Farmers Resilience to Climate Change in Meatu and Iramba District, Tanzania

James A. Nyangas[1], and Emmanuel E. Chingonikaya[2]

[1]Department of Education, Sokoine University of Agriculture (SUA), P. O. Box 3038, Morogoro, Tanzania.

[2]Department of Development Studies, Sokoine University of Agriculture (SUA), P. O. Box 3024, Morogoro, Tanzania.

Abstract

This paper analyzed household resilience due to climate change in Iramba and Meatu districts. A cross-sectional design was used. Data were collected from 183 households in three villages, two from Meatu and one from Iramba district. The quantitative data were coded on SPSS. Inter-district analysis of the resilience index indicated that there was no significant difference of household resilience on the districts. The study shows that most of households have low to moderate resilience. The resilience of farmers is significantly impacted by their sex, education, type of occupation and household income. Resilience significantly increases with increase in the annual income which acts as safety net to absorb shocks as well as increase resources and inputs availability. The study concludes that resilience of the farmers in the study area is low; and education and household income of a local community on climate change are the most determinants of household resilience. Thus, the study recommends improving ability of the household to absorb shocks by increasing their adaptation capacity, such as constructing irrigation infrastructures and creating opportunities for diversification of income source from non-farm income.

Key words: Resilience; Farmers; Climate change; Households; Iramba; Meatu

1. INTRODUCTION

Resilience to climate change has become an important issue in international and domestic discussions on climate change. The concept of resilience is a complex and multi-interpretable which has contested definitions and relevance (Jordan, 2009). Resilience in general sense means the system's ability to deal with stresses and disturbances and also maintaining its basic structure and ways of functioning, capacity for self-organisation, and capacity to learn and adapt to change (Speranza, 2010). So, resilience is about managing the changes and adapting to the test of current and future climate risks (Speranza, 2010). According to the Fourth Assessment Report of IPCC (Baede*, et al*, 2007), resilience is defined as "ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change".

Further, Adger (2000) differentiates between social and ecological resilience. The social resilience result due to social, political and environmental changes and it is the ability of groups or communities to cope with external stresses and disturbances. While ecological resilience is the characteristic of ecosystems to maintain themselves in the face of disturbance (Adger, 2000). According to the Resilience Alliance (2002), resilience has three distinct characteristics, which are the system's capacity to undergo change and still be in the same state, capability of self-organization and ability to build and increase capacity of learning and adaptation. Further, resilience can be viewed as layered concept which ranges from individual to household, community, ethnic group and global level (Jordan, 2009).

Farming households face dynamics and disturbances in their farms induced by climatic shocks (Milestad and Darnhofer, 2003). In order to sustain agricultural production farmers need the ability to cope with, adapt to and shape change (Folke *et al.,* 2003). Some studies have shown that some societies in Tanzania are already coping with the effects of climate change in agriculture (Shayo, 2006). But due to the dynamic nature of climate change not all climatic threats or disasters can be averted. Thus, resilience theory may be used as a powerful tool in the sustainability discourse (Holling, 1973). The resilience of the community or household will increase its adaptation potential and will help to lessen the impact from climate change. Also, the communities or households that are resilient are less vulnerable to the climate change, i.e., they are less prone to suffer the same magnitude as the non-resilient groups from the climate change (Speranza, 2010).

This paper analyses household resilience with the view of contributing knowledge on the impact of climate change on households' resilience in Iramba and Meat districts. Some of semi-arid areas located in central part of Tanzania. The specific objectives were (i) to determine level of household resilience (ii) to find the determinants of households' resilience (iii) to compare household resilience among the two districts. The following sections explain the study area, sources of data presentation of the results and discussion and finally the paper provides conclusions and recommendations.

2. METHODOLOGY

2.1 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 farmers' 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 Shimiyu Region. The district covers 8 871 Sq. km (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 is semi arid with seven to eight months of dry season, lasting from late April to early November. The mean annual rainfall ranges from 600mm to 800mm 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 two minor seasonal peaks in December and March to April (Otysina and Asenga, 1993). Precipitation, which occurs in brief storms, is lost through quick surface runoff and high evapotranspiration rates. Dry-season precipitation extends between May and November with

less than 50mm per year, whereas, monthly evaporation rate exceeds the monthly rainfall almost every month (Ministry of Tourism, Natural Resources and Environment, 1995).

2.2 Research Design

A cross-sectional research design was used to determine the farmers' resilience to climate change. This design allows data to be collected at a single point in time (Levin, 2006). The design can also be used in descriptive studies and determination of relationships between variables (Varkevisser *et al*., 2003). The design was considered favorable to the nature of this study.

2.3 Data collection

The study employed both qualitative and quantitative research approaches to investigate farmer's resilience to climate change. The three key qualitative data collection approaches for this study included field observations, in-depth interviews with key informants and focus group discussions (FGDs). Two FGDs were carried out in each village, each covering a range of social classes and gender.

2.4 Sampling procedure

Multistage sampling was adopted for this study, whereby, purposive sampling was used to select the regions, districts, wards and villages and random sampling was used to obtain sample households. The sampling unit for this study involved the list of all households participating in agricultural production in Iramba and Meatu Districts. These study sites were selected purposively in areas which frequently experienced crop failure and have received food aid from the government (Kabote *et al.,* 2013). The criterion for inclusion in the sample was participation in farming and pastoralism. The sample was drawn from two districts namely, Iramba district and Meatu district. One village was selected from Iramba district, namely Kidaru village and two villages, namely Mwashata and Mwamanimba were chosen from Meatu district. Fifteen percent (15%) of the total number of households in each village was used to determine the sample size. Thus, 183 households were randomly drawn from the population from the three villages to form the sample size.

2.5 Measuring resilience

Resilience and vulnerability is interlined with each other and can be embedded in one another. This means ones component can be embedded into another. According to IPCC Fourth Assessment Report (2001), vulnerability may be formulated as:

Vulnerability = Exposure + Sensitivity – Adaptive Capacity

In this study adaptation practices adopted by the farmers are taken as the ability to absorb shocks which they have been practicing for long period. Further, vulnerability to climate change will cover the aspect of self-organization and adaptive capacity. Hence resilience is measured as:

Resilience Index = Ability to absorb shocks – Vulnerability

The absorption of shock is taken as function of adaptation capacity. The adaptation can be expressed as an index, which implies how the households are adapting to the current changes after they have absorbed the shocks of natural hazards. Adaptation index can be expressed as:

$$Aj = w1j\ p1j + \ldots + wnj\ pnj$$

Where w1 = weighting factor of adaptation practice 1 (from PCA), p1j = j*th* household's value for practice 1 (value of 0 or 1).

The resilience index values ranged from -6 to 11. It was further categorized into five categories of resilience which as very low resilience, low resilience, moderate, high resilience and very high resilience as follows Less than -5 very low resilience, -4 to -3 low resilience, -2 to 2 moderate, 3 to 3 high resilience and more than 4 very high resilience.

2.6 Data analysis

Quantitative data were coded on statistical package for social science (SPSS). Household resilience was classified into five categories based on their resilience as: Very low resilience, Low resilience, Moderate, High and Very high resilience. Descriptive statistics such as frequency and percentages were employed while inferential statistics including t-test was used to test significance difference on the households' resilience among the two districts and multiple regression analysis was used to identify the determinants of households 'resilience to climate change.

$$Yj = \alpha + 1Xij + \ldots\ldots\ldots + kXkj + Uj$$

Where, Yj is the household resilience index, Xij are the explanatory variables for resilience while are the coefficient of the explanatory variables and α is the constant and Uj error.

Before running the regression model, the Collinearity/multicollinearity diagnostics test was done in order to detect whether there is a correlation among the independent (X_i) variables. According to Pallant (2011), the multicollinearity problem is described by the presence of linear or near linear relationship among explanatory variables. Testing of the model on multicollinearity was done by using tolerance and Variance Inflation Factor (VIF) test which builds in regression of each independent variable. Pallant (2011) suggests that a tolerance value less than 0.10 and a VIF above 10 indicates multicollinearity. Table 1 shows that there were no variables had VIF >10. This observation confirms that there ware no violation of the multicollinearity assumption in this current study.

Table 1: VIF on the determination of Resilient

Variables	Collinearity Statistics	
	Tolerance	VIF
Age of respondent	.881	1.135
Sex of respondent	.887	1.128
Level of education	.690	1.450
Marital status	.840	1.190
Number of household members	.885	1.130
Type of farming	.486	2.059
Distance from home to market	.473	2.114
Distance to source of water	.384	2.605
Farm size	.655	1.526
Type of occupation	.745	1.343
Distance from house to farm	.770	1.299
Annual income	.866	1.155
Farm size	.854	1.171
Distance from farm to market	.366	2.729

In addition, Durbin-Watson's d tests were used to test for autocorrelations. The results found that the Durbin-Watson's is 2.1 which fall within the rule of thumb values of $1.5 < d < 2.5$ (Kutner *et al,* 2005). Hence there is no auto-correlation in the multiple linear regression data.

3.0 RESULTS AND DISCUSSION

3.1 Household Resilience

Analysis shows that only 21.9% of households had very high resilience while around 12.0% had very low resilience to climate change (Table 2). Most of the households (54.6%) belong to the group of low resilience to moderate resilience. In addition to this, households in the study area also stated that they had been able to cope with small scale natural hazards, but with recent increase in natural hazards, they are not able to manage them properly. This shows that climate changes have added additional challenges, increasing their vulnerability while reducing their resilience.

Table 2: Household resilience (n = 183)

Resilience category	Frequency	Proportion (%)
Very low resilience	22	12.0
Low resilience	54	29.5
Moderate	46	25.1
High resilience	21	11.5
Very High resilience	40	21.9
Total	183	100.0

3.2 Determinants of Resilience

The analysis used the multiple regression analysis to find the determinants of resilience. From the analysis it was found that sex of the head of household, education level, type of occupation and household income significantly increased the resilience. Results (Table 3) reveal that the multiple regression correlation coefficients (R) were 0.710. This means that the independent variables which were used in the regression model collectively were highly associated with the dependent variable. Equally, the coefficient of determination (R^2) was 0.504 implying that the model was able to explain 50.4% variation in the dependent variable (resilient).

Table 3: Determinants of Household Resilience

Variables (n = 183)	Unstandardised Coeffi-cients		Standardised Coefficients		
	B	Std. Error	Beta	T	Sig.
(Constant)	-10.913	2.962		-3.684	.000
Age of respondent	-.310	.209	-.096	-1.483	.140
Sex of respondent	-1.526	.534	.184	2.858	.005
Level of education	1.326	.447	.217	2.967	.003
Marital status	-.314	.497	-.042	-.633	.528
Number of household members	-.151	.122	-.080	-1.241	.216
Type of farming	-.071	.733	-.008	-.097	.923
Distance from home to market	.597	.425	.124	1.404	.162
Distance to source of water	.576	.294	.192	1.958	.052
Farm size	.119	.187	.048	.636	.526
Type of occupation of the household head	1.596	.559	.201	2.852	.005
Distance from house to farm	.244	.358	.047	.682	.496
Annual income	1.176	.194	.396	6.070	.000
Farm size	.032	.061	.035	.534	.594
Distance from farm to market	.513	.292	.177	1.760	.080

$R=0.710$, $R^2= 0.504$, $p=.0.000$

Sex of the head of household had negative contribution (-1.52, p = 0.005) to household resilience. This implies those female headed households were less resilience than their counterparts. This could cause by the lack of access to extension services and early warning information to the households headed by females which would

enable them to make informed decisions. In times of climate stresses and shocks like drought, these categories of households tend to have fewer options to find other ways of making a living, because their very low levels of literacy reduce their opportunities in coping mechanisms such as wage employment. Similarly, female household heads are likely not to be empowered enough in pastoral communities to make household decisions (Nabikolo *et al*., 2012) and are frequently without access to credit services and adequate capital assets or not able to own large herds to manage households' daily requirements. Similar observations have been made by Kakota *et al*. (2011) in Malawi and Tesso *et al*., (2012) in Ethiopia that female household heads are more vulnerable because low ability to adapt to the impact of climate change.

Education of the head of household had positive significant contribution to the household's resilience. This implies that the household headed by person with high education had high resilience to the impact of climate change. This is similar to the study by Piya *et al*., (2012) which found that respondents attaining various trainings or formal education are able to increase their income by undertaking skilled non-farm activities, which are less climate-sensitive compared to farming and grazing, thereby helping the households to avert climate risks and hence increase their household resilience to the impact of climate change.

The study found that type of occupation performed by the head of the household had significant influence on the household resilience to the impact of climate change. It was found that major occupation of the respondents were farming, performing small business and employment. Positive value implies that respondents who were full engaged on agricultural activities were less resilience than other categories of occupation. This is because farming have direct effect with impact of climate change thus respondents performing other occupation than farming enable households to increase their income from the less climate-sensitive compared to farming and gathering, thereby helping the households to avert climate risks (Piya *et al*., 2012). Furthermore, it enables diversifying household livelihood sources which help to buffer the risks posed by climate on farm income.

Furthermore, the study found that age, marital status, household size, distance to farm and market, distance to water source and farmer size were not significant. This is contrary to previous studies by Eriksen *et al*., (2005) and Notenbaert *et al*. (2013) which found some of these were the determinants of households' resilience. The reason for this variation could probably be explained that the significance of human capital to resilience does not only consist of household size, age, marital status or the quantity of man power, but also education level of household members and dependency ratio (Rayner and Malone, 2000).

3.3 Household Resilience among the Selected Districts

The average index values for the two study districts are presented in table 4. District with higher value of resilience index is more resilient on the impact of the climate change while one with low index value is less resilient on the impact of climate change.

Table 4: Mean values for resilience (n = 183)

District	Mean values	T	Df	P value
Iramba	0.48	2.76	181	0.746
Meatu	0.68			

According to the value of the resilience index, Iramba is the less resilient district while Meatu is the least resilient. However, the difference is not significance (P>0.05). The less resilient of the people in Iramba could be attributed by the fact that it is highly affected by floods. During the focus group discussion respondents said that floods in their area minimize their adaptive capacity due to reason that they have no way to control them.

4.0 CONCLUSION AND RECOMMENDATIONS

Resilience mainly depends on the socio-economic condition and also on the geographic location. The study shows that most of households have low to moderate resilience. The resilience is significantly impacted by their sex, education, type of occupation and household income. Resilience significantly increases with increase in the annual income which acts as safety net to absorb shocks as well as increase resources and inputs availability.

Thus, the study recommends improving ability of the households to absorb shocks by increasing their adaptation capacity by constructing small irrigation facilities which will enable them to decreases the sensitivity of crops to droughts and creating opportunities for diversification of income sources from non-farm income.

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