An Assessment of Autonomous Adaptation Practices to Climate Change in Kishapu District Tanzania

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Abstract:

Local knowledge is important in successful adaptation strategies for climate change. A repertoire of varying autonomous practices for adaptation to climate change is found in the existing literature which confirms the dynamic nature of adaptation to climate change which is mainly determined by the extent of vulnerability caused by continued depletion of resources in the environment. Case specific studies are therefore important in understanding why and how people in specific spatial and temporal scales respond to climate change in a certain manner. This article assesses autonomous adaptation practices to climate variability and change in Kishapu district in Tanzania reflecting on local knowledge. A descriptive research design was adopted for the study. Questionnaires, in-depth interviews and observation were used to collect data. Thematic data analysis and descriptive statistical analysis were used to analyze such collected data. The study establishes that traditional rainwater harvesting, agro-forestry, conservation agriculture, pest control, shifting planting time, change of planting methods, changing crop varieties, changing harvesting methods, and planting crop seeds in different fields are the major autonomous adaptation practices employed to adapt to the varying and changing climate in the study area. The study suggests policy considerations on building local peoples capacity in such areas as rainwater harvesting. The study further suggests that promoting traditional medicines in pests' control, and sharing weather forecast information should form one of the important policy agendas at national level.

Keywords:

Adaptation to Climate Change, Temperature Increase, Local Knowledge, Rainwater Harvest, Pest Control, Planting Methods

1. Introduction

There is a wider consensus that climate variability and change continue to affect many sectors including agriculture in many parts of the world see for example Hellmuth *et al*. 2007 and Thornton *et al.* (2006). Yanda *et al*. (2005) and Mwandosya

(2007) reported that Tanzania has shown a general increase in temperature over the past 30 years as well as decreasing rainfall over the same period in most parts of the country. Katunzi and Bushesha (2015) noted that Kishapu District experiences climate variability and change where rainfall is highly variable and the district experiences prolonged drought.

Climate variability and change threatens the stability and productivity of production. In many areas of the world where agricultural productivity is already low and the means of coping with adverse events are limited, climate variability and change is expected to reduce productivity to even lower levels and make production more erratic (Stern Review, 2006; Fisher *et al.*, 2002; IPCC, 2007). Climate variability and change tends to alter the seasons from normal to unpredictable trends. Such biophysical and socio-economic vulnerability is that which triggers the communities to find alternative ways to adapt to extreme weather events so as to reduce the associated effects (UNFCCC, 2011).

According to Hellmuth *et al*. (2007) adaptation to climate variability and change is crucial for avoiding or at least reducing climate variability and change associated effects. Adaptation to climate change occurs in physical, ecological and human systems. It involves changes in social and environmental processes, perceptions of climate risk, practices and functions to reduce potential damages or to realize new opportunities. According to Boko *et al*. (2007), adaptation includes anticipatory and reactive actions, private and public initiatives and can relate to projected changes in temperature and current climate variations and extremes that may be altered with climate variability and change. In practice, adaptation tends to be an on-going process, reflecting many factors or stresses, rather than discrete measures to address climate variability and change specifically. Adaptation to climate variability and change is divided into two major groups' namely planned and autonomous adaptation (FAO, 2007). Planned adaptation is a result of deliberate policy decision, based on the awareness that conditions have changed or are about to change and that action is required to return, maintain, or achieve a desired state (FAO, 2007). Autonomous adaptation on the other hand refers to ongoing implementation of existing indigenous knowledge and technology in response to changes in climate (IPCC, 2007). Such, local knowledge is precious for developing adaptation strategies in response to the changing climate (IPCC 2007).

There are some efforts already been done to assess local knowledge based practices in adaptation to climate variability and change around the world. A case study of farmers' strategies for adapting to climate vulnerability in the low valley of Ouémé river in southern Benin by Kpadonou (2012) showed that local people had developed a remarkable ability to adapt to climate threats, they turned threats into opportunities. For example, using local knowledge, locals have been able to absorb shocks from fishing failures by practicingagro-fishing.

In Tanzania, similar efforts have been undertaken to assess local knowledge in adaptation to climate change. A study by Theodory (2016), for example, reports that the Haya possess a repertoire of practices which have assisted them in responding to recurrent climate change risks including wetland cultivation during long drought season, growing early maturing crops, and the use of locally made pesticides. However, important to note is the facts that all such practices are embedded within Haya peoples' socio-cultural context (Theodory 2016). WIREsClim Change (2013) conducted a similar study in Dodoma Tanzania and suggests that assessments of the role of local knowledge for adaptation need to give more consideration to local power relations and the interaction with government strategies, while also addressing structural constraints to the use of local knowledge across scales.

Clearly, the literature acknowledges that local knowledge is important in successful adaptation strategies for climate change. In recent years, there has been a growing awareness that scientific knowledge alone is inadequate for solving the climate crisis (Finucane, 2009). Based on this, the knowledge of indigenous people – often referred to as indigenous knowledge is increasingly being recognized as an important source of climate knowledge and adaptation strategies. In addition, indigenous knowledge is already seen as pivotal in fields such as sustainable development, agriculture, agro-forestry, traditional medicine, applied anthropology, biodiversity conservation and natural resource management. Consequently, many are expecting this knowledge to play a prominent role in climate science and in facilitating autonomous adaptation to climate variability and change.

A repertoire of varying local practices for adaptation to climate change is found in the existing literature. Such varying local adaptation strategies from one community to the other, confirms the dynamic nature of adaptation to climate change which is mainly determined by the extent of vulnerability caused by continued depletion of resources in the environment. According to Mirza (2003), adaptation to climate variability and change as well as risks take place in a dynamic social, economic, technological, bio geophysical, and political context that varies over time, location, and sector. This complex mixture of conditions determines the capacity of systems to adapt.

However, the literature falls short in terms of spatial and temporal coverage where findings in the existing literature may not form basis for generalizations. The spatial and social cultural setting of Theodory's (2016) case study, for example, may not be a full representation for the whole Tanzanian community. The country has more than 120 ethnic groups within different social, economic and cultural settings leave alone the diversity in bio- geo- physical environment, all of which forms a basis for differences in levels of vulnerability among members in specific communities. As Kpadonou (2012) made it, like climate, climate change adaptation is a dynamic and evolving process which the main determinant is the degree of vulnerability; this calls for local spatial scales studies for findings objectivity. While the Haya are basically banana growers, for example, Sukuma, the dominant ethnic group in Kishapu district on the other hand are agro-pastoralists; the differences in economic mainstay may by itself lead to differences in levels of vulnerability hence differences in climate change responses among the two communities. Likewise, although WIREsClim Change (2013) was conducted in a semi-arid areas of Tanzania (i.e. Dodoma) where the community in question practices agro-pastoralism as the case is for communities in Kishapu, yet the field study, for WIREsClim Change (2013) was conducted in 2006 i.e. a decade ago where many changes are likely to have happened so far given the dynamic human society nature. A decade time period may make significant change, in terms of, for example, environmental and resources availability hence levels of vulnerability and finally likely adaptation options. Therefore, knowledge gaps in this study were realized in terms of temporal and spatial scales where there is no clear documentation on how indigenous knowledge among community members in the study area is realized in autonomous adaptation to climate change; this is why this study was undertaken. This article therefore presents an assessment of indigenous knowledge as autonomous practices for adaptation to climate change with reference to Kishapu district.

2. Materials and Methods

2.1. The Study Area

The study was conducted in Kishapu district, Shinyanga region Tanzania. Kishapu District is in the South-western of Shinyanga region situated south of Lake Victoria (Figure 1). The district lies between latitude 3^0 15' and 4^0 5' South and longitudes 31^0 30' and $34^0$15' East. (Kishapu District Profile, 2013).

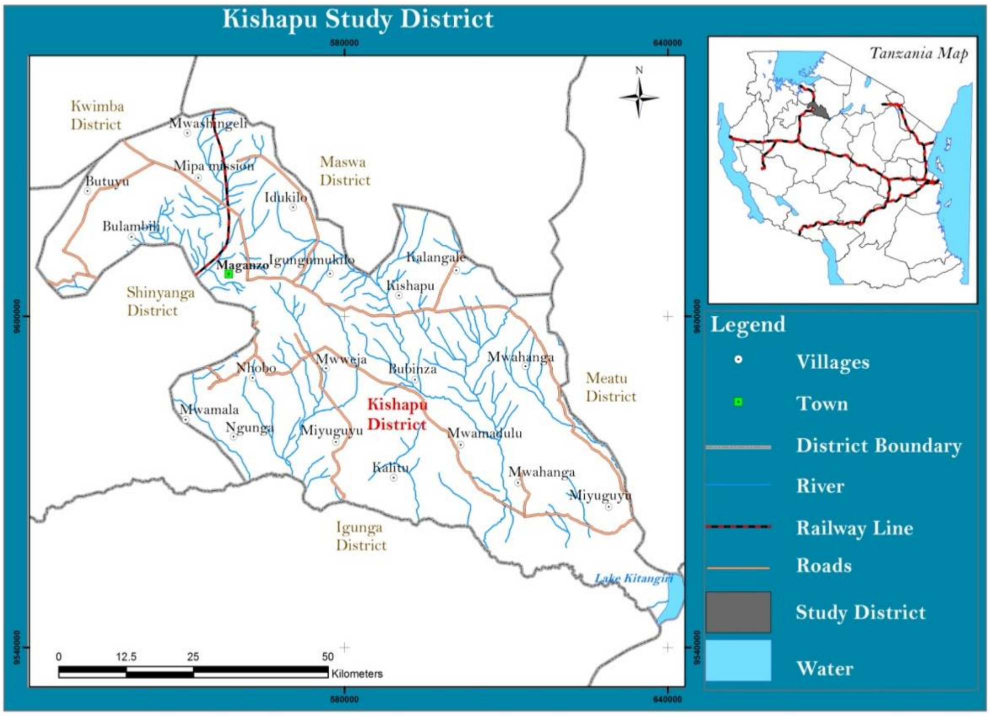

Figure 1. *Location of Tanzania, Shinyanga Region and Kishapu District*

Kishapu is a semi-arid area characterised by flat, gently undulating plains land (Monela *at el*. 2005). Main vegetation types in the district comprise wooded grassland, open grassland, wooded bush land, bushed grassland and forest. Woody species include *Terminalia* Catappa, *Acacia polyacantha*, *Acacia Senegal*, *Acacia indica*, *Balanites aegyptiace*, and *Senna siamea.* Grass species include Pennisetummezianum, Pennisetumstramineum, Chrorisroxburghiana and sporobulusangustifolia, Chlorisguyana and Cenchrusciliaris(Kishapu District Profile, 2013).

In addition to population growth rate of over 2.9%, local labour migration is common in the district. Population density is estimated at 63 people per km^2 which is higher when compared with 49 people per km^2 for Tanzania. Kishapu Disrict has an average household size of 6.3 which is higher when compared with 4.8 of Tanzania mainland (TPHC, 2012). The major ethnic groups are the *Wasukuma*, *Wanyiramba*, and *Wataturu*. The major economic activities include crop farming, livestock keeping, mining, forestry and agro-forestry as well as fishing.

2.2. Methodology

Pragmatism guided the study. The philosophy behind the study is that those things that are experienced or observed are real and the focus is on the reality of experience. Reality is constantly changing and that we learn best through applying our experiences and thoughts to problems as they arise. The world is dynamic not static so there is no absolute and unchanging truth, rather, truth is what works. Thus agronomical practices in the study area are critically examined along perceptions and experiences on climate variability and change using a descriptive research design.

2.2.1. Sampling

The focus population for the study was heads of households, elders, village leaders, professionals and policy makers. A multiple-stage sampling was applied to accommodate various data needs for the study. A household was used as a sampling unit. Household heads made the sampling frame. A systematic sampling technique was employed in selecting households for the study where 235 households were selected. Table 1 presents the sample population for the study. The researcher in collaboration with village leaders selected key informants using purposive sampling targeting such people as village leaders, agricultural extension officers, environmental officers, diviners, policy makers, aged people, and people who stayed longer in the villages e.g. 40years and above. These were to be subjected to in-depth interviews.

Table 1. *Sample Population*

Village	No of households	Sample size	%
Buganika	541	54	23
Kiloleli	421	42	18
Mangu	426	43	18
Masagala	462	46	20
Mwamadulu	351	35	15
Unyanyembe	148	15	6
Total	2,349	235	100

2.2.2. Data Collection and Analysis

At the household level, a semi-structured questionnaire was administered to probe household heads and capture information on the role of indigenous knowledge on climate variability and change adaptation. Moreover, informal discussions were held with key informants; these were to give deep information on particular issues. The study also used observation method to observe social economic activities undertaken focusing agronomical activities. Descriptive statistical analysis was employed for numerical data whereas thematic data analysis was used to analyze qualitative data.

3. Results and Discussion

From farmers' perspective, climate change has led to unpredictable rainfall, increase in temperature, decrease in soil fertility, and increase in crop pests, disrupting crop calendar and crop failure (Table 2). Rainwater harvesting, agro-forestry, conservation agriculture, pest control, shifting planting time, change of planting methods, changing crop varieties, changing harvesting methods, and planting crop seeds in different fields are the major agronomical adaptation practices employed to adapt to the varying and changing climate in the study area. The subsequent subsections discuss each of the practices.

Table 2. *Climate change impacts on crop production*

Perceptions	Frequency	%
Unpredictable rainfall	208	78.5
Crop failure	197	83
Low soil fertility	87	37
Increase in crop pests	134	57
Increasing temperature	78	33
Disrupted farming calendar	168	71

3.1. Rainwater Harvesting

Findings indicate that 78.1% of all respondents voted that rain-water harvesting is an essential agricultural practice that is currently used to reduce the impacts of climate change. Respondents explained that with rainwater harvesting farmers continue to produce even when rainfall ceases. They perceive that rainwater harvesting increases water availability in the area, and that this plays a big role in crop and livestock production.

There are several methods used to harvest rainwater in the study villages, one is used to harvest is excavation of bounded basins popularly known as *majaruba*. The *majaruba* farming technique is mostly used for rice production in valley fields. Under this approach, fields are subdivided by bunds of 100 cm height to form cultivated rainwater reservoirs; these are thereafter transplanted with paddy. With the perceived declined rainfall trend the *majaribu* height has been made as high as 120cm. These bounded basins are basically prepared during dry season ready to tape water during rainy season (Figure 2).

Figure 2. *Ridge preparations for water harvesting*

The other rainwater harvesting approach reported in the study area is collection of water from house roofs and storing it in concrete tanks. Local craftsmen have been trained on how to construct water tanks for storing water harvested from house roofs. Key informants reported that Tanganyika Christian Refugee Service (TCRS) ameliorated traditional rainwater harvesting by co-operating with local people in Kishapu District to construct roof rain water harvesting tanks. Figure 3 shows one of the tanks at Mwaweja primary school.

Figure 3. *Rain water harvesting tank constructed*

Dam construction is another approach used to harvest rainwater in the study area. Key informants reported that farmers in collaboration with technicians participated in sand-dam construction. In order to ensure sustainability; locals have been trained on how to construct sand-dams in their local areas.

3.2. Forest Conservation

2.1% of all respondents were of the opinion that agro-forestry is an essential agronomical practice used in food production for adapting to changing rainfall and temperature patterns in the study area. The well-known agro-forestry system in the study area is a system locally called *ngitili*; this is an *in-situ* conservation system whereby during rainy season *ngitili* tend to be closed while during extreme dry weather where pastures tend to be limited in the area *ngitili* is opened up for grazing. *Ngitili*, according to key informants, is a system used to adapt to reduced fodder, fuel-wood, building poles, timber, grass for thatching, and medicinal plants due to pronged dry seasons. Under *ngitili* system tree trunks are never cut, instead tree branches are the ones cut for such purposes as fire wood collection; drop from the larger trees for fuel. In some cases farmers harvest mature trees for fuel especially where they need fuel for making charcoal and bricks.

Key informants explained that many families are now planting nitrogen-fixing legumes such as Gliricidia, Calliandra and Leucaena. Some grow such trees for fodder while others grow them specifically to improve soil fertility and crop yields. Also, some farmers have also begun to recognize the potential value of *Faidherbiaalbida*, an acacia-like tree found throughout much of the district. The tree sheds its leaves during the early rainy season, at a time when farmers are planting crops in fields, once the dry season begins, the trees sprout new leaves, and during that time most crops are at last stage of development (Figure 4). Respondents admitted that the acacia-like trees behavior help them to get better yields. They perceive these trees to improve soil fertility, provide them with construction timber and thorny branches which are used for fencing enclosure where cattle are kept at night.

Figure 4. *Maize yields beneath Faidherbia albida*

Respondents revealed that growing trees is challenging due to water scarcity. However they do apply drip irrigation technique to save newly planted trees during dry season short of which they get wiped off due to water shortage. Under the drip method, during dry season a farmer fills water in bottles and close the bottle caps, boring two small holes on each cap and at the bottom of the bottle then turns the bottle upside-down on each tree. Water from the bottles comes out slowly allowing availability of moisture around the tree for longer times. A one and half litres bottle could be replaced very three to four days. According to key informants, the drip watering technique has proved serving tree lives during such harsh weather (Figure 5). Key informants were of the opinion that the drip irrigation technique uses small amount of water compared to other irrigation methods; it is efficient and cost effective. They were also of the opinion that the method could be used to reduce the effects of deforestation in the area.

Figure 5. *Drip irrigation supporting planted trees in early stage of development*

On the other hand, farmers reported that they planted foreign trees such as *Luceana leucocephola*, *Tamarindu-indica*, *Moringaolifera* and *Grevillearobusta* to improve soil fertility and animal feeds.

3.3. Conservation Agriculture

5.1% of all respondents were of the opinion that conservation agriculture is one of the practices used in adaptation to reduced rainfall and increased temperatures in the study area. Farmers in the study area grow crop varieties that are drought tolerant and withstand excessive higher temperatures and prolonged drought. Some farmers use mulches to reduce the impact of excessive temperatures in their fields, this is done particularly in small fields. Mulching is perceived to lessen excessive-evaporation of soil moistures from the soils and increase the organic matter in the soil to improve soil fertility. Crop debris and grasses are the common mulching materials. Burying crop debris and grasses in the soil is another practice used to adapt to the impacts of climate change; the practice is locally known as *kugoyela.*

It was further reported that most farmers use mixed farming in response to frequent crop failure which is also associated with prolonged drought in the study area; the common crop combination in this case is maize with cassava, groundnuts (*Arachis hypogea*) and cowpeas (*Vignaunguiculata*). One of the unexpected findings is that key informants noted that most farmers did not use kraal manure in crop fields. Despite the lower crops production which is partly caused by increasing soil infertility on top of unfavourable weather conditions yet application of manure is unpopular despite its abundance; there were no clear explanation for such practice.

3.4. Pests Control

During focus groups discussions, farmers reported that climate variability and change causes changes of new patterns of pests to emerge, affecting food crops in the fields. For example stalk borers *Calideadregii* locally called *somi* and cutworms *Agrostis ssp.* locally known as *gegesha*, attacks maize and sorghum especially during dry periods leading into reduced availability of cereals in the area. Respondents reported that farmers use ashes and hand picking and squashing to control such pests. The other method used to control pests is that at the end of the growing season farmers tend to burn the maize and sorghum stalks to break life cycle of pests (Table 3).

Table 3. *Methods used to control pests*

Control options	F	%	Valid %	Cumulative %
Field sanitation	92	34.7	39.1	39.1
Use of ashes	58	21.9	24.7	63.8
Scaring devices for pests	29	10.9	12.3	76.1
Use of pest resistance varieties	20	7.5	8.5	84.6
Smoking	10	3.8	4.3	88.9
Selection of planting materials	10	3.8	4.3	93.2
Intercropping	6	2.3	2.6	95.8
Hand picking and squashing of pest	5	1.9	2.1	97.9
Fallowing and shifting cultivation	2	8	0.9	98.8
Use of herbs to treat grains in granaries	2	0.8	0.9	99.7
Uprooting diseased plant	1	0.4	0.4	100.0
Total	235	88.7	100	

Table 3 presents different approaches used to control pests in the study area. Findings show that 39.1% of all respondents use field sanitation to control rats

Ratusratus during excessive wetter condition; such pests affect both cereals and non-cereals in the fields and in the granaries. On the other hand, respondents (0.9%) reported use of traditional herbs such as neem tree, *Azadirachtaindica* locally known *Muarobaini* and *Solanumpanduriforme*, locally known *tulatula* to control pests in the fields and granaries.

Farmers use smoke (4.3%) to control such storage pests as bruchids beetles *Callosobruchusmaculatus* and grain weevils *Sitophilus* spp for beans and maize respectively. They simply place respective crops above the cooking places. The other approach that is used to control pests is use of scaring device (12.3%); the approach is used mainly to control birds. The other approaches used to control pests include use of ashes (24.7%) where respective crops tend to be dusted using ashes as preservative mechanism against pests. Use of pest resistance varieties (8.5%), Selection of planting materials (4.3%), Intercropping (2.6%), hand picking and squashing of pest (2.1%), fallowing and shifting cultivation (0.9%) and uprooting diseased plant (0.4%) are all approaches used to control pests by locals in the study area. During discussion with key informants it was noted that use of tight containers such as calabash gourds; use of cats as a natural enemy to rats, and traditional traps to combat the pest mostly in granaries are all other approaches used to control pests in the study area.

3.5. Shifting Planting Time

Findings indicate that farmers shifts planting time as a way to adapt to climate variability and change. Crops as maize normally used to be grown in September and October; the situation has changed partly due to changing rainfall and temperature patterns. Field data reveals that 69.8% of farmers have shifted planting time to November and December, and 19.6% of all respondents plants maize from January to February. Very few respondents (0.4%) indicated to plant maize from January to February (Figure 6). In addition, key informants noted that some farmers were not using the September and October rains for planting since they experience that currently, such rains tend to be sporadic in such way that planting maize or sorghum during such months is no longer feasible. Instead, such rains are now perceived useful in terms of pasture rejuvenation.

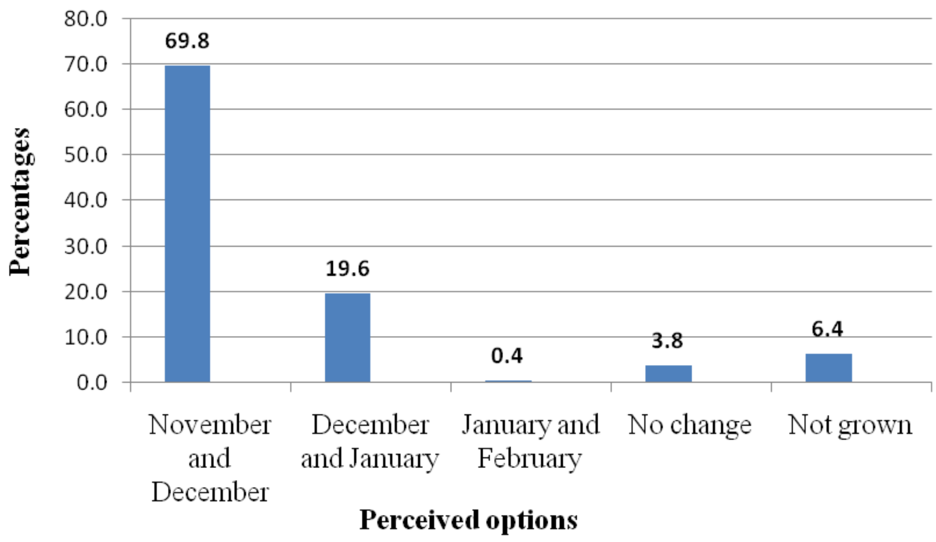

Figure 6. *Shifting maize planting time to November - February*

Beans are a leguminous crop or pulse which is grown in areas with medium rainfall; it is among the major food crop in the district. The major variety grown is a traditional variety known as *Mihanda* which is tolerant and resistant to dry condition. Red beans varieties which were grown in the mid-1970 and early 1980's are extinct. Based on findings from the field, 25.5% of all respondents shifted to plant beans in November to December and January due to the delaying of rains where previously rains started in late October to early November, this change was associated with delaying of rainfall in the area. About 2.6% of farmers had been planting even in January and February (Figure 7).

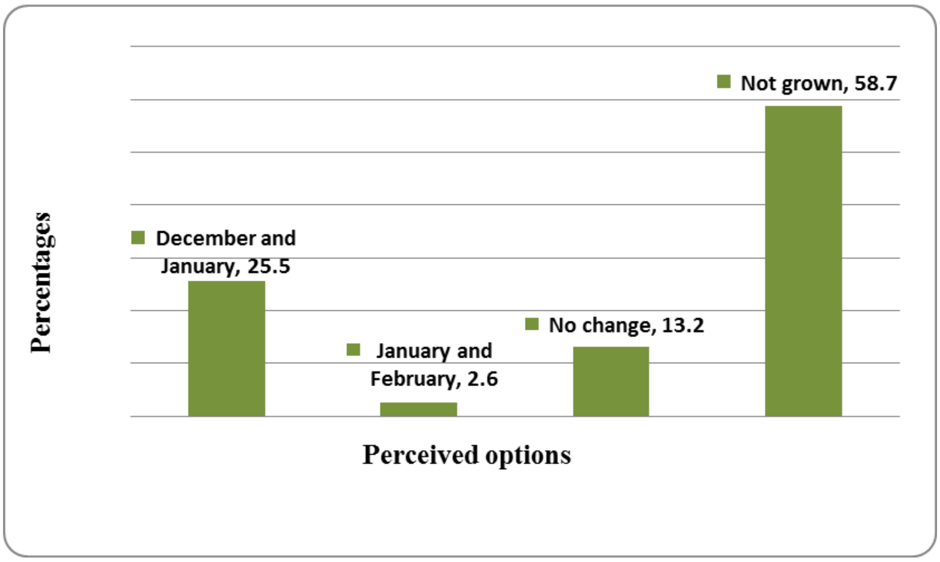

Figure 7. *Shifting of planting time for beans from October to November*

Furthermore, key informants reported that the changing of planting time was modified by farmers in this district after experiencing changing of rainfall and air temperatures patterns in. Based on the findings some farmers exposed that planting beans *mihanda* wasdone twice a season, for example, those who planted beans in November could plant again in February (Figure 8).

Figure 8. *Mihanda field*

Paddy is a cereal crop which need high soil moistures to grow better normally cultivated in lowlands where addition water could be supplemented in case of waters stress. Most of paddy field found in lower and upper agro-ecological zones in the district where the land is relatively flat and areas near the rivers such as ManongaNhumbu and Mangu. Respondents reported that during the past paddy was planted direct to main flat field by broadcasting in late October and November but nowadays this crop is planted in December and January due to climate variability (Figure 9). Findings also revealed that other paddy farmers planted the crop in January and February but these farmers tend to do transplanting paddies from the nursery to main fields where they maintain crop spacing from row to row and plant to plant, this increases the plant population as well as tillerring.

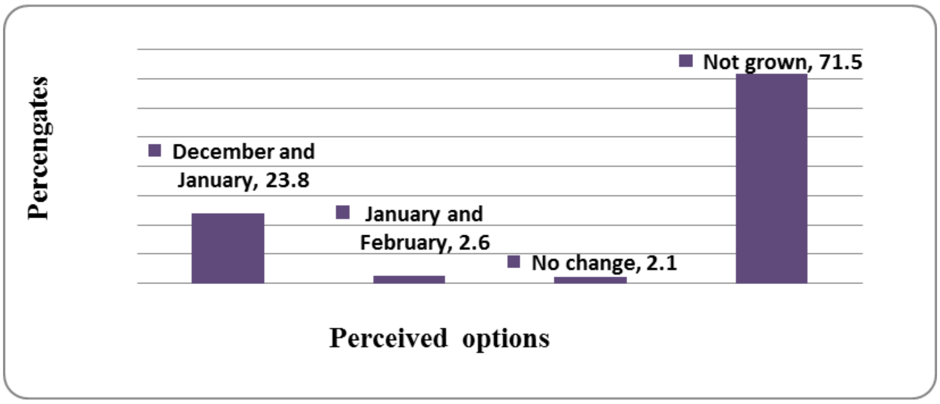

Figure 9. *Shifting of planting time for paddy from October andNovember to December and January in Kishapu District*

3.6. Change of Planting Methods

A few respondents (16.4% and 2.6 %) reported to have changed planting methods of maize from broadcasting on flat lands to planting on ridges and bounded basins respectively (Figure10). Such changes were reported to help in terms of moisture conservation, reducing soil erosion, and increasing soil fertility in the area. However, majority of the respondents (72.8%) indicated not to have changed planting methods, while 7.2% reported not growing the crop at all (Figure 10). Key informants perceived ridges to be good in soil moisture conservation given the prevailing weather condition in the study area. The other reason for using ridges noted from key informants was the perceptions that ridges are good in boosting soil fertility as at the time of lifting ridges; some crop residues and weeds are buried in the soil thus, adding organic matter.

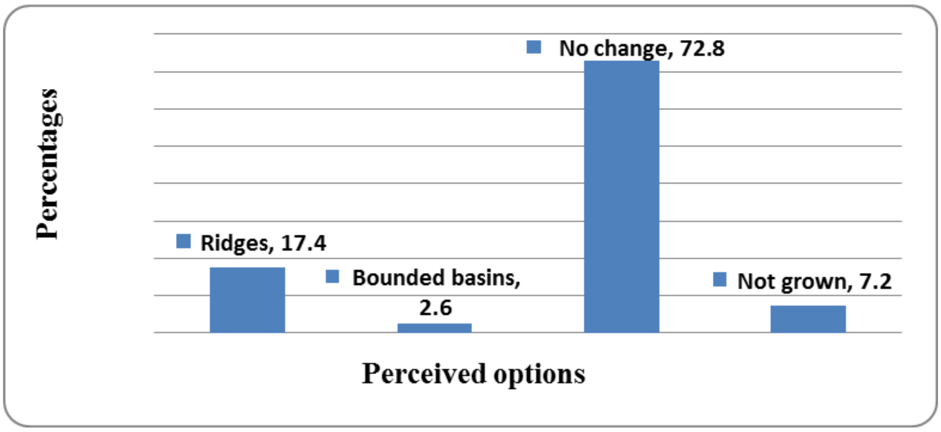

Figure 10. *Change in planting methods*

Findings revealed that about 41% respondents never changed beans planting methods as indicated in Figure 11.

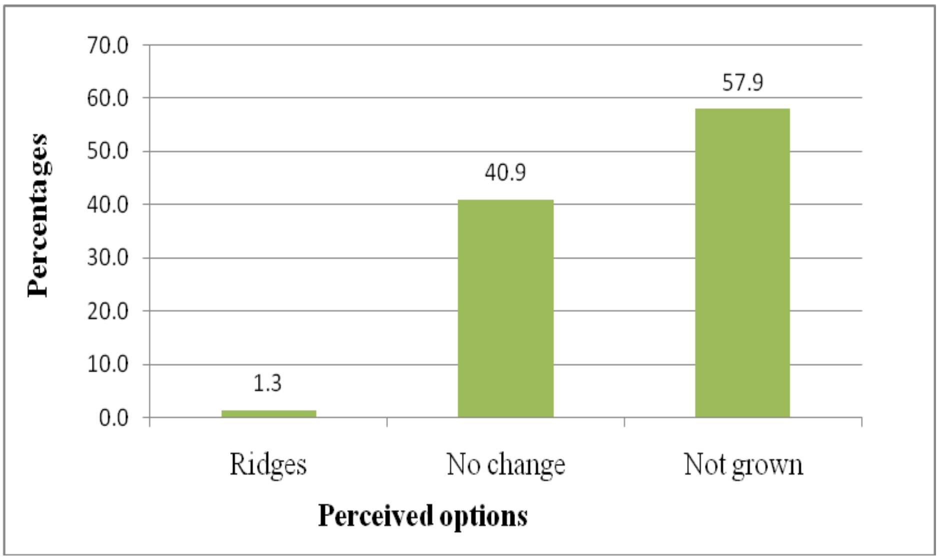

Figure 11. *Changing of planting method for Beans*

Furthermore, 23.8 % of all respondents reported to be involved in paddy production in the area had changed planting methods from planting on flat lowlands to bounded basins (Figure 12).

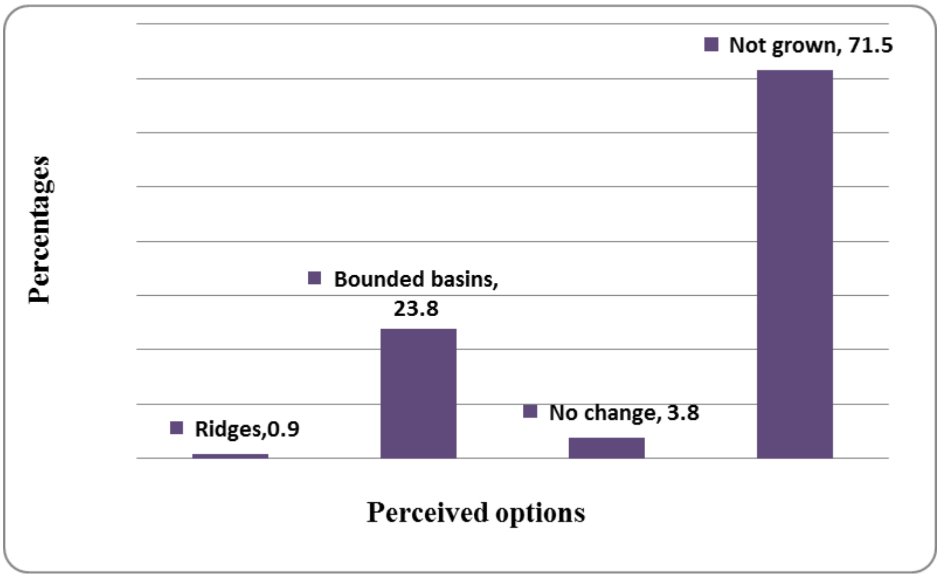

Figure 12. *Changing paddy planting method*

Key informants exposed that this was done in order to conserve more soil moistures as adjustment strategy to the prevailing condition. As modification is a gradual process farmers continued to observe the advantage of using a new method, cost involved and amount of paddies to be harvested, these encourage or discourage the adaptation process. The study established that to uplift ridges in crop production is better a method as it conserves the amount of waters in the bound basins and restricted excessive water during heavy rains which could affect the vegetative growth of paddies. Respondents explained that when water level dropped in bound basin farmers had a chance to open again the ridges to add more water in the basin from nearby water streams or rivers. However, other respondents reported ridges are also used to cultivate paddy, this is particularly practiced in flood prone areas; ridges help paddies not be inundated and hence destroyed during once floods occur.

3.7. Changing Crop Varieties

Changing crop varieties is another practice reported to be used in adaptation to climate variability and change in the study area. Planting early and late maturing crop varieties in the same plot (e.g. maize and beans) was reported during discussions with key informants. The idea behind is that in case of short rains where late maturing crops are likely to fail, early maturing crop would come up with good harvest. On the other hand, where prolonged wet season occurs then late maturing crops would give good harvest as compared to early maturing crops.

A good number of the respondents have shifted from growing maize to drought resistant crop varieties. From Figure 13 it can be learnt that 27% of all respondents indicated to have shifted from growing maize to sorghum and bulrush millet and 8.1% have shifted from maize to sweet potatoes. Furthermore 7.7% reported to have not grown the crop without indicating whether they replaced the crop with any other crop. Hence, combining those who have shifted to drought resistant crops and those farmers who have just stopped growing the crop one will note that 43% of all respondents no longer grow maize in the study area; this is a significant number as it is nearing 50% of the total number of respondents. The findings are in line with Ajan (2013), who noted that many farmers prefer the use of indigenous grains such as millet and sorghum that are more drought-resistant and tolerant than maize. It is worth nothing however that majority of the respondents (57%) have not changed crop varieties (Figure 13). This implies that most farmers still cultivate maize in the study area despite poor yields (Figure 14); it was noted from key informants that maize if perceived to be more palatable as opposed to such crops as sorghum and bulrush millet.

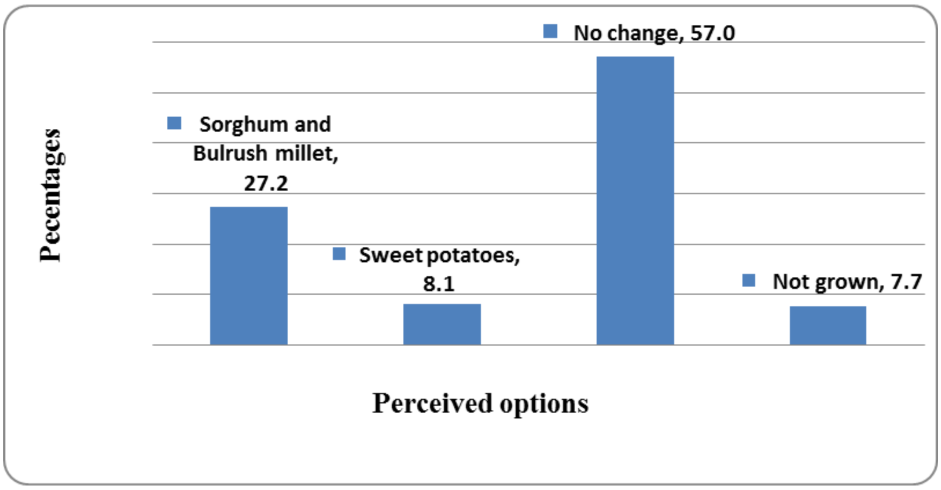

Figure 13. *Change from maize to sorghum and bulrush millet in Kishapu District*

Respondents reported that even though sorghum and bulrush millet are drought tolerant still there were varieties within these crop which were more drought tolerant and resistant than others. Key informants explained that the Ministry of agriculture in early 1970’s introduced new crop varieties such as Serena, Ark 1097, Brazilian hybrid and goose neck varieties. These varieties were more yielding compared to local varieties and were more birds resistant. However, nowadays due to prolonged drought these varieties are no longer suitable in the district. Findings on Figure 14 indicate that most farmers changed back to local long varieties.

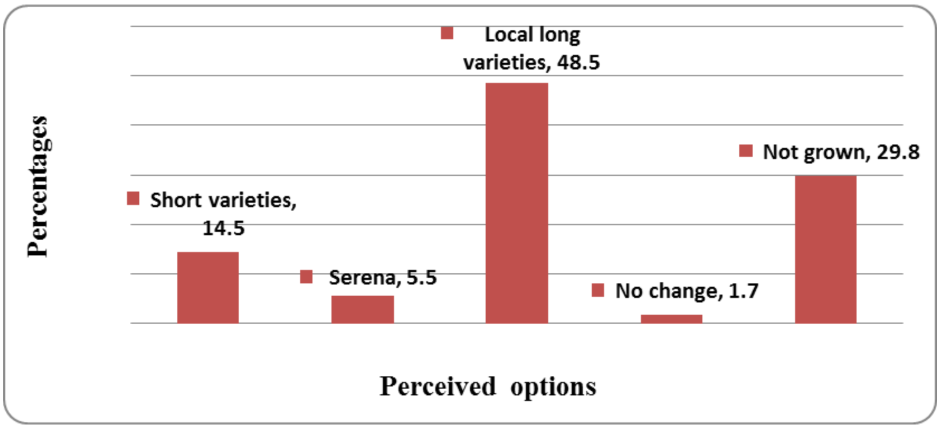

Figure 14. *Change in sorghum and bulrush millet varieties in Kishapu District*

Agricultural extension had introduced various maize varieties in the study area since early 1980s for improved agricultural production and productivity. Due to prolonged drought, these maize varieties no longer provide a good yield as before (ASARECA/KIT, 2014). This has forced farmer to use more local varieties (Figure 15) that are doing better.

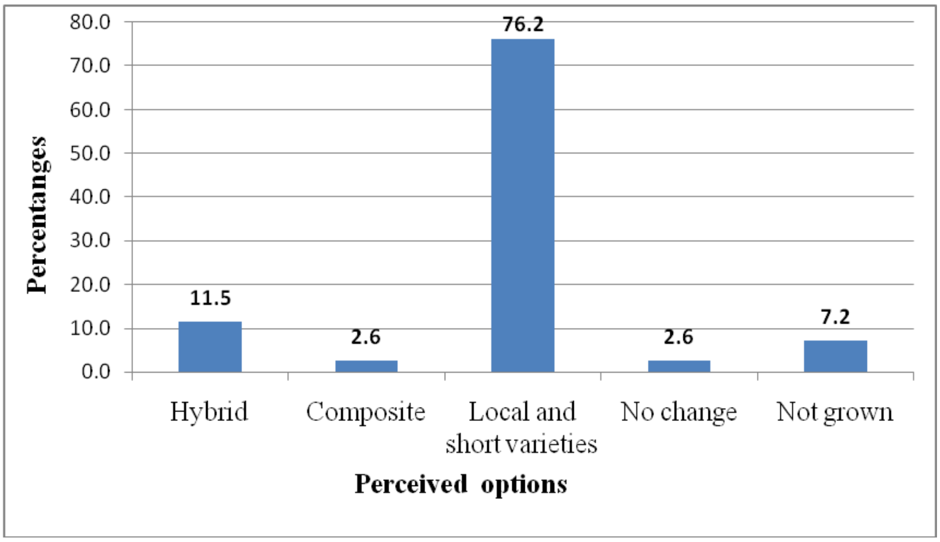

Figure 15. *Preferences on maize varieties in Kishapu District*

3.8. Change of Harvesting Methods

Key informants reported that changing rainfall and temperatures patterns in the area has led to changes in maize harvesting method. Throughout history, farmers in Kishapu district used to cut maize pilling them in hips in fields and left them there for about three to four months. This method helped to reduce moisture content in maize. Nowadays, farmers abandoned this procedure since given the unreliable rainfall patterns it has been difficult to tell when it will wet and when it will remain dry. As a result many times floods had swept such maize hips due to unexpected torrential rains during dry seasons. Such sweeping mostly led to 80 to 90 % loss of the pilled maize. Such events and the like influenced most farmers to change harvesting methods from pilling hips in the fields to harvesting dry maize storing then straight away into *vihenge*, sacks and drums. Findings from the questionnaire indicated the same (Figure 16).

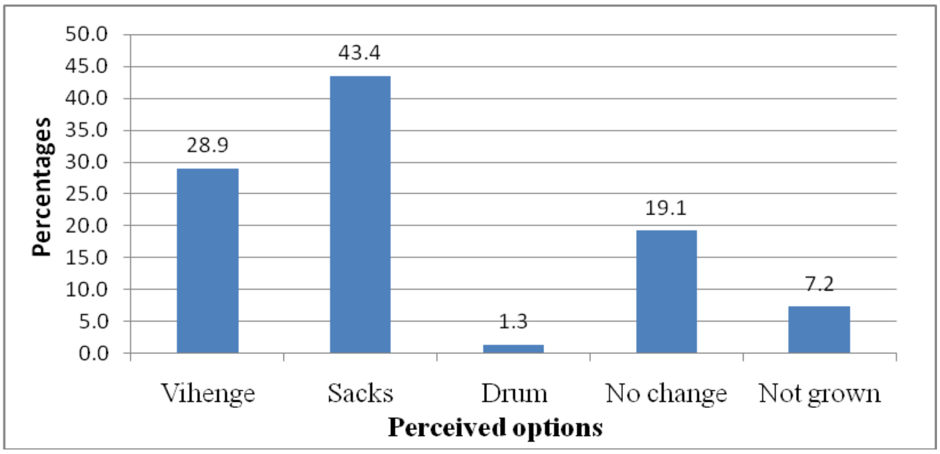

Figure 16. *Change of harvesting method*

Although the new harvesting approaches are time consuming yet key informants noted that they are of much benefit as they perceive them to have helped farmers to reduce the post-harvest losses.

4. Conclusions

The study was set to assess autonomous adaptation to climate change in Kishapu District. From farmers perspective climate in the district is highly variable where by rainfall is on the declining trend whereas temperature is on the rise. Crop cultivation has been affected in a number of ways but the general trend has been reduced crop production. Henceforth farmers adopted several agricultural practices in response to variability and change in climate. One of such practices has been those related to traditional rainwater harvesting, agro-forestry practices, conservation agriculture, pest control, change in planting time, change in planting methods, changing crop varieties, and changing harvesting methods. The study suggests considerations on building local peoples capacity in such areas as rainwater harvesting. The study further suggests that promoting traditional medicines in pests' control, and sharing weather forecast information should form one of the important policy agendas at national level.

Conflicts of Interest

The authors declare they have no conflicts of interest.

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