Local-based initiatives to adapt to climate variability and change in Tanzania

Ronald Boniphace Ndesanjo[1] and Theobald Frank Theodory[2]

Abstract
This paper presents results from a study on impacts of climate variability and change on social and ecological systems in Arumeru district, Arusha, Tanzania. Broadly, the paper sought to assess local communities' perception of climate variability and change; and to identify ways through which local people's perception(s) are informed by climate change vulnerability and adaptation. Drawing on results generated from Key Informant Interviews (KII), observed climate variability and change is noted to have serious negative-and potential positive-impacts on social and ecological systems, especially in areas where adaptive capacities are still low. The findings unveiled that basic livelihoods, especially livestock keeping and farming are already affected negatively by climate variability and change impacts exhibited by, among other things, dwindling pasture and crop productivity as well as water scarcity. Subsequently, the study notes increasing scarcity of basic household necessities, especially food - including pasture - and water for both people and livestock, which were directly associated with frequent dry spells and altered rainfall patterns as observed by the local people in the study area.

Key words: *climate variability and change, farming, pastoralism, resilience, social and ecological systems*

Introduction

There is high level of certainty that climate change is a result of global warming that has significantly been caused by increased emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and other greenhouse gases (Collier *et al.*, 2008). It is concluded by the Intergovernmental Panel on Climate Change [(IPCC) 2007] that more than 90 percent of the current global warming is a result of greenhouse gas emissions from anthropogenic activities including fossil fuels burning for industrial manufacturing and other consumption as well as land use practices. Consequences of this climatic alteration are starting to become highly visible as climatic conditions and ecosystems begin to change (Yanda and Mubaya, 2011). Given these emission rates, 2 degrees Celsius (°C) rise in temperature is highly probable and possibly inevitable (Stern, 2006). As a result of this trajectory, social and ecological systems are at greater risk of adverse effects including, but not restricted to, decreased crop productivity and coastal flooding in low latitudes; animal and plant species extinction threats; and annihilation of marine ecosystems, particularly coral bleaching (Yanda and Mubaya, 2011; IPCC, 2007b).

[1] University of Dar es Salaam, Email: ndesanjo@udsm.ac.tz.
[2]Mzumbe University, Email: fttheodory@mzumbe.ac.tz.

The East African region is amid regions the most affected by climate change. Such changes will have serious implications for water resources, food security, and spread of disease, productivity of natural resources, sea-level rise, and desertification (*ibid.*). Holmgren and Oberg (2006) argue that people at high risk in times of climatic change are those living on floodplains, coastal areas, mountains as well as those having no means of adapting to changes. As the largest, most populous, and poorest country in East Africa, argue Ehrhart and Twena (2006), Tanzania is likely to feel the impacts of climate change more than most. Diverse climatic conditions, corresponding to the country's varied topology, mean that national trends are likely to mask considerable variation at the sub-national level. Whereas annual mean temperatures are expected to rise by 3°C to 5°C and average daily temperatures by 2°C to 4°C by 2075 (URT, 2003), rainfall predictions are less certain. Indeed, major discrepancies remain between climate models. However, the most commonly used projection for Tanzania foresees annual rainfall increasing by 10 percent by 2100 (Kibona, 2008).

In this respect, massive food shortages are projected for Sub-Saharan Africa in the next quarter century, based on current rates of population growth and food production. The results have included further increase in livestock and agricultural intensification in arid as well as semiarid lands. Thus, with increasing population pressure on a declining and highly variable resource base, human vulnerability to drought and floods has increased. Therefore, the overall objective of this paper is to examine coping and adaptive strategies of social and ecological systems in the on-going climate change and variability. Specifically, the study sought to assess how stakeholders in Arumeru district perceive climate variability and change; to assess the vulnerability to and impacts of climate variability and change on livelihood security; and to assess coping as well as adaptation strategies given observed and expected climate change impacts. Field work for the study was undertaken in Arumeru district, Arusha, Tanzania.

The Study Area

Arumeru district covering about 1,452.692-kilometre squares (km^2) is located between $3^0$00- $3^0$40'S and $36^0$15'-36^0 55'E. Kisongo ward, where the study was undertaken, is one of 37wards in Arumeru district located west of Arusha city between 3°22'26.74''S and 36°34'22.53''E. It is bordered to the north and west by Monduli district, to the east by the Kilimanjaro Region and to the south by Arusha city and Monduli district. The district is divided into three main zones, namely, the higher, middle and lower zones located on highlands between 800 and 1,800 metres (m) above mean sea level. According to the 2012 Tanzania Population Census, the population of the Arumeru District was 591,342 (URT, 2013). Ward Chairpersons' office statistics/census of 2010 indicate that the four villages understudy, namely, *Engorora*, *Lesiraa*, *Ilkerin* and *Loovulukuny* have a total population of 12,344. Traditionally, the area had been dwelled by *Maasai* pastoralists until 1945 when the Arusha (*Waarusha* in Kiswahili) ethnic group migrated to the area from the eastern part. The major livelihood activities on all zones are farming and livestock keeping (zero grazing in the higher zone) where coffee, pyrethrum, tobacco, banana, Irish potatoes, sweet potatoes, maize, wheat, barley, beans, cow peas, Kikuyu black beans, fruits, flowers and vegetables form the

main crops grown. Livestock kept include hybrid cattle as well as goats, local cattle, sheep, goats, pigs and chicken.

The area experiences two main rainy seasons, namely, long-rains (from March to May) and short-rains (from October to December), associated with Inter-tropical Convergence Zone (ITCZ). Generally, the area receives unreliable and poorly distributed rainfall of less than 1000 millimetres (mm) per annum with about 65 percent falling in the months of March through May. The *El Niño* Southern Oscillation (ENSO) plays an important role in inter-annual rainfall variability. The soils appear to be allophonic-dark-coloured deep young soils derived from volcanic ash. Wind speeds are moderate for most of the year, ranging between 130 and 170 kilometres per day (km/day), but increasing to 250 km/day at the end of the dry season. The natural vegetation of the area has been considerably modified by human activities. Tree cover is most extensive in the northern section (higher zone), as there has been little felling on the steeper slopes and thus, forming most water catchment areas in the district. The dominant species is *Acacia drepanolobium,* while *Ballanites aegyptiaca* and *Commiphora spp*. are common. The central and southern areas are dominated by grassland. *Solanum incanum*, (the Sodom Apple), a woody shrub resistant to grazing and with harmful effects on cattle, is common. Other planted trees/shrubs found in the area are *Schinus molle, Senna spectabilis, Senna seamea, Croton magalocarpus, Gravelia robusta* and several species of eucalyptus. Selection of Kisongo ward was based on the fact that it is one the most vulnerable wards to climate change risks in Arusha Region, and had experienced serious climate variability and change in recent years.

Methodology

The major sources of secondary data were the Arusha District Council; Arusha Agricultural and Livestock Development Office; the Arusha Community Development Office; and Arusha Land, Natural Resource and Environment Office. Other secondary data were drawn from research reports and publications. Primary data were collected through household questionnaire survey that covered both farmers and livestock keepers and/or a combination of both. Key informant interviews were held with the local authorities at district, ward and village levels. Also, undertaken, at village level, were Focus Group Discussions.

As the study sought to make a detailed assessment of implication of climate variability and change on social and ecological systems, in-depth key informant interviews (KII) were used as data collection technique. The key informant interviews (KIIs) were undertaken with focal persons at district, ward and village levels. The focus was on sectors that are affected by variability and changes in climate, namely, agriculture, water and livestock. Community development departments were also consulted to provide insight on how households are impacted, especially in terms of food security aspects. A total of four villages, namely, *Engorora*, *Ilkerin*, *Loovilukuny* and *Lesiraa,* all from Kisongo ward, were involved in the study. Purposive sampling procedure was used to determine KIIs whereby aspects like the climate-related sector one is working in, gender and age were considered. Gender was considered because in agro-pastoral

societies, each gender has its specific task(s), for instance, looking after livestock for men and household management by women.

Qualitative data were collected using notebooks and digital audio recorders and then they were later transcribed, coded, and translated into English. Data analysis was done using a qualitative software package, Atlas ti. Qualitative data are presented in form of summary narratives, and verbatim illustrative quotes to substantiate the findings. We first created a primary document family, in which all interviews were categorized into their respective groups, for example, local leaders (Ward Executive Officers and Village Executive Officers), local people and extension staffs. Thereafter, all texts were assigned codes and code categories were created by merging different codes to form themes or patterns. Finally, all categories and themes were assessed as well as filtered in terms of their utility in responding to the study objectives.

Results

Local community perception of climate variability and change

Understanding of local community's perception on climate change is important to design and implement appropriate adaptation strategies to withstand climate change impacts. This sub-section presents the local communities' perception of climate change and variability in selected villages of Kisongo Ward in Arumeru District, Arusha region.

Rainfall

Rainfall is one of key variables that the study focused on to assess local communities' perception on climate and associated changes. The study established from KIIs that rainfall has declined over the past 20 years, both in amount and distribution. It was further noted that some areas do not get rainfall at all in certain years, 2009 being one of them. One key informant was of the opinion that for every year, the amount of rain is declining. *Mukulat* Division Forestry Officer stressed that the rains were sufficient between the year 1994 - when he moved there - and 2000. He further noted that rains used to fall from December to February then late March to late May. Given sufficient rainfall during the years already noted, *Mukulat* Division Secretary ascertained that people were able to grow short-term crops such as sweet potatoes, black beans, and beans, whereas these days, the situation is not the same as rains are insufficient and no longer predictable. The following quote from an interview supports this view:

> "Recently, there have been scarcities in rain compared to previous years. Now we have planted black beans and sweet potatoes but as you can see, it is not raining. In the past, rains were sufficient to enable crop growth. Currently, the rainfall amount has decreased and it is inconsistent, even our farming activities are greatly affected" (KII, Kisongo Ward).

When asked as to why such changes have occurred, one elder noted that the rains have declined as a result of God's will. However, the District Land, Natural Resource and Environment Officer had a different opinion, that until two decades ago, there was a very small population in the district, particularly Kisongo ward. He further noted and

clarified that, "population growth that has been witnessed over the past 20 years. It is a contributing factor to changes in rainfall due to increased need for farms and settlement expansion that resulted into clearing of vegetation, especially trees, which help in climate regulation and rain formation." Overgrazing is also a reason. Overdependence by households on wood fuel like charcoal and firewood was as well noted to have brought about deforestation and subsequent rainfall decline. Thus, overdependence on natural resources for different livelihood activities pose serious threats to the natural surrounding and hence, decrease in rainfall ensues.

Temperature

Another climate variable that the study investigated is temperature. The aim was to determine, from respondents, how dynamic temperatures have been over the last two decades. One informant noted that temperature regime has changed as nowadays cold season commences from August all the way to December. In the previous days, the informant further noted, cold seasons used to be between January and late July then, warm season from August to December. One Principal Agricultural Field Officer noted that in the 1980s, Arusha used to be very cold and rivers flowed throughout the year, but they have now become seasonal and some dried. She further established that recently, temperatures have become warmer to an extent that one can even sweat in Arusha, something that never used to be the case before. When asked what could be the factor for the observed changes, she noted that forest loss and global warming caused by air pollution are the major factors. The following remarks underpin this argument as follows:

> "Nowadays, temperatures have increased, unlike in previous years….in the past, we had more cool months than warm months. Currently, warm months have increased compared to the cool months. For example, it was difficult to have extremely warm conditions during this month of July as the month was the coolest of all months in the year. The weather in this month has changed and we cannot use blankets to protect our bodies while sleeping at nights due to extreme warming" (KII, Kisongo ward).

The quotation unveils that local communities experience different weather conditions unlike it were in the past. This is an indication of increased damages of the surrounding environments done by the local communities themselves.

Pasture availability

One of the key livelihood activities in *Kisongo* is pastoralism. Since pasture is climate dependent, on one hand, and reliable source of feed for livestock, on the other, the study looked at current situations of pasture availability in relation to on-going climatic variability. The study found out that pasture availability as well as grazing areas have shrunk. In views of one of village chairmen in *Kisongo* Ward*,* it was disclosed that two decades ago, there was enough pasture for livestock to the extent that other areas, especially hilly ones were made by the village authority as pasture reserves for grazing during drought seasons. Findings indicated that currently, no reserves are there due to pasture shortage. One of the interesting quotes forms the basis for this argument:

> "We don't have sufficient pastures for our livestock, particularly during dry season. During this period, some of the pastoralists are forced to reduce the number of their livestock. We have observed many pastoralists losing herds of cattle due to long dry season, which culminated to scarcity of pastures and water" (FGD, Kisongo ward).

However, it was reported during KII that population increase, as opposed to climate related factors, was noted to be the most contributing factor due to the fact that settlement and farm expansions have taken up what previously used to be grazing areas. Currently, most people around Mount Meru practice zero grazing as noted by the study noted. In Kisongo, which is located on the lower altitude area, grazing is still practised. It was however, it was noted that there are few herds in studied villages unlike it was in the past thirty (30) years where a household could have over 100 cows. The findings established that rainfall shortage was another factor for pasture scarcities in all studied villages. For instance, January to June months were noted to be the period of pasture availability before the ongoing rainfall decline started to manifest. In some years, particularly in 2009, there was a very serious drought that left hundreds of herds dead as a result of lack of pasture and water. In view of this, population increase and increase in herds have contributed much to environmental degradation due to establishment of new settlements and farm expansion. As a result, chunks of natural vegetation and forests have been cleared and hence, disruption of the local climate is happening.

Crop productivity

The last aspect that the study looked into in regards to perception of impacts of climate change and variability is crop productivity. This study noted that food productivity has been declining on a yearly basis in recent years due to unreliable rains. This incident affects much the livelihoods of the local communities since production is not guaranteed as it was in the past. It was established during the KII with one of the elderly people in Kisongo that food production has decreased tremendously due to increased climate changes and variabilities. It was further established that nowadays, it is very rare for households to get good harvests. In views of the local communities, good harvests can happen once in every 5 years. Moreover, they alluded that in the past, food harvests were quite sufficient. For instance, respondents noted that a single household could get 12 bags of maize and 6 to 8 bags of beans in one acre. In the present days, however, an average amount of food harvests ranges between 3 and 5 bags of maize per acre or nothing at all, respondents noted. Such amount of food, should one get lucky and harvest, cannot be sufficient for the whole household until another harvest, it was further established. Findings also indicated that only few households with larger farms that have better water retaining soils and who preserve their environment can have sufficient harvests but that applies only to very few and thus, majority of households are food insecure.

In search for factors for the noted changes, the study found out that rainfall shortage in the present days has greatly contributed to crop failure and subsequent food insecurity. One division official noted that farmers work hard and cultivate larger

farms but drought following recent rainfall shortage is the key challenge at present. Apart from rainfall shortage, loss of soil fertility and lack of fertiliser use among most peasants are other contributing factors, the study established from respondents. One important remark with regard to decline in crop productivity was given by an elder respondent during KII in Kisongo ward by alluding that,

> "Basically, the climate of the village was favourable in the past. The weather of the villages was good and there were bumper harvests. During those days of which I refer as the good years, food was sufficient within the villages. We could sell our surplus beans and maize to Arusha city or traders who were coming to buy crops in our villages. Generally, the harvesting was good enough throughout the year. Now the situation has changed, crop productivity has decreased due shortage of rains. As the rainfall keeps decreasing, the harvests become worse than previous years. We are completely confused" (KII-Kisongo Ward).

Though it is widely accepted that crop productivity is affected by climate change, decrease in crop yields is not only due to insufficient rains as there many factors associated with the decrease. These factors can pose more risks to crops if they are not monitored and managed correctly. Some studies have documented how pests and diseases affect crop productivity (for example, Donatelli *et al.*, 2017; Theodory, 2020). Presence of pests and diseases in a farm may cause damage in a number of ways. Besides the direct damaging effect on crops, there are pests that damage plant roots and hence, affect nutrient and water uptake capability of the plant. Consequently, the plant is highly susceptible to other diseases and hence, poor yields.

Local community vulnerability to and impacts of climate change and variability

Household vulnerability and impacts

Looking at impacts the local community has endured regarding observed climate variability and change, the study found out that food insecurity turns out to be the most adverse at household level. On one hand, households are food insecure, given rainfall scarcity since the majority farmers depend on rain to grow food. On the other hand, however, herders who are noted to be the hardest hit, rely entirely on their livestock as sources of meat and milk as well as for sale to buy food. Thus, scarcity of pasture has adversely impacted on pastoralists' wellbeing as they are unable to address household food security issues. Respondents also noted that development pace has been halted as the major sources of income, which are farming and livestock keeping are compromised. One respondent stressed that,

> "Local people are like local chicken. They do several things just to get food. They farm, rear livestock and trade products from these activities. Thus, failure of rains has compromised the most reliable livelihoods."

Not only is food security the sector that is vulnerable but also water availability, especially for household needs. Findings established that over the years, most places in the district have been depending on gravity water supply from nearby hills. Lately, the amount of water has declined as less as half or quarter of the amount that used to be supplied two decades ago, noted Arumeru district senior water technician. He further noted that deforestation and destruction of catchment areas have affected

availability of rainfall, leading to less water available for household consumption. It was also established that both gravity water supply as well as borehole sources, particularly in Kisongo area have been affected as a result of rainfall shortage. Following such water shortage, the study noted that a lot of hours that could be invested in other productive activities are wasted in search for water. The study learnt that, for instance, a housewife leaves her household at 5:00 am and get back at around 1:00 pm with lots of chores awaiting her. The following quote from one FGD confirms this claim:

> "In this village, there were more than eleven boreholes, which provided clean and safe water throughout the year. But currently, we have only three boreholes within the village, and one of them almost dries out in this summer. This is a big challenge to the community as we have to depend on only two boreholes, which are not enough for the whole community. Sometimes we have to walk long distances to fetch water, and this affects other livelihood activities since we spend most of our time in search for water" (FGD-Kisongo Ward).

Other extreme climatic events like flooding and drought were cited as threats to people's health among the study population. Kisongo Ward Community Development Officer was of the opinion that there have been reported cases of malnutrition, especially kwashiorkor among children due to household food insecurity that has mainly been contributed to by rainfall shortage and apparent crop failure in Kisongo. She further established that children's school performance and attendance are also on the decline as the parents cannot afford feeding them properly at home as well as contributing food to schools, which is a common practice in most schools in the area. Moreover, due to water scarcity, household sanitation is also affected, the study established. For instance, it was learnt that most people take bath once a week and thus, facing high chances of skin diseases. Because of drinking less water that is nor clean neither safe, it was feared to be a major cause of abdominal infections. During drought, people share water with livestock, which causes a lot of health problems. The study also noted from some KIIs that malaria cases are on the rise in Arumeru district, citing changing temperature regimes that favour malaria vector reproduction as the factor. One elderly respondent was of the opinion that increased temperature in the whole district favours prevalence of malaria disease, unlike in the past when the district was characterised by cold weather almost throughout the year, a condition that does not favour the prevalence of malaria.

> "Nowadays, there are high prevalence rates of malaria within our communities. This is a new experience to us since Arusha and particularly this district of Arumeru, it used to be too much cold to accommodate mosquitoes that are vectors for malaria parasites. The common disease in that particular weather was fine but recently, things have changed as the prevalence rate of malaria is very high, affecting mostly children under five years of age and pregnant women" (KII-Kisongo Ward).

Also, the study went further by looking at the extent to which the community as well as individuals are vulnerable to the impacts. It was found out that individual pastoralists are at the highest risk due to lack of rainfall that adversely affects

availability of pasture. Pastoralists depend directly on animal products such as milk and meat, which form most of their diets. Apart from that, they only have livestock to sell so as to raise money to address other needs like food, health care and school fees for the children, to mention but a few, the study learnt. When livestock are unhealthy due to lack of pasture and water, they attract poor prices thereby failing the pastoralists in leading their daily lives.

> "For the past ten years, we have experienced unusual long dry spell periods. Thus, accessing pasture for grazing has been a challenge, considering the rains we get do not support grass regeneration in many places. Our livestock are becoming unhealthy and hence, failure to get reasonable prices at the wholesale market. This, in turn, affects our livelihoods as it is difficult to meet other household expenses, including access to better health services and paying tuition fees for kids" (KII-Kisongo Ward).

At an individual level, the study established that women and children are the most vulnerable. Among pastoral community, particularly in the study area, it was noted that women are the ones to look after a household on a daily basis. Men just provide money for food and even when they do not, women still have the responsibility of making sure that the husband and children have something to eat, noted the study. In addition, it was reported that children also help their mothers with some chores when they (mothers) are away searching for scarce water and firewood and as a result, children are delayed to start school. A child is allowed to go to school only when the immediate younger one is older enough to help the mother, it was further established. Another vulnerable group to climate related shocks is the elderly, established the study. This group is mostly vulnerable to food insecurity since they cannot work in farms, keep livestock or work elsewhere to be able to address their food needs.

Coping and adaptation strategies

Most responses from undertaken interviews imply that local people believe observed climate variability and change is a result of environmental degradation due to livelihood activities such as overgrazing, unsustainable farming, charcoal making and deforestation, mostly for firewood. In that regard, the study noted that individuals have responded to the impacts by implementing some environmental rehabilitation activities. It was noted that in areas where people are aware and knowledgeable about the environment, tree planting has been the major intervention. In Kisongo area, for instance, the study noted that apart from tree planting, people have been engaged in land rehabilitation and water harvesting by planting reeds along gullies and digging small dams to retain water for livestock during dry season, respectively.

Another strategy that has been used to curb climate related shocks is rural to rural migration, especially by pastoralists. The study was informed that during times of drought or pasture scarcity, herders migrate to such other areas as Monduli district, Ronjoku in Manyara region, Kilindi and Handeni in Tanga region as well as Mbeya region in search for pasture and water for their livestock. It was also established that at times of good harvest in Kisongo, herders usually return their livestock to graze on

left over crop feedstock. One district official, however, noted that due to high population growth in most parts of the country, pastoralists have fewer migratory destinations and thus, they are slowly adopting sedentary way of life and give away with the nomadic one. In that regard, herders are starting to grow crops and thus, transforming from pastoral to agro-pastoral society, the officer stressed.

The study found out that during rains seasons, most of local people try to harvest rainwater to cope with water scarcity. It was noted during the study that majority of local people rely on rainfall to get water for household consumption. However, the leading challenge to these household was on poor knowledge on how to harvest adequate water that would satisfy their needs during severe water shortages. It was further observed that most of the rooftops for different houses in the studied villages do not support effective and efficient rainfall harvests. The rooftops of their houses were not well arranged in order to allow easy draining of rainwater into storage facilities. The study revealed that most houses were not well installed with water harvesting structures and, in most cases, water collecting gutters were found right at the front of the houses, while the other parts had no collecting vessels. This implies that much of the rainwater was lost.

Also, the study learnt that some people are now resorting to secondary activities such as trade and wage employment. On one hand, it was found out that women, nowadays, engage in small businesses, poultry projects and selling their labour to large scale coffee plantations to supplement their income, especially for household needs. Their male counterparts, on the other hand, leave their homes for urban centres to look for wage employment, especially in the security sector, which is popular among people from pastoral societies. In Kisongo area, some youths, both male and female, have entered into stone quarrying business as well as working casually at "A to Z," a mosquito net manufacturing factory found in the area. Should it happen that most of these strategies fail, the study noted that selling some livestock to raise money for household needs is an option. A healthy ox, for instance, can attract as much as Tanzanian shillings (Tshs) 700,000/-, the sum that can support a household sufficiently in terms of buying food, cater for health care and paying for children's school fees. The government, on its side, supports people by providing food aid, especially when crops fail, the study found out. However, respondents in Kisongo counteracted that by arguing that the food given to households as aid during hunger is insufficient and the final solution is to keep people going. The following quote from one of the KIIs confirms this claim:

> "Pastoralism activities are increasingly facing challenges including long dry spell periods as well as water scarcity. Many youths have migrated to towns and cities in search for more green pastures. For example, in my household, two youths have left to Dar es Salaam and Arusha cities where they are working with Security Companies. We are trying to diversify our livelihood activities rather than focusing on livestock keeping only" (KII-Kisongo Ward).

Institutional role in climate variability and change adaptation

The role of institutions in helping local communities, especially in coping and adapting to climate change is instrumental in empowering people with strategies to better cope with impacts. In that regard, this study assessed the role played by institutions in Kisongo area, in particular and Arumeru district, in general, to support local people as coping and adaptation strategies.

The study established that the Arumeru district authority in conjunction with Olmotonyi Forestry Institute and Sokoine University of Agriculture have a strategic plan to rehabilitate the environment through tree planting as a move to address rain shortage in the area. Their intervention is through provision of trees and technical assistance to people on planting and tending for the trees while emphasising on each household to plant at least 10 trees a year. Furthermore, the study found out that the Arusha district local authority is working with a community-based environmental programme in Ilkerin village-Kisongo on tree planting, land rehabilitation and water conservation. During acute food shortage incidences, the Government provides food aid, especially to such impoverished households as female headed and those with no livestock. It was established that these kinds of households get at least 60 (kilogrammes (kg) of maize when food aid is provided.

Apart from direct intervention in the community, this study established that the government also conducts awareness creation campaigns regarding coping with climate change. Between 2008 and 2009, for instance, the district authority conducted seminars in 10 villages where each hamlet from the four villages in Kisongo area sent a representative. Together with that, the seminars brought together village water committees, village government officials, religious leaders, political leaders and traditional leaders who were given emphasis to talk to their people about climate change just as it has been done for Human Immunodeficiency Virus/Acquired Human Immunodeficiency Syndrome (HIV/AIDS) campaigns. One officer in the district water office stressed that people were also trained on reusing water used in the households for irrigating small vegetable gardens and banana trees. All these initiatives have not been done without funding as the study learnt that through District Agricultural Development Initiative Programmes (DADIPs), the government have allocated Tshs 40 million for awareness creation on environmental rehabilitation in the district.

Religious institutions and other non-governmental organisations have also been working with the local people in similar pursuits like the government. The study was informed that a Lutheran Church owned Radio station *Habari Maalumu* manages a tree nursery in Ngaramtoni area where they sell trees and sometimes provide them to people for free in an effort to restore lost forests in neighbouring localities, Kisongo inclusive. Another church, the Roman Catholic, implements a community nutrition programme through food for work arrangement whereby, instead of being paid by participating in village development tasks such as digging dams, villagers are given food. Furthermore, Soil Conservation and Agro-forestry Progamme (SCAPA) project

that lasted between 1994 and 2000 was noted to be one of the programmes that tremendously contributed in efforts to bring about environmental sustainability in Kisongo and other part of Arusha. The programme used village soil conservation committees and extension officers to involve farmers in soil conservation through agro-forestry, livestock husbandry and crop management, it was found out.

Challenges facing coping and adaptation strategies in place

Despite all efforts that have been put in place to restore the environment and eventually, address climate change impacts, the battle is not yet won, the study was informed. For example, Arumeru District Land, Natural Resource and Environment Officer noted that the damage that the environment has undergone is extremely big such that it will take a long time and large sums of money to restore to its required state. This, to a great extent, has been due to poor land use planning where livestock keeping is carried out everywhere in the studied villages. Pastoralists have been grazing their cattle extravagantly, leading to severe degradation of water catchment areas. The study further noticed that nowadays, there are tendencies of clearing the vegetation cover for the sake of expanding pastures. Even more challenging, noted the officer, is budgetary constraint that halts government efforts to address this issue. Another informant working at Arusha district stressed on this aspect by arguing that in most cases, when the district authority approves and sends budgets to central government, they end up receiving less funds than they requested, in the first place, and thus, slowing down their pace to sufficiently implement set goals. The same experience has been encountered almost in every sector in Tanzania since the money disbursed to different public institutions does not reflect the actual budget and hence, failure to implement most of the set goals.

Apart from challenges noted in this study, it was found out that local communities themselves should be responsible for unsuccessful climate change adaptation at local scale. It was established, for instance, that *Waarusha* people - the majority dwellers of Kisongo - are so rooted into nomadic pastoralism. Thus, they have been quite reluctant to positively participate in tree planting since they perceive it as a threat to cattle grazing in a sense that all grazing areas will be taken up by forests. Another reason is that the government is so adamant about protecting trees. So, when drought strikes, the herders will not be able to feed tree foliage to their livestock and there is no reason for them to plant trees. Regarding adoption of sustainable agriculture, it was established that a conservation farming programme has been advocated for. It involves mulching to improve humus and preserve soil moisture. In addition, pastoralists have been noted to be against this effort since it involves leaving the crop residues to rot in the field after harvest while to herders, residues form part of their livestock feed, especially during drought times.

Conclusion

The study concludes that the local communities and other stakeholders in the study area perceive climate variability and change in terms of impacts and that they have such changes in their daily livelihoods. It is further concluded that people associate

crop failures and lack of pasture to changes in such rainfall patterns as distribution, amount and seasonality. In addition to that, temperatures are noted to have increased as it was argued that some malaria cases are on the increase in Arusha, an indication that temperatures are now favourable for mosquito breeding, a malaria vector. The impacts of noted changes significantly include food insecurity due to crop failure and water scarcity. The study also concludes that cases of malnutrition among children, gastronomic infections and skin diseases that were noted are a result of food insecurity and lack of clean and safe water for drinking including other household uses. Given these impacts, it is concluded that individual groups of people at household level who are more vulnerable in their respective order are children, the old and women. On one hand, children and old people are not in a position to go out and work for food, while women, on the other, have the responsibility of caring for the household, on a daily basis, by making sure that children and the husband eat, water is available as well as fuel wood for cooking is available and thus, climate change impacts make their lives ever harder.

Pertaining to coping and adaptation strategies, this study noted to include environmental rehabilitation through tree planting; sustainable farming as well as livestock keeping, soil conservation and water conservation. The study noted that these efforts have been introduced to people by the government and other non-governmental organisations. Individually, herders have opted for rural to rural migration whereby they move their cattle to areas they can get pasture and water. In addition, people have resorted to secondary activities such as wage employment, small businesses, especially among women and stone quarrying for gravel. However, it was note that coping and adaptation efforts are halted by budgetary constraints and reluctance of some people, especially herders who find most of the initiatives as jeopardy to their most treasured resource, livestock.

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