of adapting to climate change compared to those with low socio-economic status who are deprived of basic facilities in education, health and infrastructure which affect their overall adaptive capacity. Age, and literacy rate of pastoralists were found to be the main factors influencing their households' ability to adapt diversified strategies, particularly concerning climate change and new technologies.

Studies on the determinants of adaptive capacity for example Adger (2003) included economic, technology, information skills, infrastructure, institution, social capital and equality which are closely interconnected. However, effective use of skills as well as social network and infrastructure and how well this can deal with risk and distribute resource fairly is a matter of concern too. Nelson et al. (2010) also argue that households with greater diversity of assets and activities are likely to have greater adaptive capacity because of a greater capacity to substitute among option livelihood strategies in times of tension.

The objectives of this study therefore were to: (i) identify the impacts of climate change and variability to pastoral community, (ii) examine adaptive elements of pastoral communities on climate change in Kilosa district, and (iii) determine the contribution of state agencies in enhancing pastoral systems' resilience to climate variability and climate change impacts.

METHODOLOGY

Description of study area

The study was conducted in Kilosa district in 2013. Kilosa is among five administrative districts of Morogoro region. According to URT (2009), the district represents a unique area vulnerable to climate change impacts, with the major land use systems found in the country co-existing in the area. These include leased estate farms, national ranches, national parks, reserved catchment forests, smallholder subsistence farming, agro-pastoralism and pastoralism.

The district is categorized into three physio-geographic units namely mountains and upland, plateaus and flood plain (Shishira *et al*. 1997). The mountains and upland which lie at an attitude of 2200 m consist of the Eastern Arc Mountains namely Ukaguru, Rubeho and Vidunda (KDC 2000). The plateaus lie at about 1100 m.a.s.l and are moderately fertile and have well-drained sandy soils which support intensive crop production and livestock keeping despite their being highly erodible. The flood plains which lie at about 400 to 550 m, comprise both flat and undulating plains extending to the foothills in the West. The plains are subject to seasonal flooding and is mainly occupied by the pastoralist Wamaasai.

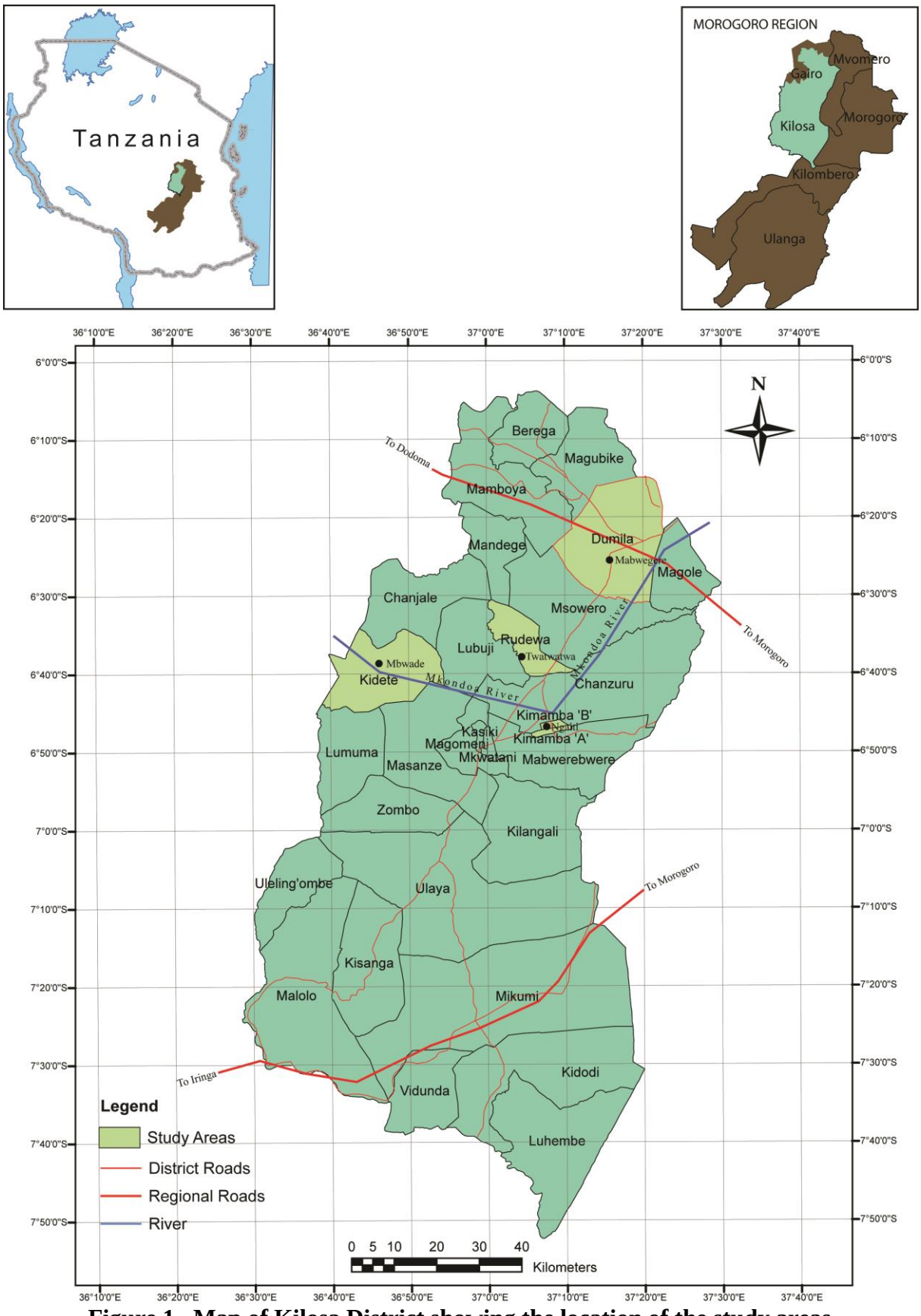

Figure 1. Map of Kilosa District showing the location of the study areas

Livestock keeping is an important economic activity in the district, following the large influx of pastoralist (Morogoro Regional Commissioner's Office 2006, URT 2009)

from other parts of the country. Kilosa district has a typical tropical semi-arid type of climate regulated by seasonal movements of the inter-convergence zone with widely dominated by Miombo woodlands (Misana *et al*. 1997).

Sampling and sample size

Four wards occupied by pastoralists were selected purposively for the study. Next, one village from each ward was selected randomly giving a total of four villages (Twatwatwa, Ngaiti, Mbwade and Mabwegere) used for sampling households for the study. A total of 104 pastoral households were randomly selected whereby 26 respondents from each village were interviewed. Kish (1965) and Sudman (1976) argue that a sample size of between 80 and 120 respondents is suitable for rigorous statistical analysis.

Key informants constituted of government officials from Prime Minister's Office, Department of Disaster and Risk Management; Kilosa District officials responsible for natural resources and environment, community development and livestock; Tanzania Metrological Agency, and Ilonga Research Station. This selection considered their familiarity with climate change and their inclusion in the response to climate change challenges. Focus group discussion involved 8-12 people comprising village leaders, gender representation, youth and elders.

Data collection

Data was collected using questionnaire, focus group discussions, key informant interviews and field observation. Household questionnaire was administered to households whereas and interview guide and a checklist were used for focus group discussion and key informants interview respectively.

Climate data acquisition

The climate data used to reflect climate change were precipitation and temperature, these data were obtained from Ilonga meteorological station as the nearest station to the study area. Past records on climate change for the past thirty five years were calibrated from the series of monthly recordings of temperature and rainfall.

Data Analysis

Quantitative data were analysed using Statistical Package for Social Sciences (SPSS). Descriptive statistics (frequencies, means and percentages) were computed. Also, Binary logistic regression (equation 1) was used to measure factors contributing to the adaptive capacity of pastoral communities.

Binary Logistic regression

The predictors (X_1 to X_9), and one binary response variable Y, which we denote p = P(Y=1). Linear relationship between the predictor variables was assumed, and the log-odds of the event that Y = 1. This linear relationship can be written in the following mathematical form (where ℓ is the log-odds, b is the base of the logarithm, and βi are parameters of the model):

$$l = log_b\left(\frac{P}{P-1}\right) = \beta_0 + \beta_1 x_1 + \cdots + \beta_9 x_9$$

Table 1: Variables used in the binary regression equation

Variable	Description
Y	Adaptive capacity to climate change (0 = Low, 1 = High)
X_1	Age (years)
X_2	Education level (0=no formal education, 1=formal education)
X3	Household size
X4	number of cattle
X5	number of goats
X6	number of calves
X7	number of sheep
X8	access to Climate Information
X9	access to Extension services

RESULTS

Trend and variability of climate change impact in Kilosa district

"Rainfall has inconsistently been showing significant shift in recent years, with clearly observed changes in the beginning of the rainy season", said by one of the key informants. Kilosa was observed to have bimodal rainfall pattern falling from March to May (long rains) and November and December (short rains) this conforms to a report by Kajembe *et al.,* (2013). Yet, recently, short rains have either disappeared or are very low (Figure 2), leading to extended drought. Present evidence of climate change supporting the shift paradigm is the observed in shift in rainfall patterns from bimodal to unimodal rainfall regimes in some areas.

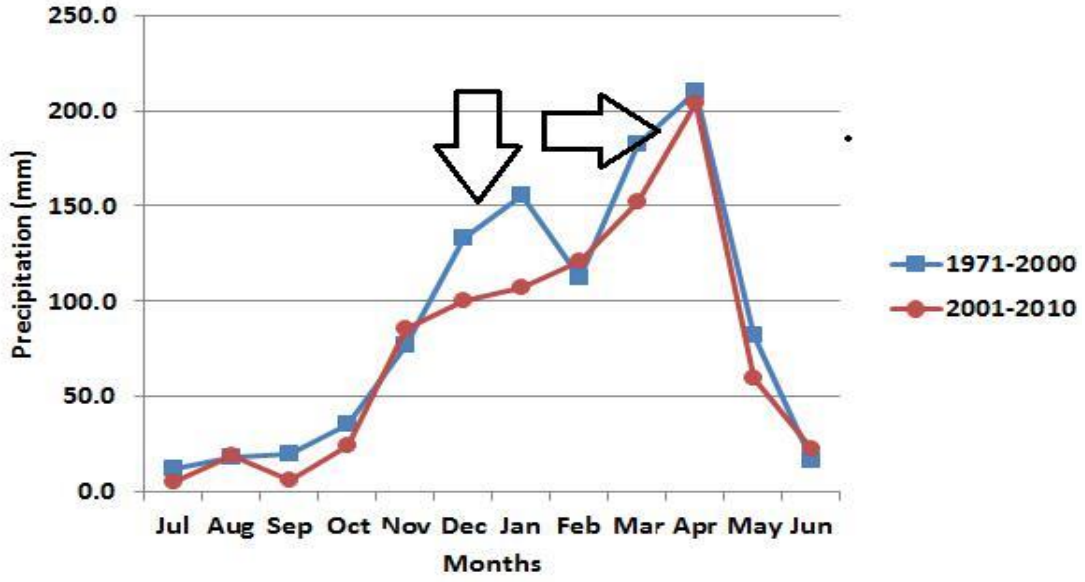

Figure 2. Rainfall trend in the study area

Increased variability of rain days and extreme rainfall events were observed in Kilosa District. Figure 2 shows a significant shift in the pattern of rainfall, which used to start in mid-September as observed from 1971-2000 while in year 2001-2010 it begins in mid of October. Decrease in rainfall amount during the short season (October to January) is also observed within the two ranges by 33%, such experience was reported to be mostly accompanied by some periods of dry spells. Nevertheless the long rains (masika) that are historically known to begin in March are also observed to be disturbed reversely that they come early and are said to be extremely heavy leading to flooding and runoffs that consequently cause damage to land and property.

Figure 3 shows that there was higher variability on the number of days with normal wetness. The indicator for change on normal wetness day is observed in Kilosa (slightly positive trend line), and Morogoro (slightly negative trend line).

There was higher variability in the number of days with rainfall greater than 50mm. The indicator for change (positive trend line) as shown in Figure 3 below, was observed in all the surrounding regions except Morogoro station. The positive trend indicate increased higher contribution of excessive rainfall that are contributing to flooding events, even though there are as well other socio-economic factors such as population increases, land use change and environmental factors such as land cover

change that could be attributed reasons for the recent increased flooding events.

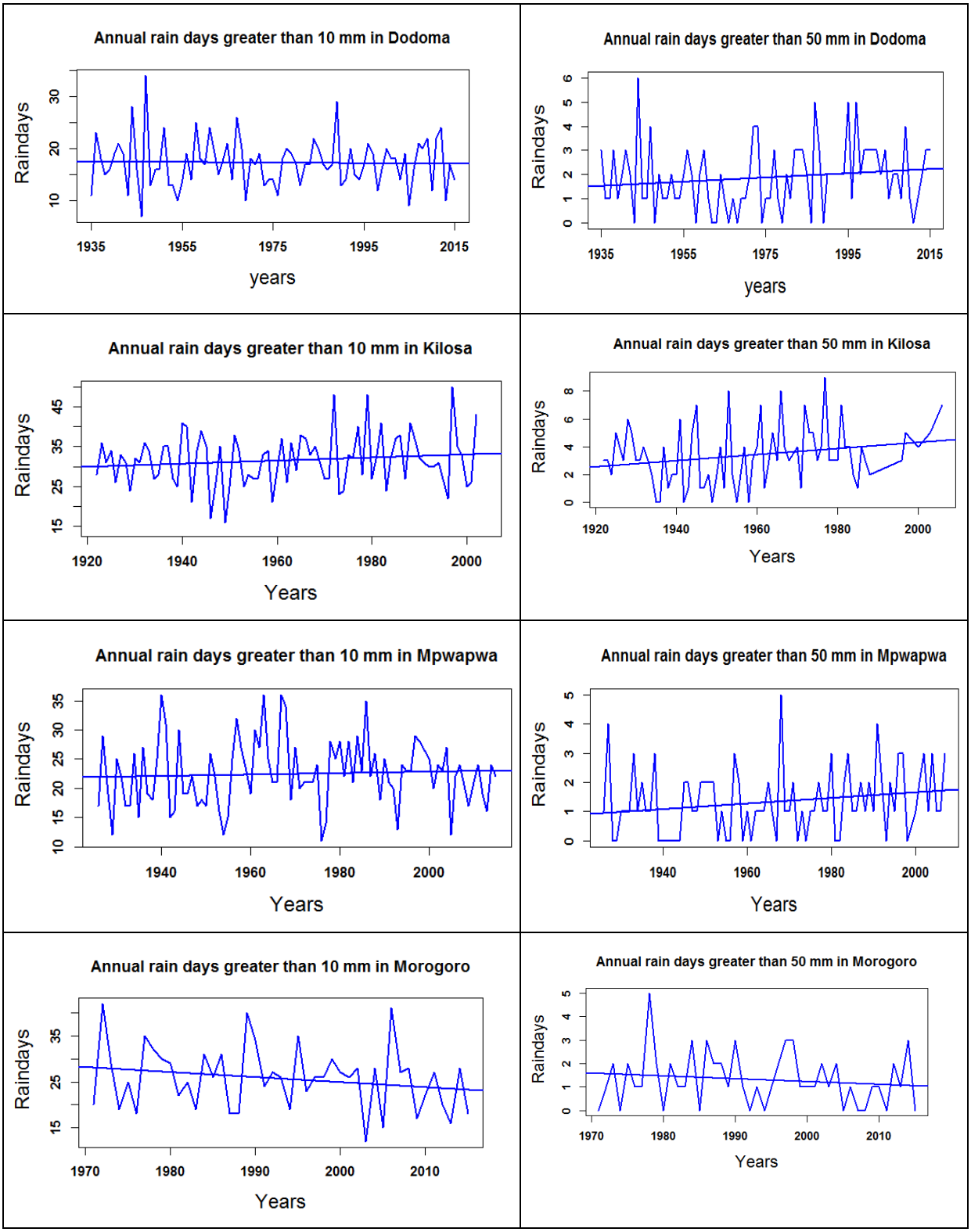

Figure 3. Annual trend line of rainfall days in the study area

Results (Figure 4) show that both maximum and minimum temperatures showed an increasing trend all over the years whereby for the short rain season, the maximum temperature was increasing at gentle slopes while minimum temperature was increasing steeply (Figure 4).

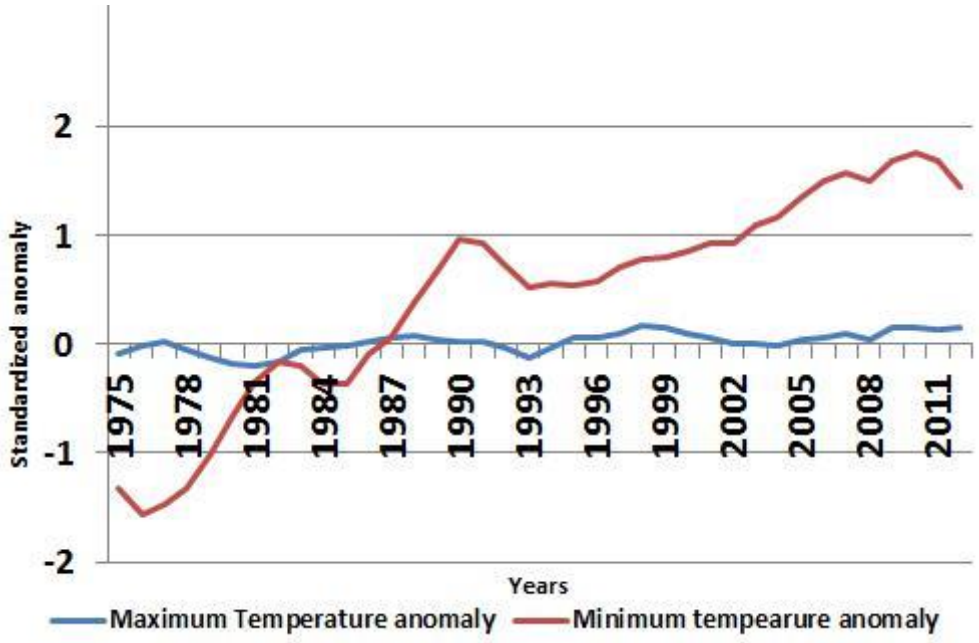

Figure 4. Temperature trend in the study area

Impacts of climate change and variability to pastoral community

In Tanzania, drought has affected different societies, particularly pastoralists, and there is empirical evidence showing that such circumstances have led to increased poverty and more prevailing food insecurity (Mbilinyi *et al*. 1999). The changes in rainfall and temperature have affected livestock production, market, water and pasture for livestock as well as increased distance to grazing areas. The following outcomes indicated effects from climate change in the study area:

Outbreak and increase of diseases

In the study villages, for the last fifteen years, new diseases such as anaplasmosis, babesiosis and East Cost Fever have been reported and cases of worms and foot-and-mouth disease have increased. Livestock mortality rate is quite high; it was estimated to range between 25% and 30% to the above mentioned diseases these results align with government report (URT 2005). The effect can be projected to extend into decreased market prospects, reduced income generation and weakened ability of households to access food recourses.

Damage to infrastructure

It was reported through key informant interviews that in 2009/2010**,** floods in Kilosa district were caused by heavy rainfall of about 107 mm which fell in Mpwapwa up-lands for about 24 hours. This was the highest rainfall received in the highlands for the last 67 years compared to the normal rainfall of about 600 mm per year. The rains caused Mkondoa river dyke to split open. The floods destroyed farms and crops that were at deferent growing stages, silted farms, while in some farms the top soils were eroded completely. Floods in Kilosa occurred also in 1940, 1945, 1964, 1998, and 1999 and are reported to have caused disturbance in commuting from the district to other surrounding areas and within the location too.

Changes to seasonal rainfall

About 89% of the respondents reported delay of rains, short duration and insufficient - less than 10mm. They also complained increased surface runoff that caused pasture deficit resulting in livestock mortality. These events increase vulnerability to diseases and poor livestock health conditions due to long distance travel in search of water and pasture. This argument is in keeping with Hein and De Ridder (2006) and Silayo *et al*. (2009) who report loss of most pasture species such as *Brancharia, Cynodon and Eleusine jegeri* which are preferred by livestock.

Increased travel distances in search of pasture and water

Results show that 99% of respondents said that distances to grazing land and water have increased in the past 10 years. It was found that 39% of the respondents walked between 6 and 8 km to reach grazing areas while 26% said they walked between 3 and 5 km.

Participants in the focus group discussion said that during severe droughts they would feed goats, young animals, sick cattle and lactating cows near homes with tree branches, pods and leaves of *Euclea sp, Acacia nilotica, Acacia lahai*and *Olea Africana* since they are the only trees that remain green during drought.

Adaptive elements of pastoralists in the changing climate

Adaptive capacity is an important measure that enables people to take in the impact of a certain shock to a greater or less extent, depending on how resilient the individual is. In the study area, coping or adaptive capacity varied from individual and location of the area under study. The respondents showed that climate change had several impacts to their livestock. They therefore developed adaptation methods which helped them cope with the situation.

Herds destocking

About 87% of the respondents said that livestock holding had changed in order to combat climate change, and this was done by selling their livestock to traders, needy households and government. On the other hand, the government issued a directive encouraging farmers to expand their agriculture fields in order to make the country self-sufficient in food production and pastoralist are encouraged to reduce the numbers of livestock to prevent overgrazing and soil erosion (Ndagala 1990).

Water preservation practices

Water preservation practices in the study area were being done by digging shallow wells, locally known as *lambo* or *pugu* for both human and livestock uses. This was done on a self-help basis locally known as *harambee*". The shallow wells were used by the community for domestic use as well as for animals; the livestock drank water from the shallow wells. Numbers of water wells had increased to four compared to previous five years where people used to get water from natural ponds which later dried up.

Changed eating habits

The majority (94%) of the pastoralists have changed their eating habits by switching from eating livestock products (milk and meat) only to eating cereals (leguminous and non-leguminous) products. According to Nestle (1989), the Wamaasai diet consists dominantly of meat, milk, and blood from cattle. Change in eating habits was associated with reduced number and poor health of livestock. Eating habit could have also been influenced by modernization of the Wamaasai culture due to interaction with other cultures.

Pastoralist migration from rural to urban areas

Traditionally, pastoralists are rural dwellers migrating from one area to other areas searching for water and pastures for their livestock. Because of ecological and economic hardships coming from the climate change impact, some Maasai people, particularly women and young men,

are compelled to immigrate to urban and peri-urban areas to look for alternative sources of livelihood, including casual labour work, petty trade of various hand-made items, selling traditional medicines, and men being watchmen.

Shifting of livestock

Results indicated that about 64% of pastoralists used to shift their herds from upland to lowland areas to search pastures in the lowlands and avoiding possible outbreaks of human and livestock hunger. Extended and severe drought have compelled pastoralists to shift their livestock to hotspot areas in search for green pastures and water. It is a common phenomenon that most of cattle left behind during drought, end up suffering from disease and death. Migration habit of this nature basically has been a traditional drought coping method and has positive impact to environment in that it allows the affected areas to recover (Potkanski 1994).

Diversification of livelihood strategies

About 95% of the respondents agreed that they were no longer depending only on livestock as used in the past, but they were also engaged in crop production, trade, and other activities such as hunting in order to increase their income and cope with the climate change impact. These practices especially agriculture, help to reduce conflict between pastoralists and farmers because the Maasai farmers are likely to keep away their livestock from crops and perhaps away from other people's crops.

Adaptive capacity of the pastoral community to climate change

Binary logistic analysis (Table 1) in which the dependent variable was adaptive capacity of pastoralists to climate change while independent variables included wealth from livestock as specified in the data analysis section show that Wald statistics were non-zero values, which implies that there was interaction between the dependent and independent variables. According to Norouis (1990) and Powers and Xie (2000), the non-zero Wald statistic values indicate the presence of relationships between the dependent and explanatory variables. Thus, on the basis of the results of this study the null hypothesis was rejected in favour of the alternative hypothesis that the number of livestock owned significantly influence adaptive capacity of pastoralists at 5% level of significance.

Table 2. Livestock ownership as indicator to adaptive capacity of pastoralists?

Variables	B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I. for EXP(B)	
							Lower	Upper
Number of cows	.002	.003	.564	1	.453	1.002	.997	1.007
Number of goats	-.002	.009	.057	1	.811	.998	.981	1.015
Number of calves	-.012	.010	1.588	1	.208	.988	.969	1.007
Number of sheep	-.006	.007	.730	1	.393	.994	.980	1.008
Constant	1.892	.537	12.401	1	.000	6.636		

Comparative mean wealth of livestock by villages

Results in Table 3 show that there was a significant (P<=0.05) difference in wealth across villages thus adaptive capacity will also vary. This means that the village with large wealth will be able to adapt to climate change easily and highly compared to village with less wealth. Adger (2003) argues that the capacity to adapt to climate change "is a function of access to resources" just as in Kilosa they depend much on livestock resources.

Table 3. Comparative mean wealth of livestock by villages

Village name	Cow wealth	Anova p-Value	Goat wealth	Anova p-Value	Calf wealth	Anova P-Value	Sheep wealth	Anova p-Value	Total wealth from all livestock assets	Anova p-Value
Twatwatwata	112.467	0.005	39.86	0.43	43.0993	0.0001	37.2742	0.0001	228.4446	0.001
Ngaiti	75.0781		52.70		14.4867		44.4652		176.5019	
Mbwade	186.944		49.59		11.7216		75.3694		346.0269	
Mabwegere	123.587		50.78		11.7817		39.7127		213.0138	
Total	**124.519**		**48.23**		**20.2723**		**49.2054**		**240.9968**	

Contribution of state agencies in enhancing adaptation and resilience to climate variability

Results show that about 77% of the respondents stated that the state agencies played an important role in adapting and resilience process. This is because most of NGOs and government officials and researchers when visited their villages were advising them about better way of livestock keeping and farming in the presence of changing climate. They also said that during floods various institution and agencies came to assist the villages. The agencies and organisations mentioned included USAID, United Nations Children Fund (UNICEF), Red Cross, Sokoine University of agriculture (SUA), Tanzania Natural Resources Forum (TNRF) and Integrated Water Sanitation and Hygiene (IWASH) to mention a few. Some of the roles performed included construction of charcoal dams in Twatwatwa and Mabwegere which were facilitated by PANTIL Programme at SUA through a project entitled "Pastoral-farmers conflicts and water availability in Kilosa district".

Results further show that 62.4% of the respondents said that the government had developed meteorological forecast capacity and provided information on climate change. The study area had access to the meteorological centre Ilonga station of which they would visit for climatic information. In addition the sessions held in various media including radio inform at large on weather forecasts and expected responses but also alerts communities of disasters.

Moreover, 87% of respondents said that the government could improve infrastructures to support efforts to mitigate climate change issues. Physical access is often a barrier to market participation in dry land areas. Improved road networks, and more locally accessible livestock sales-points are needed. The need for infrastructure is made more imperative by current and anticipated changes in climate, as pastoralists have to be able to make rapid decisions concerning the sale of their livestock.

Similarly, the majority (55.8%) of the respondents said that the government should improve bargaining power of communities and awareness of product value. The well-off pastoralists are compensated for their products to reflect their true value, the more incentive there is to participate effectively in markets. Improvements in product processing facilities, and increased

knowledge of other market opportunities such as those in wild harvested products, are also needed. About 58% of the respondents said that the government could enhance insurance. Livestock insurance is important for pastoral development. According to Mortimore *et al.* (2008), "If assets are protected from droughts, investments can be cumulative, if not, then investment in food emergencies frustrates growth".

Furthermore, 63.5% of the respondents said that the government could improve education and skills to address climate change issues in the study area. Skills and education increase adaptive capacity to climate change and options for diversification as supported by Wamsler *et al.*, (2012). They can also open up opportunities to sustain livelihoods which do not depend on the natural resource base.

DISCUSSION

Although Kilosa has a long history of rainfall variability as revealed in Figures 2, 3 and 4, the trend in current decades has been inconsistent with climate change scenarios, with lower rainfall and more frequent, severe droughts. This trend has at large contributed to some part of Kilosa drying out severely Solomon *et al*. (1987) also reported. Pastoral societies have rigorously been impacted by climate change because of variation in rainfall pattern. This is because there is excessive rainfall which leads to excessive runoff water which carries away the upper layer of the soil and in most cases leads to floods. For example, in Kilosa and Mpwapwa Districts, floods of December 2009 to January 2010 were very devastating led to killing of livestock, destroying farms and infrastructure (roads, railway line, buildings, and electricity transmission poles).

While the rainfall was decreasing and becoming unpredictable, temperature levels had also been rising leading to drying up of water sources and vegetation hence driving pastoral community to move in search of those resources. A study by the TMA, (2009) indicated that some of the previous highly productive areas such as the Southern and Northern highlands would continue to be affected by declining rainfall, frequent droughts and significant increase in spatial and temporal variability of rainfall with long term implications in the agricultural sector planning and resources allocation, such as seeds, pesticides and even the shifts in types of agricultural produce (URT 2010).

Generally, in measuring adaptive capacity this study revealed that wealth of pastoralist community positively influence adaptive capacity. The results indicate community's adaptive capacity and preparedness for climate-induced change varies across the region and that the more number of cattle an individual had the higher his ability to adaptation to changing climate is. Furthermore, mapping adaptive indicators helps to highlight community's strengths in coping with changes as well as areas for improvement.

As climatic conditions become more severe, education as suggested by 64% would allow pastoralists a freedom to supplement livestock keeping with other livelihood options which may not be affected by extreme drought or flooding. Most of pastoralists were complaining about low education in their communities. However, some of the respondents in the focus group discussion said that there is no need to attend school because they have informal education that means they value informal education than formal education such situation was also reported by Holt-Jensen, (2005). These group of persons need not be neglected but rather given like awareness or adult education.

It is important for policymakers and public officials, farmers, businesses, service providers, vulnerable households, and other stakeholders to be able to access information about how to get prepared for and cope with extreme events as USAID (2012) reports. Stern (2006) relates adaptation to building resilience, and

recognizes that it will be a key response to reduce vulnerability to climate change. Adaptation is not limited to discrete projects (Leary 1999), such as dams and sea walls. It includes a wide range of adjustments by entities such as households, firms and other institutions in response to the effects of climate change and variability. These include activities such as managing natural resources, input mixes in production, and changes in laws, programmes, policies and investments. Indigenous people can respond to climate change rate and magnitude of change by reducing the greenhouse gases (GHG) emissions, and by adapting to its impacts (UNFCCC 2011).

Recent years have witnessed rapidly increasing international attention to adaptation to the 'unavoidable' impacts of climate change (NCCARF 2010; Preston *et al*. 2011). The rapid development of adaptation as a mainstream strategy for addressing climate vulnerability is evidenced by a broad range of emergent adaptation policy developments. At international level, a variety of adaptation finance mechanisms have been established through the UNFCCC and/or the Kyoto Protocol more specifically including the Global Environment Facility (GEF) Trust Fund, the Special Climate Change Fund (SCCF), the Least Developed Countries Fund (LDCF) and the Adaptation Fund. These mechanisms are complimented by a range of other multi-lateral arrangements for adaptation finance. Developed nations have also commenced a range of national adaptation initiatives including efforts to deliver climate information and projections, the development of adaptation guidance, institutional adaptation strategies and plans (CEC 2007, COAG 2007, Swart *et al*. 2009, DCCEE 2010, and NRC 2010).

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Climate variability and change is now a reality, and this has also been exposed from trend analysis of 30 years climatic data in the area. It is likely that the revealed trends will continue and that there will be no reversal order to the near future. In the study area there is a significant shift of rainfall pattern, whereby in the past decade rainfall was bimodal, unlike currently when it has shifted to unimodal. In view of the prevailing situation, appropriate interventions that aim at increasing water access and reducing travel distances and time to water sources such as rainwater harvesting and improvement in pasture availability are imperative.

Moreover, it is concluded that climate change has several negative impacts to human, livestock and environment at large. Generally, climate change has led to reduced water, food, number of livestock and pastures. It has also lead to change in pastoral feeding habits. All these circumstances have led pastoralists to develop several coping strategies to climate change in Kilosa District and the most outstanding are: reducing number of livestock, shifting livestock and changing feeding habits. The necessity of examining the efficacy of those adaptation strategies arise and looking on the impact to the local social system and environment.

Pastoralists in Kilosa District have declared that there are important roles played by state and agencies in enhancing their adaptive capacities. The most important role played is supporting pastoralists to diversify their economies, planting trees, infrastructure development as well as ensuring accessibility to climate change information. For instance, TMA has the role to ensure that pastoralist and farmers in Kilosa District have access to information. For example, they provide three types of information: one-month forecast, three-month forecast and ten-day forecast; all of

these are updated regularly. This is a strength to be emphasized.

Recommendations

Recent negative perceptions of pastoralism as a backward production system must be replaced by a recognition of the rationale of such systems in dry land areas. Policies and programmes should be put in place to support local resilience and adaptive capacity to climate change.. Removing policy obstacles will allow pastoralism to function unimpeded and help ensure the resilience of the semi-arid dry lands and their communities in the face of climate change respectively.

i. Emphasise adoption of climate smart agricultural practises under livestock production as adaptation strategies to climate change should be given priorities in the district.
ii. Climate adaptation should be mainstreamed into dryland plans and strategies at national and local/district level and at sectoral levels, such as disaster risk reduction, livestock development and agriculture.
iii. Better awareness of how/where to access, interpret and use climate information. This is because pastoralists claimed during focus group discussion that they don't understand the information disseminated by TMA because it's too scientific.
iv. Full socio-economic costs and benefits estimates should be calculated for different adaptation strategies involving pastoralists. The costs and benefits should consider livelihoods, ecosystems and wider economic contributions.
v. Strengthening the capacity of pastoral groups to engage with debates on policy issues directly affecting their lives and livelihoods.
vi. Effective public information campaigns be ensured to help people understand and respond to the climate change challenges faced in different regions and district.

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