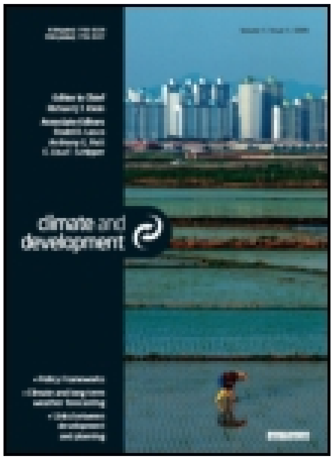

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Community-based adaptation for improved rural livelihoods: a case in eastern Uganda

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CASE STUDY

Community-based adaptation for improved rural livelihoods: a case in eastern Uganda

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Climate change adaptation is a priority and is fundamentally about sound and resilient development tailored to local conditions and needs. Several researchers have underscored the importance of community-based adaptation in achieving this. This article examines community-based approaches in order to build an understanding of community vulnerability to current and future climate risks in eastern Uganda. Primary data were collected at the community and household level applying participatory vulnerability and capacity assessment, in-depth household, and key informant interviews. Major climate risks in eastern Uganda that exacerbate community and household vulnerability are heavy and erratic rainfall leading to landslides in hilly areas and floods in low-lying areas, and droughts within the year and mid-season, affecting crop and livestock yields. Communities and households have innovative coping mechanisms based on past experiences, local knowledge and expertise albeit in an *ad hoc* manner. Household labour endowment, farm size, livestock ownership, access to weather information and credit positively and significantly affect the adoption of adaptation technologies by households. At community level, inherent knowledge and skills, and social and financial capital, play a critical role in shaping adaptation to climate risks. This study therefore strongly suggests that analyses of climate change impacts and design of adaptation projects should take into account community perspectives, knowledge and resources. Government and other stakeholders should identify and evaluate potential, location-specific adaptation measures, and incorporate them into the country's development policy and management practices particularly national development plan.

Keywords: community-based adaptation; climate variability; participatory vulnerability and capacity assessment; eastern Uganda

1. Introduction

Africa has been portrayed as one of the most vulnerable regions to impacts of global climate change. For a range of reasons, such as widespread poverty, heavy reliance on rain-fed agriculture, lack of economic and technological resources and insufficient safety nets and educational progress, Africa's people have low capacity to adapt to climate impacts and anticipated extreme events (IPCC, 2007). By 2020, yields from Africa's rain-fed farm production could decrease by 50% as a result of changes in climatic conditions (Boko et al., 2007). Furthermore, estimates predict economic losses as a result of climate change of up to 14% of gross domestic product if adaptation measures are not implemented, at least in coastal countries in Africa (Boko et al., 2007). If this were to occur, significant levels of investment would need to be diverted away from key rural development projects to short-term emergencies, which would especially undermine the achievement of Millennium Development Goal one and the implementation of the Comprehensive Africa Agriculture Development Programme pillars (Poulton, Kydd, & Dorward, 2006).

In the eastern and central Africa (ECA) sub-region, climate variability is increasingly limiting the growth and development in agriculture which is considered as the engine for further growth in economy and poverty reduction (Christensen et al., 2007). Rainfall pattern is influenced by large-scale inter-seasonal and inter-annual variability resulting in frequent extreme weather events such as floods and droughts which over the years have become more frequent and severer (Haile, 2005). In the ECA sub-region, more than 50% of the severe natural disasters recorded have occurred during the past decade, affecting nearly 100 million people (EM-DAT, 2004). Uganda, one of the countries in ECA has had a total of 14 disasters, both natural and human induced in the period 1996–2010 (FAO, 2010a). Economic losses resulting from climate-related disasters alone contribute well over 70% of the natural disasters and destroy annually an average of 800,000 ha of crops making economic losses in excess of USD 65 million (UNWD, 2005). Droughts have also taken a significant toll with, for example, 1.8 million people in Uganda affected through increased malnutrition, poverty, illness, asset loss and migration (GOU, 2009).

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Climate change adaptation is a priority and is fundamentally about sound, resilient development (IPCC, 2007). The key areas of adaptation, which when sustained could bring development, are disaster risk reduction; sustainable land, water and forest management; watershed management, increased agricultural productivity; health and social issues (World Bank, 2009). Adaptation responses, however, have to be tailored to local conditions and needs, as the nature of risks and the affected livelihood groups vary from one ecosystem to another (FAO, 2008). The role of community-based adaptation has been underscored (Ebi, Jan, & Semenza, 2008; FAO, 2008; Hozuma et al., 2009; Saleemul & Reid, 2007), as it acknowledges that communities possess various mechanisms for making decisions related to their autonomy, and thus are positioned as important entities in development assistance projects. Engagement of communities not only enhances their resilience to climate stressors, but also increases their ability to cope with a wide range of other societal issues (Ebi et al., 2008).

This study therefore employed participatory vulnerability and capacity assessment (PVCA) tool to determine community-based adaptation options, based on analysis of current vulnerabilities, and community resources and capacities to adapt to climate variability and change. The study first reviews the policy context in Uganda to provide preliminary insights into the policy issues and trade-offs that vulnerability research needs to address if it is to be policy relevant. The study then explores the extent of current extent of community vulnerability to climate variability and change in eastern Uganda; community-based coping mechanisms to the past and current impacts of climate change; and the community's inherent livelihood assets and capacities which could help to enhance their resilience.

The study results can improve understanding of how environmental and socioeconomic change affects the livelihoods of rural, natural-resource-dependent women and men, what shapes their vulnerabilities, and what assets they have for coping with and adapting to environmental and socioeconomic change. This will be useful in formulating recommendations (for planners and policy-makers) to improve individual and collective assets, with the aim of enhancing the adaptive capacity and resilience of vulnerable communities in their responses to climatic change.

2. Materials and methods

2.1. *Research design and variables*

The research used a case study design approach (Leedy, 1997). This involved collecting qualitative and quantitative data from seven community-based organizations. Qualitative data were obtained on community perceptions of climate change, practices they perceive as adaptation approaches, and actual practices employed at community and farm level adapting farming systems to climate variability and change. Quantitative data were obtained on household socio-economic characteristics (gender, age, income, off farm enterprises, labour endowment), land ownership and land use practices, and access to agricultural extension and weather information. The study also explored available institutional support mechanisms for enhancing local community adaptation.

2.2. *Location of the study and target population*

The study was conducted in seven districts of eastern Uganda (Figure 1), targeting rural households who are mixed crop and livestock farmers. The region in general has about 6,301,677 people, which is 25.5% of the total population of Uganda (UBOS, 2002). The region has the highest mean population size per village with 304 households (Bashasha, Kasozi, & Isoto, 2008). More than 70% of the rural families in this region are involved in subsistence farming as the main source of livelihood. Major crops grown are bananas, coffee, maize, sweet potatoes and cassava, in the highlands, and millet, sorghum and beans in the low-lying areas. Although all the agro-ecological zones of Uganda are grappling with the effects of climate change and variability, the eastern region is most affected. It is characterized by a combination of acute poverty; vulnerability to drought, floods and landslides; poor infrastructure and basic services delivery; natural resource degradation; and social and cultural marginalization (GOU, 2009). Recent floods in the Teso sub-region (Pallisa and Kumi districts) and landslides in Bududa have led to crop loss and hunger which has displaced inhabitants (GOU, 2009). These climate challenges, when combined, constrain crop production and increase crop failure, thus exacerbating poverty in the region.

2.3. *Sampling technique and sample size*

A purposive sampling technique was employed to select study respondents. The entry point was via community based organizations (CBOs) who are partners with Heifer International (Heifer), a non-governmental organization (NGO) engaged in community development. One CBO was selected from each of the seven districts covered by Heifer in this region. The size of the groups ranges from 120 to 394 farming households. Membership in these groups is heterogeneous, representing all sections of the community, but with particular focus on the vulnerable members – orphans and vulnerable children, vulnerable women and widows, persons with disability (PWDs), persons living with HIV/AIDS, and other resource limited households – which are the major criteria for accessing support from Heifer. With this fact in mind, the researcher is confident that these groups are representative of the broader communities, particularly the most

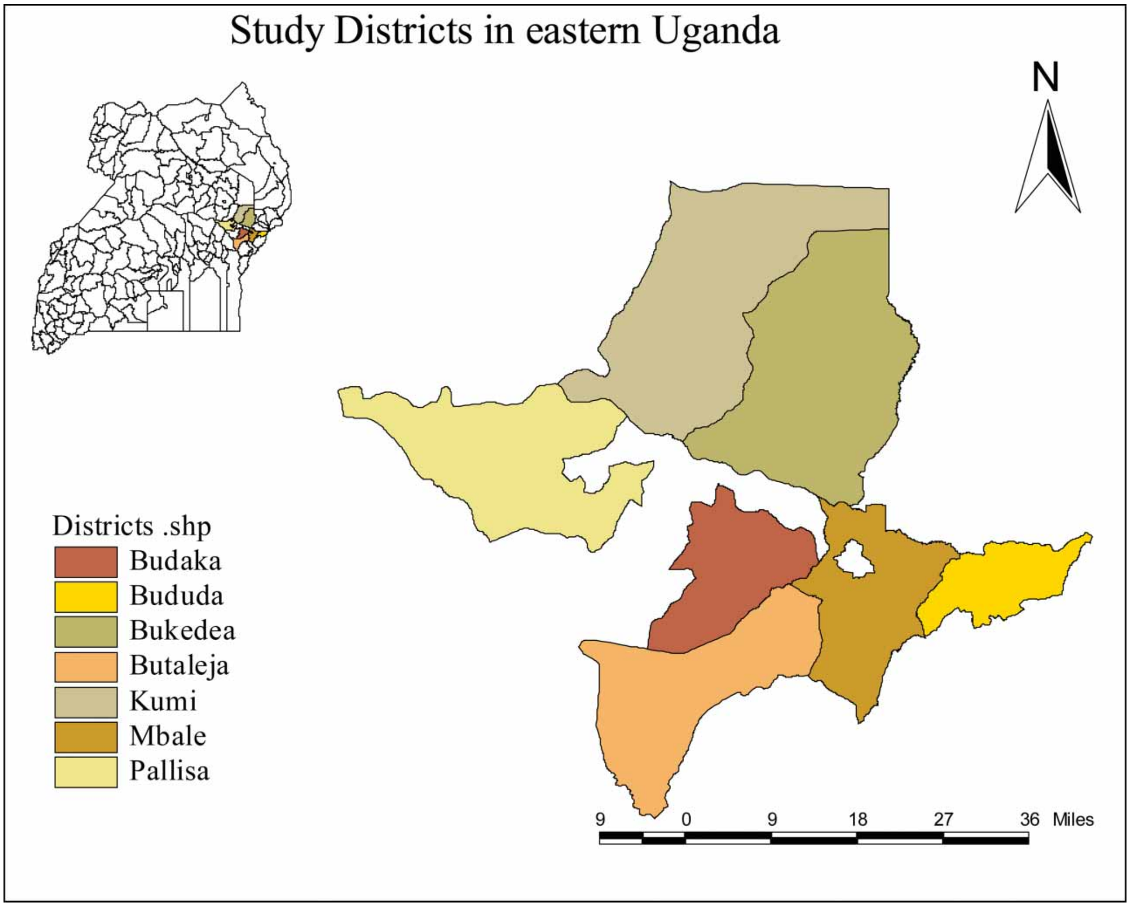

Figure 1. Map showing the study districts in eastern Uganda.
Source: Based on ILRI GIS maps; http://www.ilri.org/GIS.

vulnerable. A selection of study respondents followed the same criteria, to ensure representation of all socio-economic categories from the groups. Leaders of the respective groups helped to identify respondents based on their membership lists. A total of 151 household interviews were conducted, and 157 members (representing 18% of the total CBO membership) participated in PVCA exercises. In addition, 16 key informants were interviewed – one community leader and extension worker per group and two Heifer project managers (from regional and national offices in Mbale and Kampala). Table 1 shows the study districts and sample size.

Table 1. Study districts, community groups and sample size for the study.

District	Name of CBO	Total CBO membership*	PVCA participants			Household interviews		
			Male	Female	Total	Male	Female	Total
Bukedea	Bukedea Women Strugglers Association	200	6	12	18	10	10	20
Budaka	Kaisu Women and Youth Heifer Project	125	15	16	31	12	13	25
Bududa	Bududa Evangelical Friends Heifer Project	70	5	8	13	5	6	11
Butaleja	Bunyole Women Heifer Project	208	7	14	21	12	13	25
Kumi	Koile Olemcan Draft Cattle Association	379	17	15	32	15	10	25
Mbale	National Council for Women Living with HIV and AIDS (NACWOLA)	395	8	14	22	10	15	25
Pallisa	Umoja Women's Association	254	10	10	20	10	10	20
Total		1,631	68	89	157	74	77	151

*This was the group membership as of December 2009 when data were collected.
Source: Group records and field data, 2009.

2.4. *Data collection techniques*

Data for this study were collected between September and December 2009. Primary data were collected at the community and household level using different research methods and tools including PVCA, in-depth household interviews and key informant interviews. Vulnerability-driven approaches were employed focusing on assessing current vulnerability to both climate-related factors (e.g. climate variability, drought, flooding and extreme weather events) and non-climate factors (e.g. lack of resources, inadequate institutions and poverty), and examining current practices in adaptation. Community-based adaptation strategies and policy options that can potentially strengthen adaptive capacity were developed, based on inherent community resources (Action Aid, 2003; CARE, 2009). Primary data were complemented by an extensive study and analysis of secondary literature and policy documents.

2.5. *Analytical methods*

Content analysis was used in the analysis of qualitative data (Bryman, 2008) from the PVCA. Qualitative analysis was continuous during data collection. Major issues were identified, consensus was sought, and the process concluded with an in-depth description of the results. Data were summarized and illustrated by recounting relevant experiences and views of smallholder farmers, essential for authenticity of findings. For quantitative analysis, data were summarized, coded and entered into the Statistical Programme for Social Scientists (SPSS). Descriptive statistics analysis involving percentages, means and frequencies of variables was done to describe the current coping mechanisms and identify community adaptation measures. Regression analysis was done to determine the magnitude, direction and significance of the various household socio-economic characteristics on adoption of adaptation technologies. The regression model was defined as $Y_i = \beta_0 + \beta_1 X_i + \varepsilon$. Where Y_i is adoption of adaptation measures by households, and X_i a set of explanatory variables. The explanatory variables for the regression model are presented in Table 2 and the expected sign of the coefficients.

This study hypothesizes that household characteristics (education of head of household, household size, total income, off-farm income, livestock ownership, farm size) and access to extension services, credit and information on weather, positively affect adoption of adaptation measures. Various studies indicate a positive relationship between the education level of the household head and the adoption of improved technologies (Mugisha, Ajar, & Elepu, 2012; Okuthe, Ngesa, & Ochola, 2007; Uaiene, Arndt, & Masters, 2009) and adaptation to climate variability and change (Maddison, 2006). Household size is considered an endowment in terms of family labour and is expected to positively affect the probability of adoption, given the labour-intensive nature of agricultural technologies (Mugisha et al., 2012). Benin et al. (2007) report that shortage of capital and credit facilities, scarcity of agricultural inputs, lack of adequate farmland and unfavourable weather patterns are critical constraints to the adoption of new technologies.

On the other hand, the expected sign of gender and age of head of household, and local agro-ecology is indeterminate. While Uaiene et al. (2009) report that, with age, farmers accumulate more knowledge and personal capital

Table 2. Variables for the regression model.

Variable	Description	Mean	SD	Sign
Dependent variable				
Adaptation	Dummy, =1 if farmers reported to have adopted one or more technologies in response to climate variability	0.56	0.49	
Explanatory variables				
Gender	Dummy, =1 if the household head is male, 0 otherwise	1.29	0.47	+/−
Age	Age of the household head in years			+/−
Education	Level of education of the household head	1.53	0.60	+
Household size	Number of household members	7.49	3.71	+
Income	Total annual household income (UGX ‘000’)	1.3e6	1.5e6	+
Off farm income	Dummy, =1 if the household earns off-farm income, 0 otherwise	0.42	0.49	+
Livestock	The number of cows, sheep and goats owned by the Household (total livestock units)	0.90	0.04	+
Credit	Dummy, =1 if a household member has taken out a loan in the past 12 months, 0 otherwise	0.25	0.43	+
Farm size	Total farm size in hectares	4.22	2.73	+
Extension	Access to extension services by household members	0.33	0.47	+
Weather information	Access to weather forecast information	0.83	0.38	+
Local agro-ecology*	Local agro-ecology represented by the study districts. Dummy=1 if district is in AEZ1			+/−

*Study districts fall in three distinct agro-ecological zones (AEZ) as classified by Wortmann and Eledu (1999) – (1) Southern and Eastern Lake Kyoga basin (Pallisa, Kumi, Bukedea); (2) Mt. Elgon high farmlands (Mbale, Bududa), (3) Lake Victoria Crescent and Mbale farm lands (Butaleja, Budaka).

and thus show a greater likelihood of investing in innovations, Walusimbi (2002) reports that younger farmers, because of being more educated and less risk averse are more likely to adopt technologies more readily. In the same way, male-headed households are often considered more likely to get information about new technologies and take risks in business than female-headed households (Asfaw & Admassie, 2004), but Nhemachena and Hassan (2007) indicate a contrary result by showing that female-headed households are more likely to take up climate change adaptation methods. Local agro-ecology increases (decreases) climate-related risk, and subsequently adoption of adaptation measures by households.

3. Results and discussion

3.1. *Institutional and policy framework*

A recent International Climate Risk Report labels Uganda as one of the most unprepared and vulnerable countries in the world due to poverty and low-income diversity. Vulnerability, the potential to be adversely affected by an event or change is a key concept for appraising effective interventions and responses to climate change. On the basis of macro-level indicators, Uganda can be considered to be highly vulnerable given its dependence on primary production and natural resource use, weak institutional and policy frameworks and heavy reliance on rain-fed agriculture (GOU, 2007).

Uganda is a party to the United Nations Framework Convention of Climate Change, adopted in 1993 and its Kyoto Protocol that came into force in February 2006. It obliges Uganda to put in place appropriate mitigation and adaptation measures to address the cause and effects of climate change as well as undertake education and awareness programmes. These treaties have been ratified but not yet domesticated. Several studies undertaken by the Ministry of Water and Environment on the climate change policy scene in Uganda have shown that most of the relevant sector policies have not integrated climate change.

In 2007, a National Adaptation Plan of Action (NAPA) was launched by the Government of Uganda, which presents a list of nine priority projects with a cost of approximately USD 40 million (GOU, 2007). Limited progress has been made in implementing the NAPA due to lack of funds, and inadequate capacity to prepare detailed proposals and mobilize funding (GOU, 2010). A National Disaster Preparedness and Management Strategy, Policy and Institutional Framework have been designed to establish and improve national and local capabilities to minimize the damages caused by natural hazards. Raising public awareness has proven to be a pivotal point for effective hazard mitigation. The Ministry of Relief, Disaster Preparedness and Refugees serves is the Government's focal point for disaster preparedness, and thus the lead actor on preparedness in Uganda (UNWD, 2005). Others include the Department of Meteorology; Ministries of Water, Lands and Environment; Agriculture, Animal Industry and Fisheries; Health; and Local Government.

The Government of Uganda has further included climate change as one of its priority focus areas in the recently launched National Development Plan (GOU, 2010). The Government is also considering promoting climate-based disaster management policies and practices aimed at minimizing the population's vulnerability levels to climate-based hazards and to save lives and livelihoods when such disasters occur. The desired policies are to focus on providing early warning information of approaching disasters, predicting and mitigating their impacts on the country, the population and people's livelihood, and preparing for and managing the disaster.

The government's intention is to come up with a comprehensive integrated national early-warning system (EWS) for food security and overall disaster prevention, mitigation and management (GOU, 2007). In addition to government efforts, a number of NGOs have been in the support of communities to manage disasters and climate-related risks. Their main focus has been training on conservation agriculture, water harvesting, tree planting, provision of agricultural production inputs, and general agricultural and livestock extension services. In addition, NGOs have been active in responding to disasters, for example in providing humanitarian aid (NIDOS, 2009). At local level, community-based organizations are also engaged in collective and group-based adaptation approaches which include strengthening of social safety nets, particularly strengthening farmer self-help groups and savings and credit associations. The social safety nets are important elements for reducing vulnerability to risks.

Available data indicate that response to climate change is currently being handled by different ministries depending on the nature of the risk. There is a clear lack of strategy, though the various government implementation programmes have tried to address this. The current approach is generally reactive to a hazard or disaster happening, rather than focusing on long-term adaptation of farming communities. This approach may not be appropriate as there is need for real concerted and harmonized efforts to plan and respond to current and future climate-related risks. In addition, the approach of the Government of Uganda is more broadly focused, and yet research has indicated that adaptation options of smallholder farmers are location specific (Kassie, Zikhali, Manjur, & Edwards, 2009) and need to consider complexity in household crop and livestock productions and non-market relations. This study addressed this gap by providing region-specific assessment and recommendations for government to design policies targeted at improving local adaptation of communities in eastern Uganda.

3.2. *Climate-related vulnerabilities and coping mechanisms in eastern Uganda*

3.2.1. *Community vulnerability to climate variability*

In a comprehensive review, Nelson, Adger and Brown (2007) defined vulnerability as 'the susceptibility of a system to disturbances determined by exposure to perturbations, sensitivity to perturbations, and the capacity to adapt' (p. 396). Consistent with this definition, the vulnerability of human–environment systems to climate risk is widely agreed to depend on their relative exposure to climate variability and change, their sensitivity to exposure and capacity to adapt (Nelson, Kokic, Crimp, Meinke, & Howden, 2010). Globally, evidence is emerging that climate change is increasing rainfall variability and the frequency of extreme events such as drought, floods and hurricanes (IPCC, 2007). Projections in east Africa suggest that increasing temperatures due to climate change will increase rainfall by 5–20% from December to February, and decrease rainfall by 5–10% from June to August by 2050 (Hulme, Doherty, Ngara, New, & Lister, 2001; IPCC, 2007).

In Uganda, climate analyses and predictions indicate that the wetter areas of Uganda, around the Lake Victoria basin and the east and northwest are tending to become wetter (GOU, 2007). Goulden (2008) indicates high percentage increases in rainfall for December, January and February, which is historically the driest season for many parts of Uganda. This indicates that the current wet season from March to May (known as the 'long rains') may shift forwards in time, or that the September to November rains, known as the 'short rains' may extend longer. Studies in Uganda and government analysis papers also confirm these results indicating increasing trends in inter-annual rainfall, and decreasing trends in March–April–May rainfall (e.g. GOU, 2007; Hepworth & Goulden, 2008; Osbahr, Dorward, Stern, & Cooper, 2011). NGOs working in Uganda also report that farmers recognize an increasingly erratic rainfall pattern in the first March to May rainy season, causing drought and crop failure, but also more intense rainfall, especially in the second rains at the end of the year, causing flooding and erosion (Oxfam, 2008).

Increase in Uganda rainfall will not necessarily benefit agriculture as it is likely to be sporadic and sometimes delivered in large rainstorms. In particular, climate variability and change is likely to mean increased food insecurity; shifts in the spread of diseases like malaria; soil erosion and land degradation; flood damage to infrastructure and settlements and shifts in the productivity of agricultural and natural resources (GOU, 2009). For example, drought in 2008 caused an average reduction in yield of 50% of simsim, sorghum, groundnuts, cassava and maize (Ocowunb, 2009). As of March 2010, at least 900,000 people in Karamoja, northeastern Uganda, were facing severe food insecurity as a result of four consecutive years of failed rains and poor harvests. Further, a shift in the viability of coffee growing areas could potentially wipe out USD 265.8 million, or 40% of export revenue, as a result of climate change (GOU, 2009).

Findings from the PVCA correlate with this scientific evidence. Communities noted changes in cropping seasons as a result of delayed onset of rainfall, early cessation and prolonged dry spells. Communities reported that the first season had shifted from a start in early March to mid or late March and now ended in June rather than May. Meanwhile, they claimed the second season had shifted from a start in August to September and now ended in November rather than December. During the past 20 years, farmers highlighted specific problems of variability in the duration, timings and intensity of the rains, including in winds and heavy rains at the start of the seasons, such as in 2004, 2006 and 2007. In addition, communities report more frequent occurrences of climate-related hazards particularly floods, landslides, droughts, erratic and heavy rainfall, crop and livestock pests and diseases outbreaks in the last 3 years. These combined have greatly affected the production cycle of the farming households in eastern Uganda leading to increased famine situation.

From the communities' perspective, these climate hazards are likely to worsen in future, a situation they attributed to poor land use management practices such as cutting of farm trees and forests to free more land for cultivation. There was general consensus from the PVCA exercises that there is increased settlement and cultivation in risk-prone areas such as swamps and very steep slopes as well as deforestation, land clearing and bush burning by the majority of community members. In extreme cases, land which used to produce good vegetation is now bare and hard. Owing to the relatively small area of productive agricultural land available in eastern Uganda, there is intense pressure to produce food on a relatively small footprint. The combined effects of climate- and human-induced hazards therefore are likely to worsen livelihoods of communities in eastern Uganda, affecting food production, health and the environment.

3.2.2. *Community coping mechanisms to climate variability*

Given the perceived climate variability and change effects, communities in eastern Uganda have been able to adopt innovative coping mechanisms. Coping strategies are defined as short-term actions to ward off immediate risk, rather than to adjust to continuous or permanent threats or changes. Coping strategies are often the same set of measures that have been used before (CARE, 2009). Whereas adaptation is the adjustment in natural or human systems in response to actual or expected climatic

Table 3. Household coping mechanisms in eastern Uganda.

Management practice	Mean	Standard deviation	Confidence level (95%)
Compost manure	0.80	0.40	0.08
Green manure	0.26	0.44	0.08
Soil bunds	0.40	0.49	0.10
Grass strips	0.60	0.49	0.09
Mulching	0.60	0.49	0.10
Agro-forestry	0.85	0.36	0.07
Fuel wood saving devices	0.87	0.34	0.07
Intercropping	0.97	0.17	0.03
Planting trees	0.48	0.50	0.09
Stocking food	0.35	0.48	0.12
Planting early maturing crops	0.17	0.38	0.13
Diversification of farming enterprises	0.77	0.42	0.13
Planting drought resistant crop varieties	0.22	0.42	0.14

Source: Field data, 2009.

changes or their effects, which moderates harm or exploits beneficial opportunities (Pittock, 2003). Communities' responses to climate risks in eastern Uganda range from immediate actions aimed at evading risk, for example migration, to protecting their food reserves and changing their farming practices. Table 3 shows descriptive results of household data on coping practices employed by farming households. Some of these practices may indeed be coping strategies while others are routine livelihood options by farming communities, or adaptation strategies. In the context of this study, farmers' practices will be considered as coping mechanisms as they are employed in response to extreme climate events, often on a trial and error basis.

Study results show that over 90% of the households have attempted changing their farming operations in response to climate variability and extremes. The most commonly used adaptation options employed by households are intercropping (97%), use of fuel wood saving stoves (87%), agro-forestry (85%) and compost manure (80%). Intercropping is intended to spread production risk. Dixon, Gulliver and Gobbon (2001) showed that mixed cropping systems reduce risk, reduce crop losses from pests and diseases and make more efficient use of farm labour. According to Kurukulasuriya and Rosenthal (2003) and FAO (2007), conservation and organic agriculture that combine manure use, agro-forestry and permanent soil cover have ability to increase soil organic carbon, reduce mineral fertilizers use and reduce on-farm energy costs, and have been proved to potentially increase community/household resilience to climate-related risks.

Farmers have also adopted diversification of farming enterprises (77% of respondents) to include small ruminants which are thought to be hardy to increased temperatures, feed scarcity and pests and diseases, and inclusion of other crops such as sugarcane, sorghum and pineapples, which are drought tolerant. The results correlate with literature which argues that farmers are likely to adopt diversification of crop and livestock varieties, including the replacement of plant types, in order to increase productivity in the face of temperature and moisture stress (Kurukulasuriya & Rosenthal, 2003). Further, Kurukulasuriya and Mendelsohn (2006) note that farmers adapt their crop choices to suit the local conditions that they face. Other coping mechanisms include off-farm employment, food stocks, fuel wood saving devices and tree planting. Other studies in east and central Africa also indicate several coping measures in agriculture that have been employed by communities which include development and promotion of drought-tolerant and early-maturing crop species and exploitation of new and renewable energy sources (Nzuma, Waithaka, Mulwa, Kyotalimye, & Nelson, 2010).

3.3. *Failure to adapt*

The study also analysed inequalities within communities or households which exacerbate vulnerability as well as the root causes. The determination of root causes of climate change vulnerability was critical to identification of community actions to reducing their vulnerability. From the PVCA exercises, pair-wise ranking indicated low income and narrow resource base, limited knowledge and skills, gender inequalities, and location in risk-prone areas as the major factors limiting farmer's ability to adapt to climate variability and change. Poor households are most vulnerable to climate change due to overdependence on rain-fed agriculture. They usually lack diversity in livelihoods. In addition, they have weak structures which are prone to catastrophes with limited capacity to replace them or recover from the effects of disasters. Most times the poor want to save their property first and they end up victims of circumstances such as landslides. Farmers' knowledge and skills on various strategies are critical for enhancing climate change adaptation. This goes along with availability of climate information and early-warning systems.

In terms of gender inequalities, women were sought to suffer most from the effect of food shortage. They are in charge of looking for food for their families, while men may have access to food. Children, PWDs and old people are particularly vulnerable to climate-related health impacts such as heat stress, floods and malnutrition, and lack access to and knowledge of how to use public, private and community services. In addition, they lack escape mechanisms due to reduced mobility. Location in risk-prone areas is obvious, as households located in valleys, very steep slopes and poor drained areas are at high risk of suffering climate change effects particularly floods and landslides.

While this assessment from the PVCA holds water, in order to support these results, a regression analysis was done to determine which factors were significant in determining farmers' adoption of an adaptation or coping strategy. Table 4 presents results of the regression analysis. Consistent with PVCA results, access to weather information and location of household significantly and positively influence adoption of adaptation strategies. Other significant factors include household size, farm size, livestock ownership and availability of credit. Household size is normally associated with a higher labour endowment, which would enable a household to accomplish various agricultural tasks. For instance, Croppenstedt, Demeke and Meschi (2003) argue that households with a larger pool of labour should be more likely to adopt agricultural technology and use it more intensively because they have fewer labour shortages at peak times.

Farm size and livestock ownership represent wealth. It is regularly hypothesized that the adoption of agricultural technologies requires sufficient financial well-being (Knowler & Bradshaw, 2007). On this line of argument, other studies, which investigate the impact of income on adoption, revealed a positive correlation (Franzel, 1999). Farmers with bigger land holding are assumed to have the ability to purchase improved technologies and the capacity to bear risks if the technology fails. This has been confirmed in the case of fertilizer application in northern Tanzania (Nkonya et al., 1998) and Kenya (Hassan, Onyango, & Rutto, 1998). Availability of credit eases the cash constraints and allows farmers to use purchased inputs such as fertilizer, improved crop varieties and irrigation facilities. This is in agreement with previous researches on adoption of agricultural technologies which indicate a positive relationship between the level of adoption and the availability of credit (Yirga, 2007).

Unlike community perspectives, regression results indicate a negative but significant relationship between income and adoption of adaptation measures. This also contradicts previous researches which revealed a positive correlation between income and adoption of agricultural technologies (Franzel, 1999; Knowler & Bradshaw, 2007). This may be attributed to the fact that smallholder farmers are risk averse, and prefer to invest their resources in other off farm activities, or assets such as livestock, or respond to short-term needs such as buying food other than invest in long-term technologies, which they may not even be certain of their effectiveness in reducing climate-related risks.

In eastern Uganda in particular, the increased uncertainty of household livelihoods due to increased climate hazards, may also have negative influence on farm investments, thus explaining why the majority of farmers have opted to implement short-term measures for coping with climate risks, other than investing in long-term adaptation options. This is consistent with Rosenzweig and Binswanger (1993), and Zimmerman and Carter (2003), who indicate that smallholder farmers adopt conservative management strategies that reduce negative impacts in poor years, but often at the expense of higher average productivity and profitability, inefficient use of resources, and sometimes accelerated natural resource degradation.

Table 4. Factors affecting household adaptation strategy.

Adaptation action	Coefficient	Standard error	*t* value	*P* value
Gender (male = 1)	0.034	0.133	0.30	0.764
Marital status	0.005	0.028	0.18	0.856
Age	−0.004*	0.003	−1.71	0.089
Education	−0.034*	0.054	−0.62	0.534
Household size	0.022*	0.011	1.95	0.053
Farm size	0.072*	0.059	1.23	0.221
Livestock	0.159*	0.041	3.88	0.000
Extension	−0.104*	0.095	−1.09	0.276
Weather information	0.128*	0.131	0.98	0.330
Credit	0.158*	0.097	1.63	0.105
Off farm income	0.020	0.090	0.22	0.827
Total household income	−8e-08*	2e-08	−3.31	0.001
Agro-ecological zone 2	0.644*	0.123	5.26	0.000
Agro-ecological zone 3	0.357*	0.096	3.73	0.000
Constant	−0.045	0.239	−0.19	0.851
Number of observations	151			
$F(14, 136)$	15.81			
Prob > F	0.000			
R-squared	0.289			
Root MSE	0.439			

*Significant at alpha level = 0.05.
Source: Field data, 2009.

3.4. *Community action and capacity*

The objective of this step was to determine if, and how vulnerable people take actions that specifically reduce their vulnerabilities. It also included analysis of where communities get help to reduce their vulnerabilities, their perception of their own vulnerability and how far it affects their decisions. Invariably, it looked into what capacities the communities or households have and how these have been or can be used to reduce vulnerability. This analysis revealed what has worked and not worked before in reducing vulnerability in the target communities in eastern Uganda. This information was useful in guiding development of community-based adaptation mechanisms.

3.4.1. *Resources and assets available at community level to reduce vulnerability*

The community started by identifying the assets and resources that are available that can be used to reduce vulnerability and how they can be used. This also included the analysis of the capacities to utilize the available resource to reduce vulnerability. Table 5 shows a summary of the resources and assets available at community level and how they can be used to reduce vulnerability.

3.4.2. *Identification of community-based adaptation options*

Through adaptation, individual local communities and entire nations aim to preserve themselves and maintain their welfare in the face of long-term climate change and its impacts on the environment. It involves countries and communities progressively introducing fundamental changes – in the structure of their economies, production processes and technologies, livelihoods, consumption patterns, value systems, organization and governance, etc – to be in greater consonance with a permanently changed climate or with well-established trends of a changing climate. Adaptation is in fundamental ways inherently local – as the direct impacts of climate change are felt locally (FAO, 2010b; MA, 2005). Response measures therefore need to be tailored to local circumstances. However, for these efforts to be robust, they must be guided and supported by national policies and strategies.

Based on this background and the vulnerability assessment, respondent communities drew practical strategies to mitigate impacts of the two major climate-related disasters in the area (Table 6). The strategies developed mainly included risk-coping production systems and sustainable land use management practices. The decisions reached by communities were based on the available resources in the community as well as their past experiences. The suggested

Table 5. Resources and assets available to reduce vulnerability to major hazards.

Risk	Resources and assets available in the community	How they can be used	Past community actions and perceptions
Erratic and heavy rainfall	Knowledge and skills	Use of inherent knowledge to construct terraces, soil bonds and rain water harvesting, construction of drainage channels to reduce risks of flooding	Establishment of soil and water conservation measures particularly in hilly landscapes – terracing, hedge rows, soil bonds etc.
	Social safety nets (self-help groups)	Communities support households that suffer effects of heavy rainfall such as floods and landslides	Community support to affected families
	Agricultural extension services, agro-supply shops	Management of livestock diseases, technical services, farmer training, animal vaccinations Routine management of livestock and employment of prophylactic measures for disease management	Use of local pesticides on small plots of vegetables and local drugs to treat common livestock conditions such as mastitis
Droughts	Water sources, e.g. boreholes, spring wells, and streams	Supply water to the farm households and livestock	Droughts were considered to be as a result of malicious rain makers. Communities would cane 'rain makers' and it would rain. Communities still practice this
	Two rainy seasons (March–June and August–November)	Rain water harvesting and storage, food storage, pasture preservation during bumper harvests	
	Social and physical capital (savings and credit societies)	Community groups pool funds together to support establishment of other non farm income generating activities	

Source: Community PVCA results, 2009.

Table 6. Identified community-based adaptation options.

Sources of risks/ disasters	Factors influencing vulnerability	Risk management strategies
Floods and land slides	• Swamp reclamation and clearance of vegetation cover, tree cutting, overstocking • Settlement on marginal lands e.g. wetland, low lying plains, swamps, steep mountainous areas • Poor land use management practices, e.g. cultivation without putting in place contours, terracing, strips that check flow of water/erosion • Blocked drainage • Engineering interferences, i.e. Road construction, quarrying and mining activities	• Planting of a minimum of 500 multipurpose trees per each household • Ensure functional soil and water conservation mechanisms in place, e.g. drainage ch annels on-farm, terracing, contour cultivation, catchment basins, strip cropping • Promote improved animal management practices like zero grazing and integrated farming • Planting of hedge rows on slopes to hold back the soil • Training and awareness of community members about early warning signs, awareness creation about consequences of floods • Building stronger social safety nets – group enterprises, savings and credit schemes etc
Prolonged dry spells/ droughts	• Poor methods of farming including nutrient mining • Deforestation and wetlands destruction • Vegetation cover burning-like bush burning • Overstocking of livestock • Industrialization (pollution, air, water and soils)	• Cultivate drought resistant improved crop varieties • Timely planting, crop rotation, weeds and parasites control • Pasture and fodder treatment and preservation • Advocate for by-laws to control bush burning and other forms of environment destructions • Enterprise diversification to include livestock enterprises and crops that are least affected by prolonged dry spells such as small ruminants, pineapples, sugarcanes • Water harvesting during the rainy season for, irrigation and livestock using locally available technologies • Improved farming methods, e.g. zero grazing • Adoption of fuel wood saving devices, manure re-cycling, e.g. biogas • Massive sensitization on environment conservation

Source: Community action plan based on PVCA exercise, 2009.

strategies have potential to greatly contribute to increased land productivity hence increased household incomes. This would lead to sustainable management of critical ecosystems and reduced impacts of climate change-related risks. These strategies suggested by communities are comparable with measures identified by climate change research community in Uganda and Africa as a whole (e.g. Kurukulasuriya & Mendelsohn, 2006; Maddison, 2006; Mubiru & Magunda, 2010; Nhemachena & Hassan, 2007; Nzuma et al., 2010).

4. Conclusion and policy implications

The main conclusion from the study and the main message of this article is that climate variability and change will likely reduce crop yields and exacerbate the risk of food insecurity in eastern Uganda. The major climate-induced risks in eastern Uganda are heavy and erratic rainfall leading to landslides in hilly areas and floods in low-lying areas, destroying crops, homesteads and infrastructure, and droughts within the year and mid-season, affecting crop and livestock yields. Evidence of response mechanisms by communities, government and other local stakeholders to support community adaptation exists, albeit in an *ad hoc* manner. Mechanisms employed are aimed at addressing the current problem, with limited focus on future climate risks. Most government strategic papers and policy frameworks related to climate change adaptation are still at discussion level yet to be passed for legislation.

Communities and households, however, are adopting a number of practices for adapting their farming to climate variability and change. Notable is the change in crop and land management practices such as intercropping, agro-forestry, manure use and diversification of crop and livestock enterprises. Practices for reducing farm energy requirement such as use of fuel wood saving stoves also emerged as key adaptation mechanisms. A number of factors were found to affect the adoption of these technologies. Socio-economic factors such as household size, farm size, livestock ownership, access to weather information and credit positively affect adoption of adaptation technologies. Location of households also plays a critical role in determining adoption of adaptation mechanisms.

These results have significant policy implications for community-based climate change adaptation. This study has shown that communities' inherent knowledge, social and financial capital are critical assets for advancing adaptation. The study strongly suggests that (1) analyses of climate change impacts and design of adaptation projects take into account community perspectives, knowledge and resources; (2) government (specifically ministry of Disaster Preparedness) and development stakeholders engaged in climate change agenda identify and evaluate potential location-specific adaptation measures, and incorporate them into the country's development policy and management practices particularly national development plan.

However, just because a farmer adopts technologies in view of adapting his or her farming operations to climate variability and change, it does not mean that the adaptive measure taken is appropriate or that the farmer made the same set of adaptations that one more accustomed to the climate might have made. This article therefore proposes further research on the effectiveness of the various technologies employed by farmers in achieving actual adaptation to climate change.

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