

# Exploring the influence of climate change and capital assets on livelihood formations in central region of Uganda.

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## Abstract

Current research provides less understanding of how climate change affects the livelihood process at a household level. This study explores household's perceptions of climate change and its implications on livelihood formation process using empirical data from Uganda. Climatic data, household surveys, and key-informant interviews from Wakiso and Gomba districts served as data sources for the study analysis. Majority of the respondents observed climate changes in the last 10 to 20 years and perceived them to have affected their capital assets in the process of forming livelihoods. As a result, households' livelihoods have diversified, and are pursuing livelihood strategies for sustenance. The study underlines the need to access credit conditioned to climate change resilience, access to improved varieties of crops, availing extension services, and targeted resources allocations. Incorporating climate change into the planning process at a local level and associated local institutions in order to improve livelihood formation processes of households is recommended.

**Keywords:** Climate change; livelihoods formation and assets; Uganda

## 1 Introduction

Decisions in choosing a form of livelihood happens at the household level in many societies. These decisions depend on numerous factors among which, is households' access to diverse forms of assets (capital), as well as the desires and priorities of specific households. Members of a household combine their proficiencies, abilities and knowledge with the diverse resources at their disposal to form activities that qualify them to achieve the best conceivable livelihood outcomes like income, food, security and investments. For example, choices concerning family labour apportionment for farming, non-farming activities, schooling and so on, occurs at the household level (Yunez-Naude and Taylor 2001). In the mix of this context is climate change as one of the many aspects through which households operate to form livelihoods that require further investigations. When a person's livelihood is able to endure, cope or recuperate from stresses and shocks like climate change both now and in the future while not destabilising the natural base then it is sustainable (Carney 1998).

Climate change has become a point of focus in livelihoods formation due to the far-reaching impacts on people and ecosystem functioning. For instance, developing countries depend on climate sensitive activities, and experience disastrous impacts (IPCC 2007). Atmospheric concentrations have increased substantially in the last 150 years, leading to a 0.6°C global temperature average in the past 100 years, and it may rise to 7.1°C in the next 100 years (Swe et al. 2015). Developing nations are already facing climate related challenges. Any new challenges brought about by climate change are likely to be primarily through intensification of the challenges that populace is already facing (Nuorteva et al. 2010) thus impacting livelihoods activities. Livelihood activities are rooted in natural resources onto which people are dependent both directly and indirectly. Consequently, there is close

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connection between livelihoods, the variability and productivity of the natural resource base. The natural resources base is so broad to enable a wide choice of alternatives and diversification for the populace decision making.

In other words, livelihoods activities depend on the environment in which the household functions (Winters et al. 2009). A livelihood in this case in line with Whitehead (2000) is the way and means through which people get by (earn a living). It comprises the capabilities, assets and activities required for a means of living (Chambers and Conway 1992). That is to say, a given individual, household or group, build a livelihood by combining, the natural, physical, economic, social-political, human and financial assets (IUCN 2003). The types of assets available to people, and the way in which assets are pooled and managed, depends on local environment and setting.

Essentially, resources determine livelihood formation; however, a society like that of Uganda has to form livelihoods amidst climate-induced changes. According to Nsubuga and Rautenbach (2018), the impact of severe weather, climate trends and variability have been documented substantially in the last 20 to 30 years. Most studies indicated a rainfall decline, daily temperatures on the rise, while projections indicate a decline in rainfall and rise in temperature, both in the near and far future. Environmental resources including climate play a crucial role for large populations, so any threat e.g of climate change affects ecosystem functioning and integrity hence undermining the security of livelihoods. For example, climatic and non-climatic factors over which households may have little control affect a household's access to sufficient livelihood assets. Such as the example put forward by Badjeck et al. (2010), climate change is evident in lake/sea level fluctuation, storm and flood frequency, which subsequently affect the physical capital of households or entire communities. They can destroy assets directly, can force people to abandon their home areas, dispose of assets prematurely and drain past savings. Rising seas for instance, diminish the natural capital in ecosystems such as fisheries, mangroves and wetlands that are indispensable to the current livelihood forms of many deprived communities. Different motivators and barriers influence how people respond to climatic change impacts, exclusively on the choices that households make about using their assets. The sustainable livelihood framework according to Scoones (2009) is a tool to improve our understanding of livelihoods, more especially the livelihood of the poor and strategic relationships in forming livelihoods. Scoones advises to involve people, so that their knowledge, perceptions and interests are heard. Thus, the livelihood concept remains consistently used within a number of study fields, including development studies (Carney and Ashely 1999; Kruntz 2001; Asfaw et al 2010), political ecology (Musekene 2004; Tshatsinde 2005) and conservation (Farrington et al 1999). Although there are differences in theory and application, these fields draw upon livelihood frameworks to understand how political and economic structures impact decision making and current opportunities for social actors (King, 2011). Krantz, 2001 finds it strong because it draws attention to variety of assets that people use when constructing their livelihoods, since it comes up with a holistic view on what resources or combination of resources, not excluding the social and human but also the physical.

As observed by Ellis and Bahigwa (2003) virtually any aspect of the way society go about gaining a living is worth probing. That is why the well-being of the household is generally a key objective for most people (Messer and Townsley 2003) and specifically development agencies like CARE, UNDP, DFID, UNICEF, and SIDA etc that use livelihood frameworks in their programs. It is the intention of this study to explore the household's perception of climate change and implication of the change in climate on livelihood formation processes. This study, therefore, offers an understanding of a household's livelihood reconfiguration to cope with the effects of climate change in livelihood processes.

## **2 Methods**

The study provides evidence from three regions found in Wakiso and Gomba districts about how households perceived climate change effects on their livelihood formations. The study adopted a mixed method approach similar to those used by Berman et al. (2015) where qualitative interviews and quantitative household surveys are integrated to identify climate change perceptions and deduce the implications it will have on livelihood formations. In addition, secondary information from reviews of national policy documents, district and local by-laws, NGO reports and other literature (Helgeson et al. 2012; Osbahr et al. 2008; Hepworth and Goulden 2008; Ellis and Bahigwa 2003) related to livelihoods about the study area were explored. These secondary resources, which relate to livelihoods in Uganda, offer a better understanding of the overall circumstances in the area.

People may be involved in diverse social and economic activities as individuals, but it is at the level of the household that the actual impacts of those actions become visible. Thus, a survey instrument was applied to 70 respondents from households, including three key informants from each sub-county. The key informants included: sub-county administrative officer who is the overall government accounting officer at that level, the district environment officer and the environmental officer at the subcounty. These are persons with a key position in the management of natural resources and often transcended through a number of roles in the subcounty. For example, in Maddu the officer was veterinary doctor who also performed more than one role because the subcounty is more oriented towards animal rearing. While the selection of the sample respondents is not a total representation of the views of the entire districts under investigation, it does allow the inclusion of various accounts, observations and opinions from different sub-counties and livelihood backgrounds.

Conducting interviews first with the natural resource's managers provided a general understanding of the sub-county and its livelihood patterns. Random selection of other respondents followed depending on their availability in spite of the different livelihood sources. Interviews in a loosely semi-structured manner following certain pre-determined themes, while also allowing space free-flowing discussions occurred. The informants were encouraged to elaborate on their answers, and to explain the reasons and meaning behind their views. The qualitative interview method implemented herewith, as pointed out by Nuorteva et al. (2010) permits large amounts of personal reflections to be included in a rather short period. Respondents elaborated on issues relating to awareness of climate change, understanding of household livelihoods, livelihood assets, governance, recollection of past environmental shocks and stresses including economic and social among others. Through a purposive fieldwork and a selection procedure from districts, sub-counties and households, the study set out to categorise and describe a range of livelihood forms. These contained within them the experiences of a substantial proportion of households in Uganda.

Historical meteorological data comprising monthly rainfall and temperature, from the local meteorological stations (Entebbe international airport, Namulonge research station, Maddu meteorological station) was quality controlled and analysed to understand the climatic characteristics of the study area. Data obtained from rainfall and temperature observations, and from COSMO-CLM Regional Climate Model-Coordinated Regional Climate Downscaling Experiment (CCLM CORDEX) data, European Centre for Medium-Range Weather Forecasts (ECMWF) Interim Re-Analysis (ERA-Interim) data and Global Precipitation Climatology Centre (GPCC) have been used to generate spatial maps, seasonal outputs and projections using GrADS 2.02. These outputs validated community perceptions about climate change. Like Bhatta et al. (2015), this comparison provides an indication of how recent climatic changes, if any have been experienced? What effects attribute to these changes? This approach validates qualitative experiences with quantitative measures.

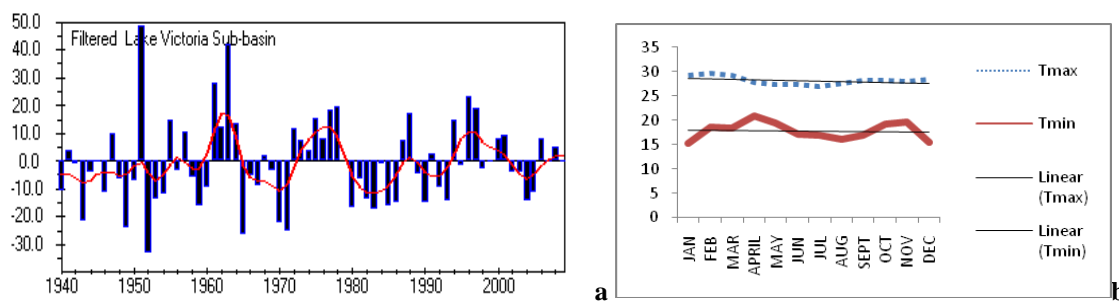
Fieldwork took two months, specifically in sub-counties of Katabi, Maddu and Busukuma. These selected sub-counties represent a variety of livelihoods patterns in Uganda in a broad sense. Variations in rainfall, proximity to or remoteness from public infrastructure and services and variations in access to non-farm activities were among the other factors considered when selecting the areas for the field study. Study villages in each sub-county have natural resources, particular livelihoods dominate and connect to climate. The procedure designated here, like in the work of Ellis and Bahigwa (2003), makes no inferences about the greater populations from which respondents come from. Further still, statistical representation of the results does not characterise entire populations in the sub-counties considered nor for Uganda as a whole. Analysis consisted of established mixed qualitative and quantitative techniques to explore patterns in the livelihood data, coded thematic narrative and interpreted using frequencies.

## **2.1 Background to the case study areas**

This article builds on the field research about livelihood formation and climate change in Wakiso and Gomba districts located in central Uganda. Two sub-counties of Katabi and Busukuma are located in Wakiso district,

while Maddu is located in Gomba district<sup>4</sup> in Uganda. The sub-counties<sup>5</sup> lie on the shores of Lake Victoria, the greatest freshwater lake on the African continent also found in Lake Victoria water management zone (Vwmz). These sub-counties have forests, rangelands and wetlands, which form a major resource base for the districts. Due to the increasing population, natural resources are under pressure, which makes them susceptible to degradation. The main environmental concerns are bush clearing, tree cutting, overgrazing, brick making, and biomass burning to make charcoal. The landscape belongs to the Buganda surface classification, lying at an approximation range of about 900 to 1340 meters above mean sea level. The districts are characterised by flat-topped hills with steep slopes and broad valleys occupied by swamps.

The location of the study areas is advantageous because they are close to Kampala, the capital city of Uganda. Since the main source of livelihood is agriculture, agricultural supplies easily find their way into the market. The marketing system relies on open trade markets, where a number of farmers carry their merchandise like surplus food crops, livestock and cash crops once a week to a strategic market town, which brings traders from further afield. The mean household size in 2002 was in the range of 4.1 to 4.6 persons (UBOS 2009) and projected to be in range of 6.5 to 6.9 in 2014. The field study revealed a mean household size of 5.8 persons (with a Std. Dev of 2.7). The soils are generally of high productivity and are mainly sandy clay soils. The dominant types are red gravel loams with occasional deeply weathered laterites, reddish brown sandy loam and yellowish sands with quartz gravel. Removal of vegetation has allowed for settlement in Katabi and Busukuma and for cropping in Maddu sub counties. The majority of people resident in the areas of study are from Baganda ethnic group.



**Fig. 1** Annual rainfall (a) and Monthly average maximum and minimum temperatures (b) at Namulonge over a 63-year period (1947 to 2009)

### 3 Results

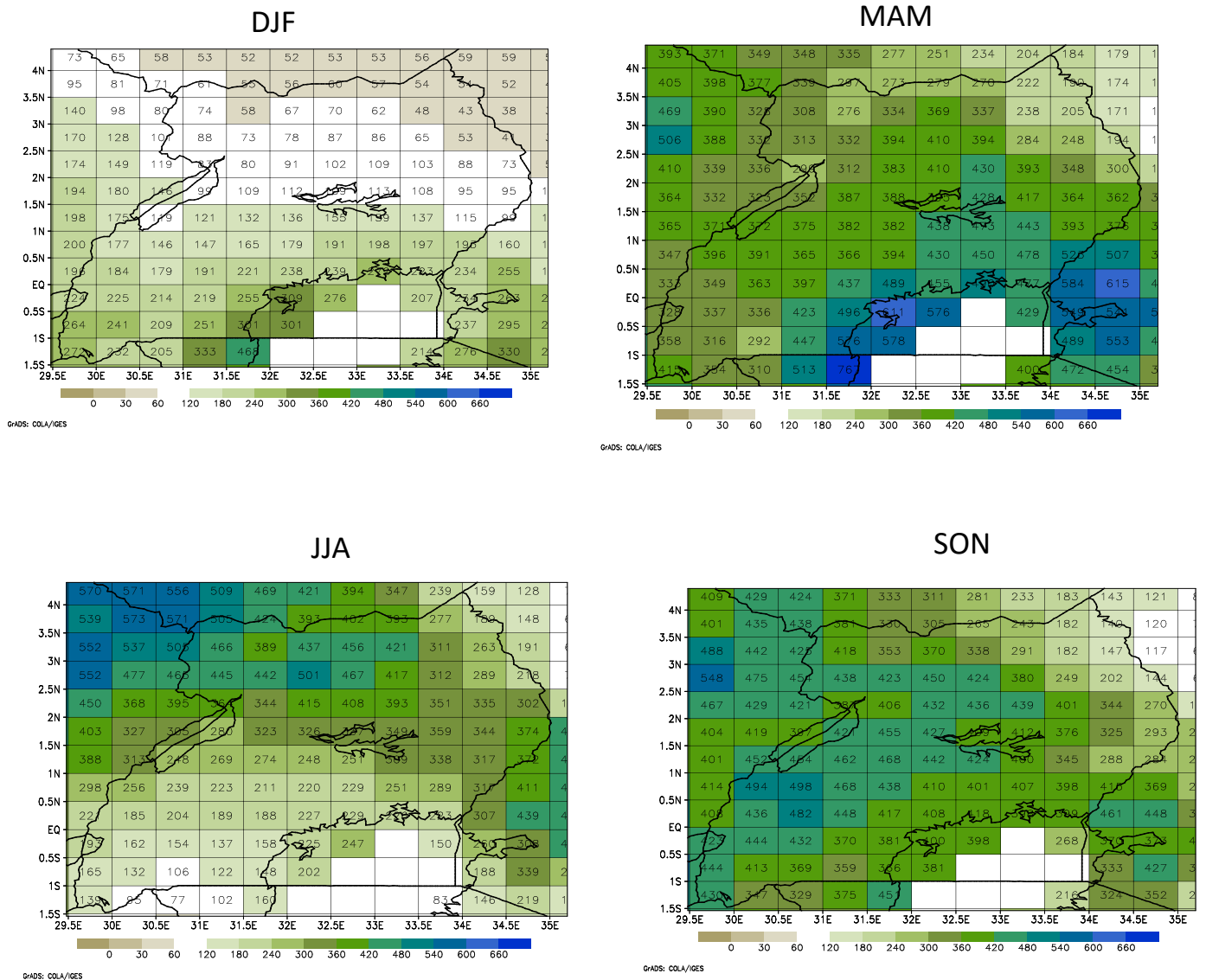
#### 3.1 Observed and projected rainfall and temperature

Climatic conditions of Uganda are characterised by warm temperatures (Figure 1) and bi modal rainfall, with high relative humidity. The study area has two rainfall seasons, with the long rains occurring from March – May (MAM) and the short rains in September – November (SON) as indicated in figure 2. The remaining months are generally dry. La Nina and El Nino occurrences in the Indian Ocean (Hisali et al. 2011; Nsubuga et al. 2014a) reconciles the rainfall pattern. The mean annual total rainfall is 1320mm while mean surface temperature is 22<sup>0</sup>C (see Table 1 and Fig. 3) derived from observed data at stations in the study area. According to respondents, the weather patterns have become more erratic in recent years. Maddu study area receives the lowest rainfall and experiences high variability compared to the others (Table 1). Heavy rainfall in short spells increase surface runoff and lower soil moisture. Runoff has heavily silted the river valleys and often destroys roads in the study area.

<sup>4</sup> First level of administration

<sup>5</sup> Second level of administration

Unusual weather events happened in memory e.g the heavy rains in 1960s, 1997/98, 2005 and the 1980s and 1990s droughts that hit the country (Hisali et al. 2011; Nsubuga et al. 2014c).



**Fig. 2** Estimated average (1981-2010) seasonal total rainfall(mm.seasonal<sup>-1</sup>) for Uganda, derived from the Global Precipitation Climatology Center (GPCC) data.

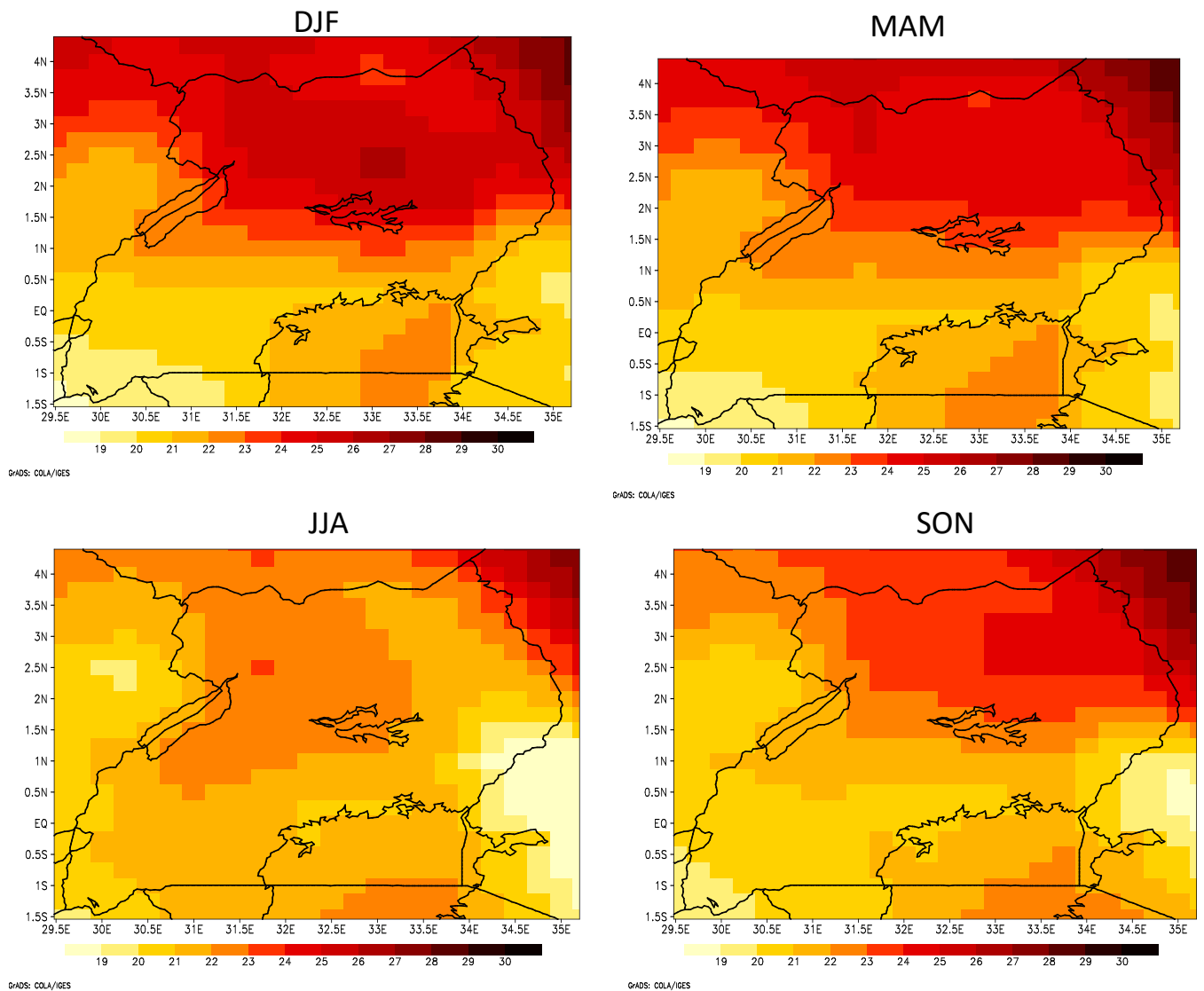
**Table 1** Rainfall characteristics of the study area using historical data from metrological stations

Meteorological. Station	Sub-county name	Mean rainfall	Highest total rainfall (mm)	Lowest total rainfall (mm)	Standard deviation	CV %
Entebbe Int. Airport	Katabi	1617	2679	1121	24	18
Namulonge Res.sta	Busukuma	1217	1747	674	18	17
Maddu	Maddu	888	1239	178	n/a	21

Future projections of near-surface temperature and rainfall in Uganda suggest that temperature will increase between 1.5<sup>0</sup>C - 2.5<sup>0</sup>C and 2.0<sup>0</sup>C - 3.0<sup>0</sup>C in the medium to low concentration pathway. High concentration pathway however provides a bleak future of temperature increase of 2.0<sup>0</sup>C - 3.0<sup>0</sup>C in 50 years and 3.0<sup>0</sup>C - 5.5<sup>0</sup>C in 80 years (figure not shown). Projections for rainfall on the other hand show that annual rainfall for medium to low concentrations pathway, show dryness in the west (-20% to -50%) and less dry in the east (+5% to -10%), whereas seasonal variability e.g in June-July- August (JJA) will go up to +20%. Projections using the high concentrations pathway for annual rainfall show dryness in the west (-30% to -50%) and less dry in the east (-5% to -30%) and seasonal rainfall will vary but mostly less than 0%. This change in climate can bring both constructive and undesirable impacts on different livelihoods and rendering them to unfamiliar conditions (Osbahr 2008). The study sought to establish community perceptions and opinions on climate and climate change. It emerged that 96% of the respondents were in conformity with observed meteorological changes. The media had informed the majority (38%), 20% the internet, and 17% through other sources about climate change. Government officials had done little to inform the respondents about climate change since only 2% could testify to that effect. It was also noted that 8% of the respondents claimed to know about climate change through personal experience, observation, own knowledge and detection. Further interrogation generated the following information on climate change awareness as shown in the table 2.

**Table 2** Percentage of respondents who strongly disagree, Disagree, Agree and strongly agree to questions that relate to climate change awareness

Perceived changes in climate and awareness	Strongly disagree %	Disagree %	Agree %	Strongly agree %
The world's climate is changing	2	-	37	61
Uganda's climate is changing	2	3	62	33
The change in climate has nothing to do with the way i secure a livelihood.	31	53	11	5
Climate change is not going to affect livelihoods.	40	50	4	6
Other factors are affecting livelihood	3	18	66	13
No climate change evidence in Uganda	31	57	4	8
Climate change impact majority of livelihoods	2	8	39	51
Climate change impacts economy of Uganda	5	-	44	51
Weather seasons have changed	3	-	43	54
Experiencing longer droughts	3	11	60	26
Experience frequent floods	7	37	43	13
Experience high temperatures	3	10	44	43
Experience more rain days in a year	7	62	24	7
More warmer days in a year	-	11	73	16
Morning temperatures are warmer	2	21	68	9
Night temperatures are warmer	-	6	67	27
Night temperatures are colder	13	77	8	2
Change in biodiversity	4	9	64	23
Species behaviour and life has changed	2	5	74	19
Living standards will decrease	-	-	48	52
Experience food shortage	2	2	31	65
Increase in infectious disease	-	8	52	40
Few problems to arise because people adapt	33	52	13	2
Experience better weather	51	44	5	-
A hydro-political situation will emerge	9	15	61	15
Experience less hydro power	3	10	71	16
Ugandans will abandon climate prone activities	13	24	39	24



**Fig. 3** Average (1986-2005) seasonal near-surface (2m above surface) temperature( $^{\circ}$ C) as captured ERA Interim Reanalysis data

Respondents also revealed that, in the last 10 to 20 years, they have noticed a number of changes that include high temperatures during the day, infrequent hailstorms, fog was rare, droughts were frequent, it was raining a lot in January, and there were few rain days in the year. This is in line with findings of Elisante and Tunagraza (2017) study in the Lake Victoria region of Tanzania. Furthermore, whenever it rains, it was intense and most importantly rainfall was erratic and unevenly distributed. Erratic rainfall and hailstorms destroy crops and increase flood risks which also affects soil quality. While answers about the recent climatic changes were diverse, answers regarding coping were quite consistent. Most interviewees were coping by changing lifestyle, diversifying to activities that are less prone to weather, irrigating the food crops, prefer lighter material for clothing, at night they use light, or no bed covers and keep windows open to let cool air in the house. This action however exposes respondents to vectors like mosquitoes, which transmit malaria and the related impacts.

Respondents raise one coping method of watering plants, which has not been very common especially in the Lake Victoria region of Uganda. Since much of the farming in Uganda is rain fed, and farmers have always relied on rainfall to grow food for own consumption and cash crops to generate income. Today a farmer has to supplement his crops with water in a growing season. This could explain why, close to 84% of the respondents disagreed with the question that, climate change has nothing to do with the way they secured their livelihood. Kinsey (2002) stated that households that rely on rain fed farming particularly in Africa face instabilities in annual income and

exhibits how components of income change in response to variations in rainfall. Households therefore try to reduce the consequence of an income shock by diversifying in or out of agriculture or both. In the research area, interviewees were diversifying and getting involved in activities, which are less prone, to weather changes. Assumption is that households with more spread livelihood sources are less susceptible to impacts of climate change (Antwi-Agyei et al. 2012). There is a mixed perception of Ugandans abandoning climate prone activities in future (Table 2). Meanwhile, farmers have discovered that they can grow seasonal crops (especially vegetables) throughout the year if they irrigated. Climate is an important natural resource, which according to the interviewees influences livelihood formation in Uganda. At the same time, a good percentage of respondents (79%) agreed that, other factors other than climate change were affecting their livelihood as elaborated on later.

Diversification corresponds with cause and incentive continuum across households at a certain point in time (Ellis 1998), whereby some causes are site specific and others are disaster driven. The study shows that 90% of the respondents agree that changes in climate will influence the majority of livelihoods, while 95% agreed to the statement that climate change was already affecting the economy of Uganda. With such thinking in many of the respondents, they are not going to wait for disaster to happen, hence the diversification in their livelihoods.

### **3.2 Livelihoods formations**

Chambers and Conway (1992) view livelihood formations resulting from an interaction of human capabilities, access to tangible and intangible assets and existence of economic activities. It is upon this line of thinking that during the research that emphasis and evaluation was not on whether the livelihood is sustainable. The study did not venture into establishing how long an individual or household had been doing the activity. Nevertheless, investigations focussed on the interaction advocated by Chambers and Conway that resulted into a livelihood. Livelihoods in Uganda have evolved based on the availability and opportunities afforded by the natural resource base and market forces. It is therefore common in the area of study to find individuals who have been involved in one or two livelihood activities before the current ones. For the purposes of this study (and at the great risk of oversimplification), we characterise the main sources of household livelihoods found in the study area as;

- Farming i.e crop, animal, pasture, poultry and bee keeping (31% of households)
- Employment i.e banking, labour provision, teaching, machine operators, domestic workers (27% of households)
- Business i.e metal fabrication, masonry, carpentry, vehicle mechanics, real estate, services, house letting, food vending (16 % of households)
- Petty trading i.e consumables, cash crops, alcohol, herbal products, retail in industrial products (10 % of households).
- Primary processing i.e quarrying, brick making, timber processing, art & craft, sand mining (9 %).
- Fishing i.e fish farming, fishing, boat making, and fish gear (7 % of households).

Other sources of income include laundry, cycle-transport also known as boda-boda riders, construction, repairing equipment and tour operations. The study established that, in the three sample sub-counties, households pursue diverse livelihoods. Agrarian based livelihood activities are more in rural Maddu and semi-rural Namulonge. Fishing and fish related employment and trade are mostly occurring in Katabi. Livestock rearing forms a big part of livelihoods in Maddu.

During the survey, respondents were asked, whether someone else contributed to their livelihoods? About 60% of households indicated that friends and family provided support, while 2% of households identified Community Based Organisations (CBOs), Non-governmental Organisations (NGOs) and Faith Based Organisations (FBOs) as partners in livelihoods. As much as 20 % of households did not have anybody else contributing to their livelihoods the rest were non-committal.



The key problems which hinder livelihood formations brought out by respondents are categorised (here listed in order of importance top to bottom) as;

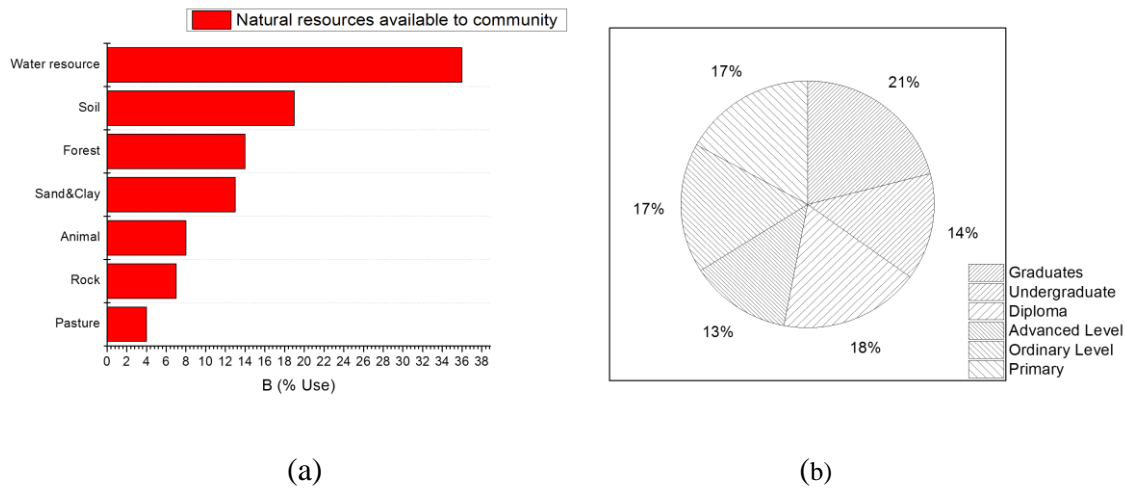
1. Economic, including but not limited to competition, high costs, capitalisation, low prices, low supply of produce, price fluctuations, limited funds, scarcity of raw materials, poverty, little pay, increasing demand, delayed payment...etc.
2. Lack of natural resources, i.e shortage of fish or being denied to fish, lack of land, land shortage, water shortage, scarcity of herbs, deforestation, diseases/pests, decreasing soil fertility, etc.
3. Weather related problems like drought, shortage and unreliable rainfall and weather-related disasters.
4. Enabling environment i.e corruption, high taxes, cost of doing business, theft, unfair business practice, policy and institutions and low business relationship (partnerships).
5. Poor technology and technological changes were also of great influence in forming livelihoods. Respondents cannot afford to purchase, maintain and match the current developments in technology.
6. Access to infrastructure including transport costs, thick vegetation, poor roads, and cost of electricity and lack of market were challenging livelihood formation.

The following sections look at the influence of capital assets, governance, environment and climate variability on a household's decisions to form a livelihood.

### **3.2.1 Influence of capital assets on a household's decision to form a livelihood**

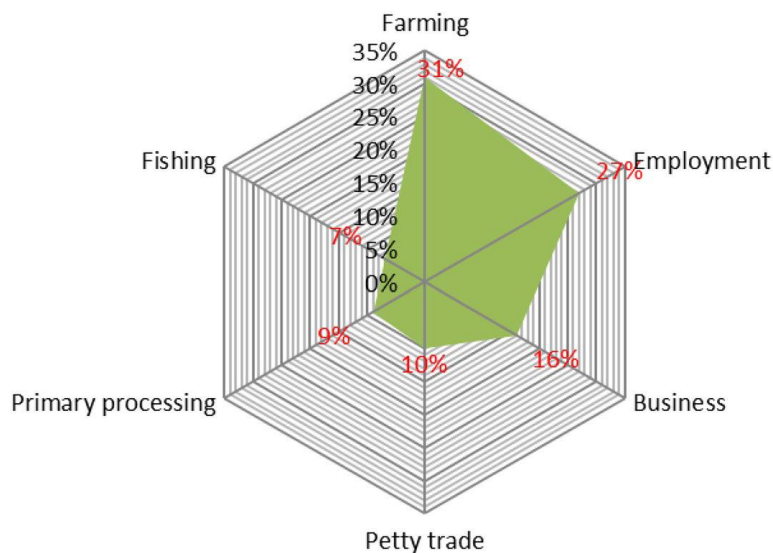
*Natural capital* is the term used for the natural resource stocks from which, resources flows and services useful for livelihoods are derived (DFID 1999). Natural capital is very important to communities that, derives all or part of their livelihoods from resources-based activities. Figure 4a, shows examples of natural capital, services, and percentage of respondents deriving from it in the study area. Since the study was around L. Victoria basin, majority of the respondents relied on water resources, followed by use of soils as natural capital from which they derive a living. Pasture, grown for sell to animal keepers supported the least livelihoods (Fig 4a). These natural capitals are environmentally sensitive. Any changes in the environmental parameters can have a significant effect on the resource base and eventually erode livelihoods. Changes in current climate and those projected are capable of impacting on water resources and the soils which support livelihood formation. Some of these effects are mentioned by respondents as problems experienced (a & b above) while forming livelihoods. In the study area, the land institution and the land tenure systems for the establishment of livelihoods have resulted in reducing access of the local communities to land and its natural resources as revealed by key informants. In addition, the introduction of cordon fences by large-scale farmers and landowners has had an adverse effect on livelihoods as it reduces access of communities to water, pasture, fishing and gathering especially in Maddu and Namulonge.

The study areas are characterised by flat-topped hills with steep slopes and broad valleys occupied by swamps. Erosion and small forms of mass wasting resulting from flash floods in many places of the study area impact on the sustainability of the main livelihoods for the respondents. The study, however, did not seek empirical evidence on the impact of changes in land tenure systems in accessing livelihoods in Uganda. This is a research aspect that can be investigated in future and inform policy makers.



**Fig. 4** Distribution of natural resources to the community (a), household education levels (b) attained by respondents in study area

*Human capital* represents the skills, knowledge, ability to labour and good health. Combined they enable people to follow different livelihood strategies using the different forms of assets and attain their livelihood goals (DFID 1999). However, size of the household, education levels, experience, age, occupations and gender (Morse and McNamara 2012) and its health determines this. The main natural resources that support livelihoods like farming, fishing and primary processing are labour intensive. Respondents interacted with during the study period, directly or indirectly provided their labour to make the best out of the activity. Percentage representation for each category is shown in figure 5 below. The best means of stimulating livelihood activities according to Winters et al. (2009) is providing households with skills through training. Figure 4b indicates a breakdown of household education levels in the study area which is literate. Such a population can be receptive to information in relation to weather, climate, livelihoods and associated changes. Hence, a shift of households partaking in rural non-agricultural wage activities can be experienced and also better revenue from the activities. Furthermore, education should integrate climate information into health programs to raise community level of awareness. For example, when weather season's change, large disease outbreaks happen or when forecasts indicate so, contingency plans and interventions require climate knowledge. A survey from three "grade 3 hospitals" (Kisubi, Busukuma, Maddu) reported high cases of diarrheal and malaria during the rain seasons. Such a finding resonates well with what de Perez et al. (2015) found in Tanzania. Results in Kenya suggested that anomalies in climate variability accounted for up to 26% of the anomalies in hospital based highland malaria cases (Githeko et al. 2000) given all factors affecting disease transmission (Ogden 2017). Cattle keepers in Maddu have their unique stories on how they battle with tick borne diseases whenever the rains come. Such outbreaks can have a big effect on the capital assets that have been accumulated. Since many vulnerability assessments anticipate climate changes will result in increased incidences of vector-borne diseases (Pandve and Giri 2015), such outbreaks can have a big effect on the capital assets that have been accumulated. Some resort to selling some of the assets to overcome such a shock. However, opportunities also exist in such situation for others to draw and strengthen their livelihoods. In the process, livelihoods formation for the artists/illustrators/educators that create information education and communication (IEC) material which show the link between climate and disease as well as methods of managing illnesses associated with change in climate has happened.



**Fig. 5** The percentage of households who identified a particular activity as their main source of livelihood.

The study also set out to find whether the knowledge acquired at school was relevant to existing livelihoods. Formal education was not the only source of knowledge for human capital. The study established what type of skills, experience and training the respondents had. In addition, the purpose they serve. From the analysis it became evident that, 32% of the respondents had technical skills, 22% management training, and the least represented was banking and finance. The study also found out that 70% of the interviewees were utilising their skills and training to form a livelihood. Only 19 % of the respondents were not using their skills and training to make a living and thus were involved in petty trading and primary processing. Among the reasons that were advanced for not using their skills and training were; having found alternative livelihoods that were more profitable e.g poultry; others felt that they were being under employed in the industry in which they had trained; some had decided to join politics, thus abandoning their training. Job scarcity and capital accumulations are the other reasons why respondents were not using their skills and training. When members differ in terms of education, even their sources of livelihoods differ. The study was not able to establish differences of education within a household, neither did it disaggregate information to apportion human capital components to establish whether they are consistent with the main source of livelihoods. However, as Morse and Mcnamara (2012) demonstrate, intra-household dissimilarities in education and training are significant factors that affect, exclusively off-farm sources of income. The level of education and school attainment has a strong bearing on the productivity of a given population. There was no mention that climate change was influencing human capital in the livelihood formation. However, anecdotes from newspapers indicated how children get involved in the search for grass during the drought seasons, thus missing school. Reports also indicated how school children get interrupted by not going to school whenever rainfall is heavy, and roads become impassable and transport means are scarce. Some children are held at home to plant crops so that they can take advantage of the wet season. Actions like withdrawing children from school according to Helgeson et al. (2012) erode households' assets of production, and this may negatively affect formations in future.

Climate change is influencing trends in training e.g climate sciences especially at high institutions of learning. Roll out of hydro-climatic stations to strengthen the monitoring and provision of climate services is happening in the country and some schools like St Mary's Kisubi have benefited from 3D-PAWS initiative. Government has contracted companies including the army to distribute mosquito nets and hybrid seeds to people as an adaptive intervention. These activities provide employment and livelihoods because they happen all year round given the increasing population, two rainfall seasons and the agricultural involvement experienced in the country. The study area has small first responder clinics that treat people especially those suffering from malaria. Malaria is more prevalent during the rainy season of March to June and August to November (MOH 2005). According to Allison et al. (2009), households with health problems are likely to have lower human capital because they often apportion

a substantial part of their resources to treat ailments thereby reducing their capability to form or spread their livelihoods. Projected increase in rainfall will create pools of water that provide breeding grounds for mosquitoes that cause malaria. Such pools of water already exist in the study area where development is taking place. With the projected changes in climate, the situation may become precarious and cause an increase in the number of those who suffer from malaria. Currently, malaria is responsible for more illness and death than any other single disease in Uganda. The 2005-2006 Uganda National Household Survey revealed that half of the population that fell sick reported malaria or fever as their major illness (UBOS 2006). Malaria remains the highest cause of both morbidity and mortality especially below 5 years of age.

*Financial assets* like savings and remittances are significant in cushioning households against weather vagaries that could result into food insecurity (Antwi-Agyei et al. 2012). In the study area, income from different sources of activities for the majority of the respondents (53%) was in the range of \$100 - \$500 per month and very few people in the study area benefitted from remittances. The other sources of finance that are available to the interviewees include, micro-finance credit schemes, bank credit, rotating credit and savings schemes, and government intervention schemes known as 'prosperity for all' (Bona-baggagawale) in a descending order. The study also established the importance of these schemes in supporting livelihoods. It turned out that respondent's ranked micro-finance credit schemes to be more important than the others, while insurance ranked as the least important in supporting their livelihoods. Climate change was affecting the way respondents were accessing finances in that, it has created a situation of uncertainties that limit loan access (13%) and loan repayments were becoming hard to pay back by 10% of the respondents. Nevertheless, a number of interviewees (6%) did not realise any influence of climate change on the way they access finances. In our opinion, the impact is indirect, e.g when the crops fail because of erratic rain, then prices of food items increase. They may also affect the incomes that people can derive from natural resources use, by increasing both the prices paid to rural people for their products as well as the productivity of resources use. Whenever the country experiences El Nino rains, Uganda Bureau of Statistics notes a rise in prices due to reduced supply of food crops in the market. A big percentage of the respondents spent their income on feeding, taxes, education, transport and electricity in that order of ranking. It was observed that low-income earners (Ushs1800 -18000 or \$1 -10) were not spending on education and health, which are considered to be basic human needs. There was no evidence pertaining to what Hassleberg and Yaro (2006) identified as disposable items like poultry or livestock that would take them through the hard seasons especially in Katabi. Instead, the pastoralists in Maddu painfully sell their animals in case of a drought to save on the numbers, but still would fetch little income. In such a situation, livelihood destruction happens instead of forming.

*Physical Capital*, one way of establishing the relative wealth of a community and households in particular is to catalogue physical assets, though it is not an easy task. In terms of 'productive assets' especially the tools used in formulating a livelihood a summary is provided in table 3. Also provided are the percentages of respondents accessing the tools.

It is evident from the table that majority of the interviewees own mainly tools and equipment used in agriculture, which are basic. Very few respondents hire or depend on loaned equipment. The percentages of hiring and loaning rise, when the livelihood form requires considerable capital investment. With such basic tools and equipment, livelihood formation is slow. Respondents are not able to operate at large scale when forming livelihoods. The majority depend on what nature offers which makes them vulnerable. These tools, however, are poorly stored and on many occasions exposed to vagaries of weather. Many of these tools are metallic, once exposed to moisture and high temperature they rust, because of oxidation the durability of the equipment is affected. The cost of maintaining tractors, boat engines, ox-ploughs among others is high in Uganda, and when climate change comes into play then livelihoods are affected. Our view is that when climate changes either positively or negatively it is likely to put strain on livelihood assets. For example, when temperatures increase, the animals that drive oxen are affected and can be stressed which reduces reproduction. Further still, when pastures reduce as rains decrease, then feeding animals will be problematic. Increased rainfall (see projections) can also make tropic soils impossible to cultivate. These environmental hazards degrade the physical capital, thus limiting diversification of opportunities, when combined with damage to infrastructure and other types of physical capital.

**Table 3** List of basic tools and equipment used in livelihood formation and respondents' access in the areas under consideration

Tool(s)/ Equipment	Owned %	Hired %	Shared %	Loaned %	Free %
Panga	67	1	4	-	-
Hoe	66	3	3	-	-
Cooking utensils	60	1	-	-	-
Furniture	56	1	-	-	-
Bicycle	47	1	-	-	-
Spray pump	27	3	3	-	-
Fishing hooks	11	3	1	-	-
Oxen	11	4	3	-	-
Fish nets	10	1	3	1	-
Boat	7	4	4	1	-
Tractor	6	17	-	-	-
Sewing machine	6	3	3	-	-

*Social/ Political Capital* The term social capital according to Bebbington and Perreault (1999) and Harris and De Renzio (1997) refers to family and kinship connection, social linkages or associational life related to groups or organisations, cross-sectoral networks that link organisations of state, market, and civil society around problem-solving tasks. Building endowments of social capital may be a means through which households might be more efficient in building and using other forms of capital and more effective in making claims on natural resources.

Social capital is an important aspect of the study areas in Uganda and can take many forms, ranging from kinship, social groups, organisation, political contacts, and patronage. A summary of how households, felt linked to other households or individuals in the community is provided in the discussion that follows. Sixty-six percent of the respondents connected to other households because of kinship (blood relation), while 63% linked with individuals and households in the community through social interactions. Interviewees who associated to other households because of patronage were 51%, to organisations were 36%, and only 24% allied based on political contacts. A household can link to more than one household based on the description above, which explains the overlaps.

These linkages according to the field interviews are important in providing mutual assistance (74%), traditional ceremonies and decision making (64%), raising capital (44%), and pooling labour (39%). Only 19% of the respondents felt that linkages with others were important during management climate disaster. These low percentages including that of abating crime are not common occurrences. Usually climate disasters happen on a large scale, so neighbouring households in the same community would not help each other unless when help comes from relatives in cities in form of food and clothing. The high percentages in the first three reasons of linkages is because it does not directly involve exchange of money. Such assistance comes from social groupings, relatives and patrons in form of mobilisation, representation and ceremonies (weddings, funerals, religious etc) where most people are obliged to attend. People who need to raise capital often affiliate to organisations where they take membership so that they can benefit from funds as loans in form of micro-credit. As discussed by Osbahr et al. (2008) communal structures provide social stability by binding individuals in a cluster and connect people from differing social and economic strata.

Climate change influences the social capital in numerous silent ways that are interlinked. In the study area of Maddu, many of the people are pastoralists. The changes in climate are forcing them to migrate in search of pasture and water. Such movements disrupt the social network formation, which may result in disrupting the level of human capital formation and the social uses to which that human capital relies. There are instances in the country where pastoralists have clashed with crop growers because animals destroy their crops.

According to Bebbington and Perreault (1999) social capital may heighten protection of natural capital from dilapidation by externalities through acts of protests, as well as from abuse by members by enforcing rules, fines and any other sanctions. However, in situations where climate change creates pressure, abuse of resources or overuse affects livelihood sustainability. Social capital is responsible for accessing different forms of capital and for shifting the way in which the state allocates resources. However, this may not happen where social capital is affected which in the end interferes with livelihood formation.

### **3.3 Vulnerability**

Vulnerability is a high degree of exposure to risk, shocks and stress (Ellis 1998). Stresses are continuous and cumulative pressures that are predictable to an extent, while shocks are sudden and traumatic impacts (Krantz 2001; Gallopín 2006). According to Fouracre (2001), the vulnerability background is particularly significant as it indicates the nature of trends, shocks and culture, and the capability of the poor to endure their impact. The phenomenon varies over time and space, dependent largely on the changing processes through which people, households and bigger social groups fulfil their immediate subsistence desires and invest in medium- and long-term reproduction of their social system (Le Sage and Majid 2002). There are two core considerations when thinking about the Vulnerability Context and these are: the extent to which different groups are exposed to particular stresses and shocks; and the sensitivity of their livelihoods to these factors (Chambers, 1995; Miller and Bowen 2013). This study does not divert from the understanding of vulnerability identified by (Smit and Wandell 2006). It considers the vulnerability in terms of the past, present and future trends to be of temporal nature as discussed by (Miller and Bowen 2013). The approach places the social-economic well-being and institutional constraints that limit the capacity to create a livelihood. Hence, these issues are best approached in a phased way, beginning with an overview of those risk factors to which different groups in the community are most prone (e.g. food insecurity, drought, eviction, illness and death.). This can be followed by more detailed analysis of key problems, the nature and magnitude of expected changes, coping strategies and potential solutions. Among the main causes of vulnerability established by De Wet et al. (2008) include; loss of income, severe illness, food availability, paying for education and disaster amongst others. Such causes can come in an instant or progressively when climate change happens. A generic concept introduced by Brooks et al. (2004) opposes the hazard and context specific determinants of vulnerability when comparing assessments of vulnerability at a national scale. As argued by Kelly and Adger (2000), this study looks at vulnerability in terms of capacity of individuals and social groups' response or coping. Vulnerability analysis along this line requires identifying specific physical, economic and social resources accessed and how they form a livelihood. Here vulnerability is at the end point of sequences of analyses that begin with past climate, developing climate scenarios then the impact on capital assets and identification of coping methods. Institutions, shocks and economic trends facilitate and affect access to rural livelihoods (Ellis 2000; Kgathi et al. 2006).

In the Lake Victoria basin, area where the study area is located, climatic vulnerability is characterised by high mean annual rainfall, compounded by low variability in its spatial-temporal distribution. In addition, the past few decades have shown a definite trend for increasing temperatures and reduced precipitation. Hence, livelihood strategies focus on coping with a high degree of uncertainty, minimising risk and meeting subsistence needs. This has implications for individual time preferences and investment decision-making amongst most people in Uganda. The common livelihood shocks in the study area include drought, diseases (animals, crops and humans), floods, desiccation of river channels (primarily due to natural geographical shifts in the flow of water) and civil unrest. Desiccation of river channels in Gomba has adversely affected access of the local communities to water resources for both human and livestock. The impact of shocks on livelihoods in the study area demonstrated by the occasional migration of pastoralists from Gomba into the northern districts close to Lake Kyoga, which causes civil unrest. Household members from the study area specifically identify the crises they have faced in the past to include crop failures, legal problems, disease, theft, death of family member, and conflict over natural resources. These shocks can be devastating especially, where institutions in the study area are very weak. Government institutions do not respond to help the people in absorbing these shocks. However, social institutions are more dependable because they are rooted in culture. Furthermore, most respondents hold a diversified livelihood and continue to hold on their livelihood's activities despite the low productivity.

### **3.4 Policy implications and Conclusions.**

Climate change poses complex problems in the studied villages at different households' levels during livelihood formation processes. The paper has provided an understanding of the process of livelihood formation in three case study areas amidst climate change. It also calls for responses to both current occurrences and more long-term climate changes.

The study relied on data from a household survey to shed light on some of the main climate change shocks that have a bearing on livelihoods formation as well as the perceptual, socio-economic institutional factors involved in livelihood formation. The main livelihoods for respondents in the study area include farming, employment, business, petty trade, primary processing and fishing. Findings reveal that respondents don't acknowledge that climate change presently affects their livelihoods. A good number of them are concerned about other factors other than climate change that hinder their livelihood formation. They are, however, able to acknowledge the existence of climate related changes. The problems that hinder livelihood formation have been categorised as economic, lack of natural resources, weather related, enabling environment, and poor technologies. Most of the climate change effects on capital formation identified here are implied as discussed on each asset. Though not identified in this study, choice of strategies households employs when impacted by climate change while forming livelihoods can include among those identified by Hisali et al. (2011) and Helgeson et al. (2012). Others consume less, solicit and scrounge, migrate, withdraw from school, rely on state provisions, vary crop choices, provide labour, refer children elsewhere or depend on remittances. The sustainability of the formed livelihoods is questionable because of diversity and degrading nature of natural assets.

In this regard, our findings and discussion call for policies that smooth the livelihood formation processes of households. Access to credit which is conditioned to climate change resilience would not only augment the ability of households to recover from consumption uncertainties that result from climate change effects but would also enable them to get access to assets that are required to implement certain livelihood process. Access to improved varieties of crops and farm implements should be enabled by friendly credit access policies. This should go along with information on climate change and some examples of resilient livelihoods and introduction of extension services that reduce the risks of relying on one livelihood and encourage households to diversify their portfolio to include some resilient livelihoods. Policies on dissemination of accurate and reliable weather data to prepare people for eventualities and enable them plan appropriately the direction of livelihoods are encouraged. Targeting vulnerable households in terms of resource allocations and other interventions aimed at reducing vulnerability of livelihoods to climate change is another option. We suggest livelihood formations consideration in a wider context within the development dimension rather than looking at only one sector e.g agriculture. To increase the resilience (see Adger 2000; Gallopín 2006) of livelihoods of households, we suggest incorporating climate change effects within the local planning process. Further still, strengthen the capacity of local governments such as village development committee and district development committee and associated local institutions to reduce livelihood vulnerability.

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