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Household's Vulnerability to Climate Change Among Farmers in Meatu and Iramba Districts, Tanzania

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Abstract: Understanding how the farming households are affected by climate change is important in formulating policies to strengthen household's adaptive capacity which are instrumental in poverty reduction and increasing food security. This manuscript analysed farming household's vulnerability to climate change in Iramba and Meatu districts. A cross sectional design was used whereby data were collected from 183 randomly selected households from 3 villages, 2 from Meatu District and one from Iramba District. Data analysis was based on indices constructed from selected indicators for exposure, sensitivity and adaptive capacity. The indicators were weighted using principal component analysis. Inter-district analysis of the vulnerability index shows that there was no significant difference in household vulnerability on based districts. However, on exposure, the results shows that Iramba was highly significant ($p = 0.001$) compared to Meatu. Generally, occurrence of drought contributed positively to the household's vulnerability due to the impact of climate change. According to the absolute value of the weights, occurrence of natural disaster such as drought contributes more to the exposure index compared to other indicators. Based on the results it can be concluded that, vulnerability of the framing households in the study area is low. Involvement of the household on non-farm income generating activities and unreliable rainfall were the most important determinants of a household's vulnerability. In addition, the impact of climate change on the study areas included the loss of lives, decline of both animal and crop production and loss of household properties such as damage to houses. Therefore, it is recommended that to improve the capacity of farming households there is need to improve adaptive indicators such as improving the irrigation facilities in the local area. Similarly, creating opportunities for non-farm income to reduce the extensive dependence of the community on natural resource based livelihoods.

Key words: Climate change, household vulnerability, Iramba district, Meatu District, creating

INTRODUCTION

Climate change and extreme weather events have undermined progress in economic sectors that largely depend on weather conditions, either directly or indirectly, most notably agriculture (Parry and IPCC, 2012). Changes in climate are expected not only to change the average levels of key weather elements but also to increase their variability along with the frequency of weather shocks (McCarthy and IPCC, 2001). Changes in the climate affect rural livelihoods through their impacts on agricultural production and income, since farm yields are directly affected by weather elements (McCarthy and IPCC, 2001). Worldwide 1.7 bln. farmers and pastoralists are highly vulnerable to climate change induced shocks (Siedenburg *et al*., 2009). Of these farmers 228 mln. live in Africa and 837 mln. live in Asia. Land degradation is widespread in these areas and yields are typically low. Such farmers are vulnerable because their farms depend directly on rainfall and temperature, yet they often have little savings and few alternative options if their crops fail or livestock die (Siedenburg *et al*., 2009). Global model indicates that farming populations residing in tropical regions are expected to experience deterioration in their agricultural yields and incomes (McCarthy and IPCC, 2001). In developing countries, different groups are vulnerable to different types of climate shocks and the impact those events have on agriculture and incomes (Mahon *et al*., 2011). Increases in temperature and rainfall have been shown to affect crop yields positively as long

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as those increases do not go out of the range thus hindering the development of the plants. Estimations for the tropical (low latitudes) regions suggest that yield losses for maize, wheat and rice range between 5 and 20% should local temperatures increase by 3°C; yield levels may halve if temperatures increase by as much as 5°C. In temperate (higher latitude) regions, yields may actually increase or decrease slightly, translating into changes in GDP that range between small losses and gains of up to 13% (Tol, 2009).

The impact of a climate change does not depend only on the intensity of the shock itself but also on the vulnerability of the system to which the particular type of shock occurs (Walker *et al*., 2004). Vulnerability is defined as a function of exposure, sensitivity and adaptive capacity (McCarthy and IPCC, 2001; Yohe and Tol, 2002). In climate change vulnerability can be categorized both physically and socially. Generally, physical conceptions of vulnerability focus on exposure and sensitivity to environmental stressors (Liverman, 1990). On the other hand, social conceptions of vulnerability draw attention to factors such as class, income distribution and endowments which engender and characterize vulnerability (Turner *et al*., 2003). According to Carpenter *et al.* (2001) vulnerability is a complex concept which can be defined as vulnerability of "what" to "what". Vulnerability of the system will make it more or less affected by the same shock. A single shock can have various impacts of diverse nature and time scale, even considering a single simple farming system. For instance, a drought in livestock grazing reduces the availability of water and grass both directly and indirectly because as the watering points are reduced some pastures are no longer accessible and so increases demand for feed at the very moment when there is less feedings available. As a consequence feed prices increase which then forces livestock owners to sell their cattle. Massive sales while there is a reduced demand push cattle prices down, forcing to sell even more to buy feedings. These effects on prices reduce farm and household income and assets (Kjohl *et al*., 2011). Also, prolonged drought has long lasting degrading effects on land due to the fact that a combination of drought and overgrazing, particularly near watering points, destroys the vegetal cover and increases soil erosion (Kjohl *et al*., 2011). Climate change also has effects on various components of ecosystem. For instance, the effect of higher average temperature on a single species on major crops, in which climate change will affect both pollinators and the plants with which they interact (Kjohl *et al*., 2011).

Socio-economic characteristics such as age, the level of human capital and gender can influence the relative impacts of climate changes (FAO, 2011). Across these groups a gender dimension is also evident because women and female-headed households are at risk in the rural areas (FAO, 2011). Both as food consumers and as food producers, female-headed households tend to have reduced access to assets, (e.g., land and other physical or human capital) savings and credit (FAO, 2011). As a result, women farmers typically achieve lower yields than men, making them more vulnerable to agricultural production and income shocks. The impacts of climate change can also be determined by the vulnerability of the system (Folke *et al*., 2003). Vulnerability helps the system to recover more or less easily from the impact of climate change. The ways in which various dimensions and scales interact is crucial, precisely because of the importance of its ability to cope with uncertainty (Cifdaloz *et al*., 2010). For instance, Karfakis *et al.* (2011) shows that increasing the level of education of farmers can be an efficient means for reducing farmer's household vulnerability to climate change. It therefore implies that it is not only climate change that has to be considered as a change relative to an average but also the change of the average itself, ultimately the question being until what point a system can adapt before changing to another type of system (Karfakis *et al*., 2011). The concrete impact of the gradual onset or the sudden incidence of climate changes is a field of study which presents relatively scarce evidence even nowadays. The outcome of knowledge of assessing how climate change affects the multidimensional and dynamic concept of household agricultural production is a key to increased vulnerability among farmers. According to Kabote *et al.* (2013) the four major threatening manifestation of climate variability and change in Iramba and Meatu, are drought, rainfall unpredictability, late onset and early cessation of rainfall. As such the objective of this study on which the manuscript is based was to determine the impacts of climate change on farming household's vulnerability in Meatu and Iramba Districts.

MATERIALS AND METHODS

Description of the study area: The study was conducted in Iramba and Meatu Districts in Tanzania. Study areas were selected based on their significant levels of climate change variability which allowed the examinations of farmer's resilience to climate change. The population of Iramba was 405 132 while that of Meatu was 405 177 (NBS, 2012). Meatu District is found in Simiyu Region. The district covers 8 871 km^2 (URT, 1996) and the altitude of between 1 000 and 1 500 m above sea level with detached hills and grassy savannah woodlands. Iramba is one of the districts in Singida Region. The climate of Iramba and

Meatu is semi arid with 7-8 month of dry season, lasting from late April-early November. The mean annual rainfall ranges from 600-800 mm and the rainfall is erratic and unreliable in terms of both amount and timing (URT, 2005).

Iramba has a highly erratic, unpredictable rainfall between October and May with 2 minor seasonal peaks in December and March-April. Precipitation which occurs in brief storms is lost through quick surface runoff and high evapo-transpiration rates. Dry-season precipitation extends between May and November with <50 mm per year whereas monthly evaporation rate exceeds the monthly rainfall almost every month (MT and NRT, 1995). The temperatures in the districts range from about 15°C in July to 30°C during October. Temperatures vary according to altitude. Furthermore, temperature difference between day and night may be vary with high hot afternoons going up to 35°C and chilly nights down to 10°C.

The districts are characterized by two superficial geological deposits. These are the alluvium, comprising sandy, soil and clay. The second despots are cainozoic consisting of cemented sand, literate and sandstone. Additional the Iramba District is characterized of bush or thicket and bush and vegetation (URT, 2005). While, Meatu District is mostly shrubs and thorny treesscattered or clustered in some areas revealing a characteristic of a semi-arid zone. Most parts in the southern zone of the district have bare soils especially during dry seasons compared to the northern zone. There are a number of seasonal rivers in the district. River Simiyu is the biggest river that used to flow throughout the year but is now drying up. Food crops grown in the districts include maize, sorghum, paddy, sweet potatoes, cassava, pulses and groundnuts. However, in Meatu a majority of the district's population grew cotton which was the main cash crop. The livestock that were raised by farmers include cattle, goats, local chicken, donkeys and sheep (URT, 2005).

Research design: A cross-sectional research design was adopted in the study on which the manuscript is based. This design allows data to be collected at a single point in time. The design can also be used in descriptive studies and in determination of relationships between variables (Varkevisser *et al*., 2003). The design was considered favourable to the nature of this study as despite the weakness of being static/snapshot, a cross sectional design can still be used for climate change studies (Alinovi *et al*., 2008).

Sampling procedure and sample size: Multistage sampling was adopted for this study. First, purposive sampling was used to select the regions, districts, wards and villages due to occurrence of extreme weather events due to climate change such as floods, droughts. Second, it involved random sampling to obtain the household heads among the households. The sampling frame for this study involved the list of all households participating in agricultural production in the selected villages in Iramba and Meatu Districts (Fig. 1). The sample was drawn from three villages, namely Kidaru, Mwashata and Mwamanimba. One village was chosen from Iramba District and two villages from Meatu District. A total of 183 households were randomly drawn from the population from the three villages to form the sample size. Bailey (1994) and Saunders *et al*. (2007) suggest that a sub sample of 30 household heads is a bare minimum for studies which statistical data analysis is to be done regardless of population.

Data collection methods and instruments: This study employed both qualitative and quantitative methods to collect data on the impact of climate change on household vulnerability. A structured questionnaire with both open and close ended questions was used to collect data, whereby face to face interview with household heads were conducted. The questionnaire comprised of general questions about the household heads and their household characteristics. Focus Group Discussions (FGDs) in each village were also used to capture qualitative data in which checklist were used to guide the discussions. In each village two focus groups composed of 7-10 people were formed. Therefore, in Iramba District, 2 focus group discussions were held in Kidaru village while in Meatu District, 4 focus group discussions were held in Mwashata and Mwamanimba villages. The FGDs covered a range of issues such as the concept of climate change, identification of impacts due to climate change and vulnerable households. Key informant interviews were also used to collect qualitative data that captured specific changes and information whereby elders and leaders in each village narrated historical information on the household's impacts of climate change in the study area.

Vulnerability indicators: Vulnerability to climate change is multidimensional and is determined by a complex inter-relationship of multiple factors. Therefore, devising an index to measure vulnerability is helpful to compare similar systems and provide insights into the underlying processes and determinants of vulnerability that are of relevance to policy makers (Vincent, 2004). Following the

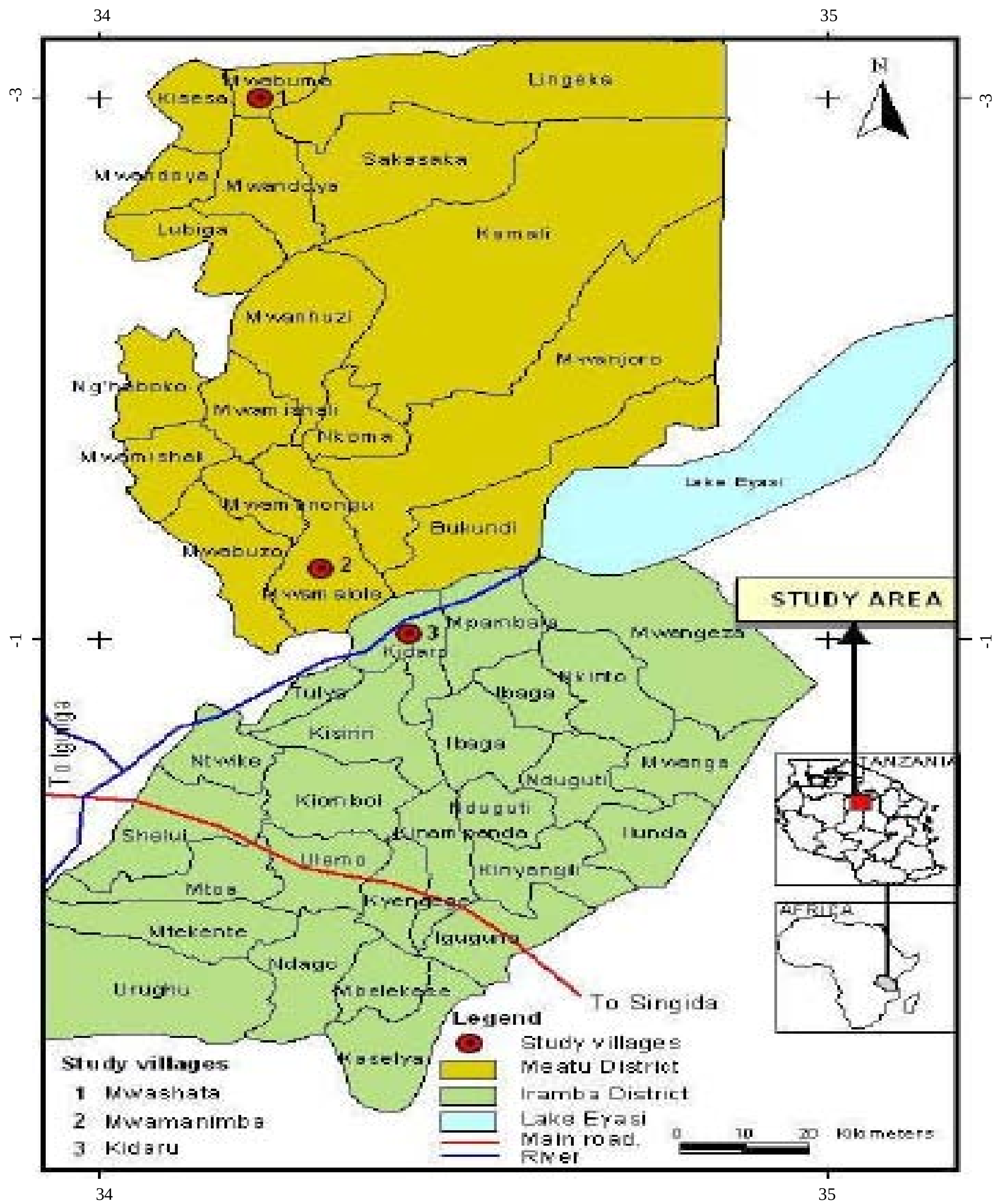

Fig. 1: Map of Tanzania showing study villages

definition of vulnerability given by McCarthy and IPCC (2001) vulnerability in this manuscript is taken to be a function of exposure, sensitivity and adaptive capacity. Generally, Exposure refers to the nature and degree to which a system is exposed to significant climatic variations. Sensitivity is the degree to which a system is affected, either adversely or beneficially by climate-related stimuli (Ford *et al*., 2006). Adaptive capacity is the ability of a system to adjust to climate change including climate variability and extremes to moderate the potential damage from it to take advantage of its opportunities or to cope with its consequences (Cutter *et al*., 2008). Selection of indicators for adaptive capacity is based on the DFID sustainable livelihoods framework whereby adaptive capacity is taken to be a function of asset possession by the households (Jakobsen, 2013; Nelson *et al*., 2010). The selected indicators for exposure, sensitivity and adaptive capacity are in Table 1.

Table 1: Indicators for the function of vulnerability

Indicators	Description of the indicators	Unit	Expected sign
Exposure			
Extreme climate events	Frequency of climate related natural disasters (floods, landslides and droughts) over the last 10 years	Number	+
Historical change in climate variables	Perceived change on temperature and rainfall	Index	+
Sensitivity			
Damage to properties	Effect of climate change on accommodation	1-Yes, 0-No	+
	Effect of climate change on soil fertility	1-Yes, 0-No	+
	Effect climate on conservation of forest	1-Yes, 0-No	+
Income structure	Share of natural resource based income (agriculture and livestock) to total income	%	+
	Share of non-natural based remunerative income (salaried job, remittance, skilled non-farm job) to total income	%	+
Adaptive capacity			
Physical	Distance to market	(1-above 1 h,2-1 h, 3-16-30 min,4-1-15 min)	+
	Type of house	(1-mad and grass,2-mad and cow dung, 3-bricks and corrugated iron sheets,4-bricks and grass,5-blocks and corrugated iron sheets	+
	Land owned	In acres	+
	Access to information	(0 = No, 1 = Yes)	+
	Distance to water source	(6-Below 1 km,5-1 km,4-2 km,3-3 km, 4-4 km, 5-5 km and 6>65 km)	+
	Availability of water	1-Almost never we have sufficient water, 2-We have sufficient water 3 month in the year, 3-We have sufficient water 6 month in the year, 4-We have sufficient water all year round, We have plenty of water all year round	+
Human asset	Highest qualification	Number of years in schooling	+
	Entrepreneurship skills	(5-highest,4-higher, 3-high, 2-low, 1-lowest	+
	Dependency ratio	-	+
Financial asset	Household annual income	Tshs	+
	Livelihood diversification	Number of IGAs	+
	Livestock	Total value	+
Social asset	Membership to associations	(0 = No, 1 = Yes)	+

Data analysis: The chosen indicators were normalized so as to bring the values of the indicators within the comparable range (Gbetibouo and Ringler, 2009; Vincent, 2004). Normalization was done by subtracting the mean from the observed value and dividing by the standard deviation for each indicator. The next step were assigning of weight by Principal Component Analysis (PCA) following Filmer and Pritchett (2001). This was preferred compared to the assignment of equal weight methods (Gbetibouo and Ringler, 2009; Cutter *et al*., 2003). PCA was run for the selected indicators of exposure, sensitivity and adaptive capacity separately in data analysis and Statistical Package for Social Science (SPSS) Software for assigning the weights. The loadings from the first component of PCA are used as the weights for the indicators. The weights assigned for each indicator varies between-1 and +1, sign of the indicators denoting the direction of relationship with other indicators used to construct the respective index. The normalized variables were then multiplied with the assigned weights to construct the indices (for exposure, sensitivity and adaptive capacity separately) using the following equation:

$$I_j = \sum_{i=1}^{k} b_i \left[\frac{a_{ji} - x_i}{s_i} \right]$$

Where:

I = The respective index value
b = The loadings from the first component from PCA (PCA1) taken as weights for respective indicators
a = The indicator value
x = The mean indicator value and
s = The standard deviation of the indicators

Finally, vulnerability index for each household is calculated as:

$$V = E + S\text{-}AC$$

Where:

V = The vulnerability index
E = The exposure index
S = The sensitivity index
AC = The adaptive capacity index for respective household

The overall vulnerability index facilitates household comparison within the districts. Statistical package for social sciences was used for data analysis. It was expected that households with vulnerability index zero or less than zero means that it is least vulnerable, the index range from 12-6. It was further categorized as <2 low, 3-4 moderate, 4-6 high vulnerable. Both qualitative and quantitative statistical methods were used for data analysis. Quantitative method included descriptive statistics such as frequency and percentages which were used to determine the frequency of impact of climate change by the households. Qualitative data was analyzed through content analysis.

RESULTS AND DISCUSSION

Socio-economic characteristics of household heads: An overview of the socio-economic characteristics of household heads is presented in Table 2. The results show that about a two thirds (64.5%) of the household heads were males while about a third (35.5%) of them were females which mean that majority of the household are headed by males. Furthermore, the results show that more than half of both male and female headed household have low vulnerability (72.9 and 78.9% for male and female headed households, respectively). The age of household heads ranged from 31-76 years with the majority having 41-60 years of age. This implies that people at the age between 40-60 years are more involved in farming. The majority (85.2%) of the farmers are married while 9.3% of them are unmarried. This indicates that there are more married individual farmers in Meatu and Iramba, these have responsibility and are expected to meet the needs of their families. It was also found that majority (80.9%) of household heads had primary school education. The finding that the majority of household heads had primary education is not surprising because primary education is a basic right for every citizen in Tanzania (Sabates *et al*., 2012). Furthermore, the results show that more than one third (33.3%) of household with >70 year had a high vulnerability to the impact of climate change.

Furthermore, more than half (60.7%) of the farmers own <3 acres (<1 ha) while only 36.1% of all household heads own >4 acres of land. This implies that majority of the household heads are small scale who do not have enough land to cultivate on and produce food for both human and livestock consumption. Table 2 also shows that more than one third (37.2%) of the household heads maintain a family (household) of >5 people, 29.0% have 1-2 household members.

Weights for indicators of vulnerability: The weights obtained from the PCA analysis is given in Table 3 for the indicators of exposure and sensitivity, respectively. The weights for the indicators of exposure are all positive. This shows that the perceived change on temperature and

Table 2: Socio-economic characteristics of household heads (n = 183)

	Household vulnerability							
	Low		Medium		High		Total	
Variable	n	%	n	%	n	%	n	%
Sex								
Male	86	72.9	13	11.0	19	16.1	118	64.5
Female	51	78.5	8	12.3	6	9.20	65	35.5
Age (years)								
31-40	33	63.5	12	23.1	7	13.5	52	28.4
41-50	56	88.9	4	6.30	3	4.80	63	34.4
51-60	27	79.4	3	8.80	4	11.8	34	18.6
61-70	12	63.2	1	5.30	6	31.6	19	10.4
Above 70	9	60.0	1	6.70	5	33.3	15	8.20
Marital status								
Unmarried	11	64.7	3	17.6	3	17.6	17	9.30
Married	120	76.9	17	10.9	19	12.2	156	85.2
Divorced	5	71.4	0	0.00	2	28.6	7	3.80
Widow/er	1	33.3	1	33.3	1	33.3	3	1.60
Education level								
No formal education	10	52.6	1	5.30	8	42.1	19	10.4
Primary education	113	76.4	19	12.8	16	10.8	148	80.9
Secondary education	8	80.0	1	10.0	1	10.0	10	5.50
Post 2nd dary education	6	100.0	0	0.00	0	0.00	6	3.30
Farm size (acres)								
1-2	84	75.7	11	9.90	16	14.4	111	60.7
3-4	5	83.3	0	0.00	1	16.7	6	3.30
>4	48	72.7	10	15.2	8	12.1	66	36.1
Household size								
1-2	37	69.8	7	13.2	9	17.0	53	29.0
3-5	52	83.9	7	11.3	3	4.80	62	33.9
>5	48	70.6	7	10.3	13	19.1	68	37.2

Table 3: Weights obtained from PCA analysis for the indicators of vulnerability

Indicator	Weight
Exposure	
Change on temperature	0.705
Change on rainfall	0.615
Occurrence of drought	0.816
Sensitivity	
Effect of climate change on accommodation	0.610
Effect of climate change on soil fertility	0.545
Effect climate on conservation of forest	0.605
Share of natural resources based income	0.804
Share of non natural recourse based income	-0.805
Adaptive capacity	
Access to information	0.772
Involvement on various income generating activities	0.767
Livestock activities	0.023
Income	0.650
Distance to water sources	-0.015
Availability of water	0.088
Distance to market	-0.344
Type of house	0.161
Education of the head of household	0.200
Size of land	0.030
Membership on associations	0.088
Dependency	-0.050
Entrepreneurial skills	0.188

rainfall trend and number of natural disasters contribute positively to the exposure index. As revealed by the absolute value of the weights. Generally, occurrence of natural disaster such as drought contributes more to the exposure index compared to other indicators. This is supported by the results in the focus group discussions in participants reported that nowadays they cultivate large land with very low produce compared to the past. The indicators of sensitivity are as hypothesized contributing to the sensitivity index in the right direction as expected (Table 1). Among the weights for sensitivity indicators, livelihood impacts due to natural disasters are seen to have a more overall to the sensitivity index compared to the income structure. Share of non natural resources based income assist to decrease the overall household sensitivity (as shown by negative sign of the weight) while higher share of natural resource based income makes the household more sensitive to climate change.

It was found that information devices have the highest influence followed by Involvement on various income generating activities and annual income of the household heads. Walking distance to the nearest water source and walking distance to the nearest market negatively impacts the adaptive capacity as hypothesized. Moreover, dependency ratio decreases the adaptive capacity as shown by the negative sign of the weight.

Indicators for the physical assets are type of house, ownership of devices to access information (mobile phone and radio) walking distance to the nearest market and water. Out of these all have low weight to adaptive capacity. Possession of better quality house is expected to improve the capacity to withstand the risks from extreme climate events (Piya *et al*., 2012, Nelson *et al*., 2010). Ownership of mobile phones and radios will increase the adaptive capacity through access to weather related information. Better access to information enables a household in planning proactive adaptation measures against climate risks. Walking distance to markets will be in a disadvantageous position for lacking the opportunity of income generation from alternative sources like non-farm labor which help in securing livelihoods during the periods of food shortage or crop failure (Piya *et al*., 2012; Ford *et al*., 2006).

Human asset is represented by highest qualification in the family; entrepreneurial skills; and dependency ratio. These indicators are not directly related to climate change; however they are still relevant because development of human capabilities through various trainings or formal education enable households to increase their income by undertaking skilled non-farm activities which are less climate-sensitive compared to farming and gathering (Piya *et al*., 2012; Jakobsen, 2013). Doing the above enables the households to avert climate risks. Furthermore, it diversifies household livelihood sources which help to buffer the risks posed by climate on farm income. Households with higher dependency ratio will have more burdens on the earning members thereby reducing the adaptive capacity (Piya *et al*., 2012). The implication of dependency ratio is common to any types of shocks including those imposed by the impacts of climate change.

Table 4: Mean values for indicators of vulnerability (n = 183)

Indicators	Districts	Mean values	t-values	df	p-values
Exposure index	Iramba	0.2612	2.760	181	0.001
	Meatu	-0.1595	-	-	-
Sensitivity index	Iramba	0.0573	0.191	181	0.844
	Meatu	-0.0252	-	-	-
Adaptive capacity	Iramba	-0.0416	-0.183	181	0.855
	Meatu	0.0117	-	-	-
Vulnerability index	Iramba	0.0496	0.919	181	0.359
	Meatu	-0.4972	-	-	-

Natural assets which include land owned by the household heads have the least weight which is quite relevant given the fact that natural resources are more impacted upon by climate change and related disasters compared to the other asset types (Piya *et al*., 2012). Thus, improving the adaptive capacity against climate extremities requires diversification to livelihoods that are less dependent on natural resources.

Financial assets and human assets are the two most important determinants of overall adaptive capacity followed by social and physical assets. This is observation conform to the previous study by Nelson *et al*. (2010). Financial asset is important as it is the most convenient form of asset that can be converted into other forms of asset when needed (Hoff *et al*., 2005; Hammill *et al*., 2008). It also pulls together other forms of capital assets (human capital, natural capital, social capital) needed for a successful livelihood strategy in climate high risk areas of developing countries. Walking distance to the nearest market and water source negatively impacts the adaptive capacity as hypothesized while an annual income have positive impact on the adaptive capacity. This is due to fact that majority of the respondents travel long distance to access to water and market for selling their produce.

Household vulnerability: The average index values for the two study districts are presented in Table 4. A district with the higher value of vulnerability index suggests that it is more vulnerable; however negative value of vulnerability index does not mean that the district is not vulnerable at all; it just means that the district is comparatively less vulnerable. According to the value of the vulnerability index, Iramba is the most vulnerable district while Meatu is the least vulnerable. However, the difference is not statistically significant. For the case of

Table 5: The Impacts of climate change induced shocks (n = 183)

Variables	Frequency	Percent
Loss of life	7	3.80
Disruption of roads	35	19.1
Loss of houses	29	15.8
Loss of animals	84	45.9
Decline of crop production	28	15.3

exposure, the results show that Iramba is highly vulnerable as compared to Meatu, the difference is significant (p = 0.001). This could be attributed to the fact that Iramba is highly affected by floods. During the focus group discussion participants from Iramba said that floods in their area minimize their adaptive capacity due to reasons that they have no way to control them. Higher sensitivity and lower adaptive capacity in Iramba result in higher vulnerability as compared to Meatu. Low adaptive capacity in Iramba implies that the livelihood impacts of sudden extreme climatic events will be quite high in this district. This fact is shown in Table 4, where the livelihood impacts of extreme climatic events on livelihood is highest in Iramba (thereby having the highest sensitivity index). This is because Iramba faced a number of floods in Kidaru village. This implies that there are higher destructions of crops and pasture for livestock.

Impacts of climate change induced shocks: In the study area, household heads mentioned various impacts of climate change induced shocks among farming households. These impacts included the loss of lives, disruption of roads, loss of houses, loss of animals and decline of crop production. About 45.9% of household heads mentioned the loss of animals. While only 3.8% indicated that they had relatives who lost their lives due to climate induced shocks. Results are presented in Table 5.

Overall, climate change could make it more difficult to grow crops and raise animals in the same ways and in places as it was done in the past. Changes in the frequency and severity of droughts and floods could pose challenges to both crop production and livestock keeping (Adams *et al*., 1998). According to Gerald (2009) the impacts of climate change on agriculture and human well-being can be divided into 3 categories, namely, the biological effects on crop yields; the resulting impacts on outcomes including prices, production and consumption; the impacts on per capita calorie consumption and child malnutrition. Generally, biophysical effects of climate change on agriculture induce changes in production and prices which play out through the economic system as farmers and other market participants adjust autonomously, altering crop mix, input use, production, food demand, food consumption and trade (Gerald, 2009).

As regards to decline in crop production, Kabote *et al*. (2013) noted that due to climate change variability, farmers in Iramba and Meatu Districts have frequently experienced crop failure and provision of food aid by the government for the people to overcome hunger. In addition, the climate change can increase the prevalence of parasites and diseases that affect livestock (Brooks and Hoberg, 2007). Generally, the increase in rainfall could allow moisture-reliant pathogens to thrive. While an increase of temperature could allow some parasite and pathogens to survive more easily. On the contrary, drought may threaten pasture and feed supplies, restricted livestock mobility, water shortage and conflict over natural resource use. Drought reduces amount of plants available to grazing livestock (Chauhan and Ghosh, 2014). In some areas of Iramba and Meatu Districts livestock keepers experienced longer and intense droughts as a result of high temperatures and reduced precipitation (Kangalawe and Lyimo, 2013).

CONCLUSION

Based on the results it can be concluded that vulnerability of the farming households in the study area is low. Involvement of the household on non-farm income generating activities and unreliable rainfall were the most important determinants of a household's vulnerability. Biophysical elements determine the exposure like temperature, rainfall and natural disasters. Also, the sensitivity as well as the adaptive factors such as physical, financial, social and human assets influences the adaptation on vulnerability of the local people. The study shows that occurrence of drought and floods contribute positively to the household vulnerability to the impact of climate change. In addition, the impact of climate change on the study areas included the loss of lives, disruption of roads, damage to houses, loss of animals and decline of crop production.

RECOMMENDATIONS

It can be recommended that to improve the adaptive capacity of farming households and reducing vulnerability there is a need to improve adaptive indicators such as improving the irrigation facilities in the local area. Similarly, creating opportunities for non-farm income to reduce the extensive dependence of the community on natural resource based livelihoods.

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