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Vulnerability and adaptive strategies to the impact of climate change and variability. The case of rural households in semi-arid Tanzania

Abstract

This study assesses the community vulnerability and existing adaptive strategies to the impact of climate change in semi-arid areas of Tanzania. The study was undertaken in Shinyanga rural district. The study methods included focus group discussions, key informant and household interviews. Findings from the study showed that the local communities are aware that the climate is changing, as characterized by variability in rainfall patterns and increasing temperature. Rainfall amounts have decreased and became more unpredictable, and drought prolonged. Temperatures have also increased. Consequently, there has been declining crop productivity and increasing food insecurity. Such situation has increased the vulnerability of local community livelihoods to the impacts of climate change. Different socio-economic groups of households (the well-off, intermediate and poor) have differently pursued multiple adaptation strategies, including growing of drought tolerant crops, increasing wetlands cultivation and diversification to non-farm activities, depending on their livelihood assets. The poor groups with limited livelihood assets were reported to be more vulnerable to impacts of climate change and more food insecure as compared to the well-off group, mainly due to their low adaptive capacity. The study concluded that livelihood diversification strategies, including integration of on-farm and non-farm activities, are crucial to enhance adaptive capacity and ensure sustainable rural livelihood in a changing climate.

Keywords: climate change, rural livelihoods, adaptive strategies, semi-arid Tanzania.
JEL Classification: Q15, Q18.

Introduction

In most African countries farming depends entirely on the quality of the rainy season – a situation that makes Africa particularly vulnerable to climate change. It has been reported that increased droughts could seriously impact the availability of food, as in the horn of Africa and southern Africa during the 1980s and 1990s (IPCC, 2001). Many vulnerable regions, embracing millions of people, are likely to be adversely affected by climate change, including the mixed arid and semi-arid systems in Africa, the coastal regions of eastern Africa, and many of the drier zones of southern Africa (IPCC, 2007).

In many developing countries climate change and its variability already emerged as a serious challenge to development, in general, and poverty reduction, in particular. Boko et al. (2007) and IPCC (2007) reported that Africa is one of the most vulnerable continents to climate change and variability. This is, partly due to a higher reliance on natural resources, such as agricultural land, forests and water which are very sensitive to changes, affecting the environment. Fischer et al. (2005), Thornton et al. (2006), and IPCC (2007) reported that some countries in Africa already face semi-arid conditions that make agriculture challenging, and climate change will likely reduce the length of growing seasons, as well as force large regions of marginal agricultural potential out of production. For instance, Fischer et al. (2005) reported that domestic food production has already declined by 10% in several of the sub-Saharan countries. IPCC (2007) reported that reductions in yield, in some countries, would be as much as 50% by 2020, with small-scale farmers being the most affected.

Tanzania is not spared from the impact of climate change. URT (2007, 2008) reported that the adverse impacts of change are already having their toll in the livelihoods of people and in many sectors of the economy in Tanzania. Frequent and severe droughts in many parts of the country are being felt with their associated consequences on food production and water scarcity among others. URT (2007) reported further that the recent severe droughts, which hit most parts of the country leading to severe food shortages, food insecurity, water scarcity, hunger and acute shortage of hydro electric power, signify the vulnerability of the country to impacts of climate change.

In Tanzania semi-arid areas, such as Shinyanga district are likely to be vulnerable to climate change through impacts on food production, and natural resources, consequently people's livelihoods. The impact of climate change may mostly affect livelihood of poor communities because of low adaptive capacity and high dependence on rainfed agriculture which is particularly sensitive to climate change. Increased droughts could seriously impact the availability of food and water for domestic use. Dwindling food security provides yet another manifestation of negative effects of climate change. Following persistent drought around rising temperatures, crop failure has been a common phenomenon particularly among seasonal food crops, the situation which predicts even worse food security conditions

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in most semi-arid and arid regions of Tanzania. Livestock is also at risk with animal's health worsening alongside deteriorating pasture quantity and quality and drying water sources.

In many parts of Tanzania, households have to contend with other extreme natural resource challenges and constraints, such as poor soil fertility, pests, crop diseases, and lack of access to agricultural inputs. These challenges are usually aggravated by the impact of climate change, such as periods of prolonged droughts and/or floods. Yanda et al. (2005), Mwandosya (2007) reported that Tanzania have shown a general increase in temperature over the last 30 years, as well as decreasing rainfall over the same period in most parts of the country. The frequency and intensity of extreme weather events, such as drought and floods, has been increasing affecting climate sensitive sectors, such as agriculture. Hence, the risk, associated with climate change in Tanzania, is real and affect human livelihoods, a situation which cannot be neglected.

According to URT (2007), Tanzania's national adaptation programme of action (NAPA) has ranked agriculture as top in the list of sectors, whose dependent population is most vulnerable to foreseeable climate change. Although, smallholder farmers have developed several adaptation options to climate change and variability, such adaptations are not sufficient for future changes of climate. Enhancing their adaptive capacity to the impacts of climate change will, thus, require concerted and long-term efforts by various stakeholders. This paper examines the impact, vulnerabilities and adaptive capacities of local communities with particular focus on agriculture, a main source of livelihood in Shinyanga rural district. The study will also enhance awareness and understanding on vulnerability and adaptive capacity of local communities to the impact of climate change, as well as informing policy making decisions for appropriate interventions.

1. Materials

1.1. The study area. *1.1.1. Geographical location and administrative set up.* The study was conducted in two villages, namely Ibingo and Ng'wang'osha, located in Shinyanga rural district, Shinyanga region. Shinyanga is in the north-western part of Tanzania, situated south of Lake Victoria (Figure 1). Administratively Shinyanga region is comprised of eight districts, namely, Bariadi, Meatu, Kahama, Shinyanga urban, Shinyanga rural, Kishapu, Maswa and Bukombe, with a total area of 50,781 ha. The districts were established in different periods. For example, Meatu district was established in 1988 while Bukombe and Kishapu were established in 2002.

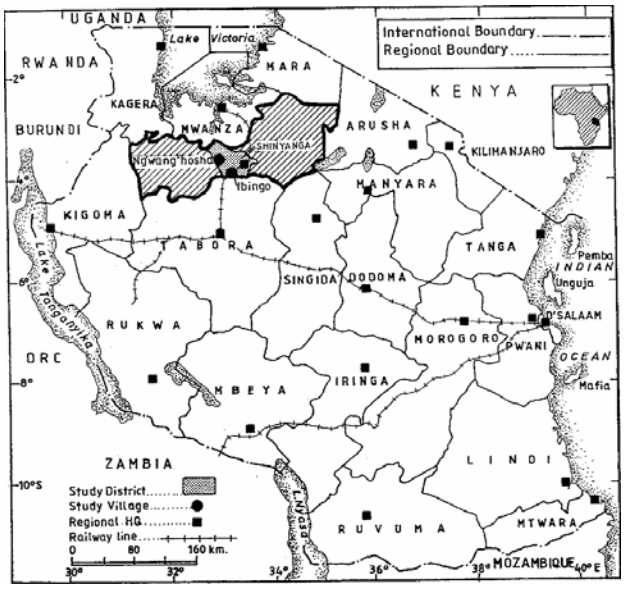


Fig. 1. Tanzania map showing the location of Shinyanga region

1.1.2. Demographic characteristics. Shinyanga is the most populated region in Tanzania with 3.4 million people, the other region with high populations being Dar es Salaam (2.9 million). The least populated region is Lindi, with 869,500 people (URT, 2008). The region is characterized by increasing population (Table 1).

The total human population in the region has increased almost three times from 899,468 in 1977 to 2,796,630 in 2002. Such situation will put more pressure on the natural resources, thus, making it less resilient to the impacts of climate change and variability.

Table 1. Population of various districts in Shinyanga region from 1967 to 2002

District	Population census in years			
	1967	1978	1988	2002
Bariadi		296,931	250,618	603,604
Maswa	430,900	304,079	220,499	304,402
Bukombe				276,393
Kahama	147,600	291,622	499,439	594,891
Shinyanga (R)	320,968	362,170	405,578	395,298
Shinyanga (U)		68,733	98,660	134,523
Meatu			159,266	248,214
Kishapu				239,305
Total	899,468	1,323,535	1,763,960	2,796,630

Source: URT (1988; 2003).

1.1.3. Biophysical features. Shinyanga is characterized by flat, gently undulating plains covered with low sparse vegetation. The northern parts of the region are mainly covered by miombo woodlands. The soils are generally loam and sandy, which are well drained with low fertility. The eastern part is characterized by heavy black clay soils which are not well drained. Shinyanga is a sem-iarid land with

clearly distinguished rainy and dry seasons. Generally, the rainy season starts between mid October and December, and ends in the end of April or early May with two peaks. First rainfall peak occurs between October and December and second peak between February and April/May. The average annual rainfall ranges from 600 mm to 900 mm. The amount and distribution pattern of rainfall is generally uneven and unpredictable. Such situation has great impact on the cropping season. The dry season occurs from mid May to mid October. During such period the soils become very hard to cultivate, pastures become very poor in quality and quantity. The availability of water for domestic use and livestock also becomes an acute problem.

2. Methods

In this study different methods and techniques were used to collect qualitative and quantitative data from both primary and secondary sources. Secondary data, relevant to the study, were obtained through reviews of both published and unpublished literature from various sources, including libraries, and as well as from Internet. Examples of such information include climate, demographic characteristics, biophysical and policies related information. Results from these reviews have been used to support various arguments related to the study.

2.1. Participatory methods. Participatory rural appraisal (PRA) techniques (Chambers 1994) were used for collecting general but in-depth knowledge of local people. Such methods have the advantage of soliciting more information from local people, since they encourage participation and dialogue between local people and outsiders (researchers), as well as among local people themselves. The PRA techniques, used in this study, include focus group discussion (FGD), key informants interview and participatory field observation and transect walk (Poffenberger et al., 1992; Chambers, 1994; Mikkelsen, 1995). The focus group discussion involved 10-15 people, representing various livelihoods and age groups in each village. The key informants were drawn from district officials, extension workers and elderly people in the respective villages. A checklist of issues relevant to the study, such as local perceptions on climate change, indicators of climate change, household socio-economic differentiation, livelihood assets and adaptations strategies to the impact of climate change, was used for focus group discussion and key informant interviews. Physical observations were also made in the field to capture and crosscheck issues raised in the focus group discussions and key informant interviews. The participatory assessments were made to capture among others experience and perceptions of local communities on climate change and its influence on food security, extent of vulnerability and existing adaptive capacities to climate change and variability.

2.2. Sample size and household interview. A sample size of 5% of the total households in each of the study village was randomly selected for structured questionnaire interviews, with the heads of the households as informant. Sampling of households for inclusion in this study was preceded by defining what constitutes a household. In this context a household is the basic unit of production and consumption in the villages; hence, it was used as a unit of analysis. The selected sample size was considered to be adequate since the collection of required data was complemented by other methods used.

3. Results and discussion

3.1. Main socio-economic activities. There are various types of socio-economic activities across the study area (Table 2). The extent of household involvement in the various activities varies considerably from one household to another, mainly depending on socio-economic condition of households.

Table 2. Main socio-economic activities in the study area

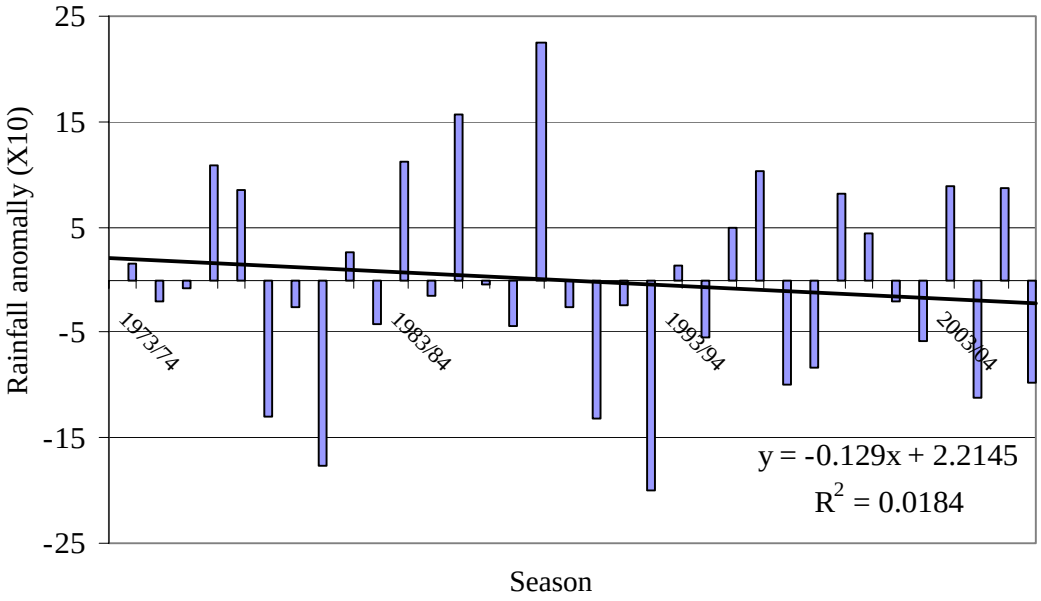
Main economic activity	Household involvement (%)
Crop production	100
Livestock keeping	67
Petty business (kiosks, food vending)	21
Casual labourer	17
Beekeeping	8

Source: Field survey (2008).

All households were involved in rain-fed agriculture as their main source of livelihood. The main cash crops grown include cotton and sunflower. The common staple foods are maize, sorghum, paddy, cassava beans and sweet potatoes. The high participation in crop production suggests that when such activity is impacted by climate change, it may have serious consequences on household food security and rural livelihoods. Rainfed agriculture depends on the patterns of rainfall and its reliability. The later are quantified as inter-annual variation in monthly and seasonal rainfall, and as the frequency of individual events in terms of their size, duration and intensity (Cawling et al., 2005). Crop production is dominated by smallholders, characterized by hand hoe and ox-plough cultivation with limited use of agricultural inputs. It was revealed that crop production is declining with Shinyanga region being among the food deficit areas in Tanzania. There are many factors associated with such situation but climatic factors, such as prolonged dry spell and shortage of rains, have compounded the problem.

Livestock keeping is also increasingly becoming an important livelihood activity with about 67% of the households, engaging in such activity. Most of the animals kept include cattle, sheep and goats which are kept under free grazing regimes. Other socio-economic activities, such as petty business and crop trading (buying and selling crops), are also important to rural livelihoods (see Table 2). The study revealed that household involvement in other economic activities besides agriculture strengthens the household adaptive capacity, when agriculture is negatively affected among other factors by unfavourable climate. Such activities were reported to complement each other in supporting household livelihoods.

3.2. Climate change facts and local perceptions. Analysis of climatic data from nearby station in Tabora region which is in the same semi-arid zone, indicated that annual rainfall had been in declining trends for the last 35 years, from 1973/74 to 2007/08 (Figure 2). However, total rainfall during the refered period appeared to decrease, though at a non-significant rate (R^2 = 0.018, F probability > 0.47.

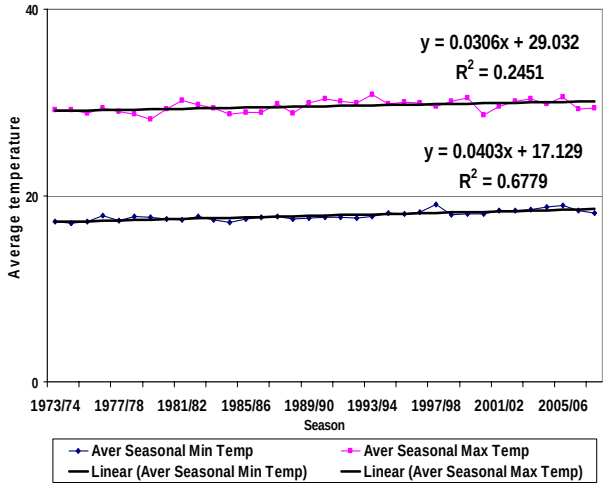


Source: TMA (2008).

Fig. 2. Trend of rainfall anomaly for seasons from 1973/74 to 2007/08

In case of temperature, both minimum and maximum temperatures showed significantly increasing trends (Figure 3). Minimum temperature increased sharply (R^2 = 0.68, Sig. F < 0.001), while maximum temperature increased gradually (R^2 = 0.24, Sig. F < 0.01). These results confirmed findings from other studies conducted in the western parts of Tanzania (cf. Tilya & Mhita, 2006; Mwandosya et al., 1998; Mongi et al., 2010) that there has been increase in temperature. IPCC (2007) has also reported that over the western Tanzania there has been an increase in temperature of between 1°C and 2°C from 1974 to 2005.

The analysis of empirical meteorological data compares well to local experience and perceptions regarding trends of climate changing over time. Discussions with key informants in the study area revealed that households in the study area perceive climate through climate-related elements which directly influence their livelihood activities, particularly farming (Table 3). The mentioned key climate-related elements were rainfall, drought, temperature, humidity and wind. In all the villages there were very high response on rainfall and drought as the major indicators of climate. In the study area, drought is the major problem hindering agricultural production, both crop and livestock production.



Source of data: TMA (2008).

Fig. 3. Trends of maximum and minimum temperature anomalies for the seasons from 1973/74 to 2007/08

Table 3. Local community understanding of climate

Understanding of climate	Percent of household response (N= 96)
Climate as rainfall	95
Climate as drought	88
Climate as temperature	60
Climate as floods	52
Climate as wind	42
Climate as humidity	38

Source: Field survey (2008).

3.3. Indicators of climate change and variability. The study has revealed that there is a growing perception among the villagers that climate change and variability is already occurring. Most of the respondents in the study area (90% in Ibingo and 97% in Ng'wang'osha) acknowledged that there has been a change in climatic conditions. At the village level, the concept "climate change" was associated with variability in weather conditions which is related to rainfall inconsistency and unpredictability over years rather than actual change. The variability was related to variations in agricultural seasons in a year. Major concerns were related to indicators like reduced amounts of rainfall, rainfall coming late, increased temperatures, increased incidences of drought and decreased crop productivity (Table 4).

Table 4. Local indicators of climate change

Local indicators of climate change	Percentage
Decreasing amount of rainfall	91
Rainfall coming late in seasons	83
Increased incidence of drought	67
Outbreak of human diseases	65
Increased temperature	58
Outbreak of plant diseases	57
Decreased crop productivity	54
Shortened growing seasons	54
Re-occurrence of food shortage	50
Decreasing number of livestock	38

Source: Field survey (2008).

According to Table 4, the indicators, that ranked high, have significant impact on the local livelihood. The local perception was that climate is continuously changing and it is getting worse over time. Bad years are becoming more frequent than ever before, resulting in food shortages in the area. It was further reported that generally rainfall patterns have changed with time, and generally perceived to have decreased especially during the past 20 years (Table 5).

Table 5. Percentage response to change in rainfall patterns for the past 20 years

Local perception of rainfall pattern	Percent of household responses (N = 48)
Decreasing	71
Increasing	21
No change	8
Total	100

Source: Field survey (2008).

3.4. Impacts of climate change/variability on rural livelihoods. The rural community in the study area depends heavily on rain-fed agriculture, making rural livelihoods and food security highly vulnerable to climate variability, such as shifts in growing season conditions and unreliability of rainfall. High sensitivity of crop production to climate parameters makes it vulnerable whenever extreme changes occur. Discussion with key informants in the study area revealed that crop production, the main source of livelihoods, has significantly been affected. Seventy percent of the interviewed households indicated that crop production especially maize is on a declining trend. For instance, in Ibingo village, it was reported that in the past they used to harvest 5-10 bags of maize per acre (i.e., 2-4 bags/ha). To date productivity has declined to 3-4 bags per acre (about 1-2 bags/ha). This situation has been attributed to prolonged dry spells, inadequate and uneven distribution of rainfall as well as unpredictable onset of rains, which has often caused crop failures (cf. Figure 4).

The declining food production was also associated with other non-climatic factors, such as declining soil fertility, pest and diseases and inadequate extension services. However, the impact of climate change and variability became more pronounced when there is interaction with other non-climatic stressors. A thorough analysis of livelihood activities in the studied villages indicates that agricultural activities are mostly affected through decrease in rainfall and prolonged drought which also influences loss in soil moisture.



Fig. 4. Drying maize plants at tussling stage due to early cessation of rainfall

Poor crop performance has partly contributed to abandonment or scaling down of cultivation activities by some villagers, especially the youth in favour of exploitation of forest products, such as charcoal burning, small-scale mining and small business. Some crops, such as rice, have been completely

abandoned in some areas due to inadequate water in the previously potential swampy areas. Also vegetable farming has been negatively affected by the drying of swampy areas, which were used for crop cultivation especially in the dry season. The above adverse effects of climate change and variability have largely contributed to declining food production.

Climate change has also put livestock at risk with animals dying alongside deteriorating pasture condition and drying water sources. Livestock keepers were compelled to walk longer distance in search of water and pasture which in most cases ends into resource use conflicts. It was revealed that water availability for livestock increasingly become difficult as ground water resources decline/dried up due to prolonged drought. In other places, such as Mbeya region, widespread livestock mortality were reported due to the lack of water and pasture (Bushesha et al., 2009). This has diminished pastoralist herds faster than the animals can be replaced, putting pastoralist livelihoods under increasing pressure. Similar situation also applies to Shinyanga region, where majority of livestock keepers depend on rainfall to recharge water sources for their livestock.

Besides the negative impacts, climate change was noted in some cases to have positive impacts on rural livelihood. For example, in Ng'wang'osha village climatic related events, such as *El-Niño*, were reported to have contributed to filling up of water reservoirs and flooding of wetlands, a situation which provides long-term sources of water for livestock and irrigation.

3.5. Vulnerability and adaptations to the impact of climate change and variability. In the study, villages' households are heterogeneous in terms of their adaptive capacities to impacts of climate change and variability. The ability and capacity to adapt to such impacts is highly influenced by the socio-economic well-being, prevailing in the communities. Kelly and Adger (2000) argued that the extent to which communities are vulnerable to climate change depends on both exposure and sensitivity to changes in climate, as well as ability to adapt to new conditions. The vulnerability to climate change and variability, and consequently, the adaptive capacity of local communities is among other aspects influenced by livelihood assets. Table 6 shows household socio-economic groups based on livelihood assets, owned by individual households in the study villages.

Table 6. Socio-economic groups of households based on local perception of wealth and poverty

Well off (13%)	Intermediate (64%)	Poor (23%)
Have farm size of at least 10 acres including rice farm	Own farm of at most 4 acres	Own farm of 0.5 acre
Have good house made of burned bricks and corrugated iron sheet	Own moderate house made of muddy and corrugated iron sheet	Own house made of mud and thatched with grass
Owns at least 10 cows and/or goats	Owns less than 10 cows or/and 5 goats	Have no livestock except poultry
He can pay medical services up to referral hospital	He can pay medical bill up to regional hospital	Can not afford to pay his/her medical bills regularly
Owns motor bike. Tractor, ox plough, radio	Owns bicycle, ox-plough, radio and hand hoe	Have no bicycle, ox-plough, radio but own hand hoe
Food secure and can assist others	He is partially food secure, sometimes have food shortage	Often food insecure, get food assistance, and hired as casual laborer
Pay fees for his children up to advanced level of education	He can pay school fees up to secondary school	He can afford to pay for primary education

Source: Field survey (2008).

A wealth ranking exercise resulted into grouping of household to *well off*, *intermediate* and *poor* socio-economic groups. The exercise was done with the help of the key informants from the study villages based on their locally accepted criteria and perception of wealth and poverty. The study revealed that the *well-off* group has more livelihood assets (see Table 6) and they have diverse livelihood activities, including farm and non-farm activities. It was reported that such group is involved in livestock keeping, buying and selling crops, crop production, especially rice, owning running shops, tractor and ox-ploughs. It was also noted that in case of drought or food shortage such groups are able to buy food or use their own stocks. They can also hire people to take care of their animals by moving them to other places, where there is water and pasture. The group was reported to pursue cumulative strategies and, hence, relatively more adaptive to the impacts of climate change compared to the other groups.

The *intermediate* group comprises the majority of the households and posses more livelihood assets compared to the *poor* group but not like the *well-off* group. Discussion with key informants revealed that households in this group have limited room for diversification compared to the *well-off* group. It was further noted that they are involved in small businesses which do not involve much capital, such as selling of local brew, keeping few livestock and doing casual labour. For the *intermediate* group diversification to off-farm activities complement income from farming especially during the adverse conditions.

The *poor wealth* group among others comprises the economically impoverished households. These include, among others, the disabled widows, divorcees and orphans. Such group was reported to have very limited livelihood assets, pursuing more of coping strategy and little adaptation, and is highly vulnerable to the impact of climate change. For such group households diversification to off-farm activities, such as hiring out labour and work for food, is borne out of necessity in order to survive. However, they have very limited room for diversification compared to the *well-off* and *intermediate* groups. Social capital (social networks), involving friends, relatives and neighbours networks, plays a crucial role in supporting such group to cope with the impact of climate change.

Diversification to off-farm and on-farm economic activities is important in enhancing household adaptive capacity. The levels of endowment of livelihood assets, which differ from one group to another, reflect the extent of vulnerability and different adaptive capacity to the impacts of climate change. Through focus group discussion it was revealed that inadequate or lack of income sources, limited productive farms, poor social network, poor health conditions and lack of cattle are among the reasons that some households were unable to adapt to the impacts of climate change. Hence, households with sufficient livelihood assets stand better chances of adapting to adverse conditions, including climate change and variability.

3.6. Existing adaptive strategies to the impact of climate change/variability. Assessment of the existing adaptive strategies in the study area has shown that households have multiple strategies for adapting to the impacts of climate change and variability (Table 7).

Table 7. Adaptation strategies to the impact of climate change

Response on adaptation mechanism	Percentage of households
Growing drought tolerant crops	96
Growing fast maturing crops	75
Buying supplementary foods	63
Cultivation in the wetlands	50
Emphasis on small stocks (small animals)	38
Emphasis on livestock keeping instead of crops	25
Seasonal migration of livestock keepers	21
Rainwater harvesting	17
Distributing livestock herds in different places	12
Early planting	4

Source: Field survey (2008).

The study has revealed that adaptation strategies, including growing drought tolerant crops such as sorghum, cassava and sunflower, were mostly preferred (see Table 7). This is particularly so because prolonged drought and inadequate rains are among major aspects affecting crop performance in the study area, which necessitates the need for using drought tolerant crop varieties. This was followed by growing fast maturing crop varieties, buying supplementary food and wetlands cultivation. Other strategies, such as early planting, were among the least (4%) mainly because rainfall is so unpredictable to guarantee early planting. Discussion with farmers revealed that the slogan of *early rains is for planting* that was used in the 1970s, is no longer holding as in many cases early planting now coincides with late onset of rains. Even when a crop is planted early, it may succumb to the prolonged dry spells when crops such as maize is at flowering stage. This is a critical moisture requirement stage for many crops in which in the absence of rains it may contribute to crop failure.

Through focus group discussion it was found that households in different socio-economic groups in the study areas undertake different adaptation strategies. For example, it was noted that most of the *well-off* groups were involved in growing fast maturing crops, cultivation in the wetlands, buying food surplus and rainwater harvesting. This has been due to their possession of financial capital and other livelihood assets as compared to other socio-economic groups. The *poor wealth* group, which has limited assets, involved in production of drought tolerant crops, such as sorghum and cassava while the *intermediate group* is most involved in production of drought tolerant crops and keeping small stocks, as well as seasonal migrations.

In addition to adaptation strategies related to agriculture, it was revealed that some households opted for diversification to non-farm economic activities to complement household income and food in case of adverse condition in agriculture. The *well-off group* diversify to non-farm activities, which involve relatively high capital investment mainly business, such as shops and rents of assets, to expand the scale of production, to increase their consumption outcomes and stock of assets. To the *intermediate wealth* group diversification into off-farm activities involve mainly sales of local beer and to a less extent hired as casual labour in the farms and petty businesses to earn some cash to supplement on-farm incomes. To the *poor wealth group* diversification to off-farm activities is necessary and it involves doing mostly casual labours mainly for the *well-off wealth group* and also move to other places to seek livelihood opportunities to complement low incomes from agriculture, as well as having social networks.

The above reported adaptation strategies indicate that a single strategy is inadequate in adapting to the impact of climate change and variability. A combination of several strategies is likely to be more effective than single strategy. However, it was revealed that not all farmers are able to engage in all these adaptation strategies particularly due to limited financial capital.

Conclusion

The climate of the study area has been and will perhaps continue changing over time involving among others variability in rainfall and temperature patterns as confirmed by available meteorological data. The rainfall amount has decreased over time and became unpredictable and there have been prolonged drought, negatively impacting on agricultural productivity and food insecurity. Temperatures have also increased, raising crop water requirement and increasing water loss due to increased evapotranspiration. Such situation has increased the vulnerability of the already poor rural community to the impact of climate. Local responses to the impacts of climate change have varied with socio-economic status of individual households, but have invariably included but not limited to growing of drought tolerant crops, increasing wetlands cultivation and diversification to non-farm activities. However, the poor households with limited livelihood assets appeared to be more vulnerable to the impacts of climate change and are more food insecure compared to the well-off group. The low adaptive capacity among the poor group makes them more vulnerable to impacts of climate change. The well-off group with more livelihood assets have been more successful in undertaking various adaptation strategies such as increasing livestock numbers, cultivation of wetlands areas during prolonged drought and purchasing and stocking food as compared to the poor and intermediate wealth groups. Hence, households with sufficient livelihood assets stand better chances of adapting to adverse conditions, including impact of climate change and variability.

The study argues that livelihood diversification strategies including integration of livestock, crop production and non-farm activities are crucial to enhance adaptive capacity of the local community in the study area and other parts of the country with similar agro-ecological conditions. Such local adaptation strategies need to be supported by relevant policies that enhance climate change adaptation at various levels.

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