INTERNATIONAL JOURNAL OF RESEARCH & METHODOLOGY IN SOCIAL SCIENCE
VOL. 2, NO. 1 | JAN – MAR, 2016 | QUARTERLY JOURNAL | ISSN 2415-0371

Scientia, Fortitudo & Victoria

QUATERLY JOURNAL
ISSN 2415-0371

Vol. 2 No. 1

Peer
Reviewed
Scientific Journal
in Social Science

Free Access
Email: EditorIJRMSS@gmail.com

ISSN 2415-0371
9 772415 037100

IJRMSS

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www.socialsciencepublication.com

International Journal of Research & Methodology in Social Science
Vol. 2, No. 1, p.19 (January – March, 2016). ISSN 2415-0371
www.socialsciencepublication.com

Smallholder Farmers' Levels of Adaptive Capacity to Climate Change and Variability in Manyoni District, Tanzania

Andrew Omari Shirima[1],
Christopher Mahonge[2],
& Emmanuel Chingonikaya[3]

ABSTRACT

Smallholder farming households in developing countries are most vulnerable to climate change and variability as their livelihoods are climate-sensitive and they lack resources to invest on adaptation measures. To formulate appropriate measures to address this susceptibility, it is essential to understand smallholder farmers' adaptive capacity. This study assessed the adaptive capacity to climate change of farming households in Manyoni District. The specific objectives were: to determine the levels of adaptive capacity of farming households to climate change and assess the impacts of households' socio-demographic characteristics on adaptive capacity levels. A random sampling technique was adopted to obtain 240 households and data were collected using questionnaire and FGDs. Both descriptive and inferential statistical analyses were done using SPSS and excel. Ordinal logistic regression was adopted to determine influences of households' socio-demographic characteristics on adaptive capacity. Majority had low adaptive capacity with financial resources ranking the highest in the resources that were required for adaptive capacity. Household size was the strongest predictor of adaptive capacity levels whereas age of the household head had a negative influence on adaptive capacity. Also majority belonged to low adaptive capacity levels. The study recommends strengthening of household farming labour for a more adaptive capacity through sensitization and strengthening farming subsidies. It also recommends creation of a more conducive financial access such as affordable credit conditions that will facilitate access to finances so as to sustain the adaptive capacities of the smallholder households under climate change variability.

Key words: Smallholder farmers, climate change, adaptive capacity.

CITATION:
Andrew Omari Shirima, Christopher Mahonge & Emmanuel Chingonikaya (2016). "Smallholder Farmers' Levels of Adaptive Capacity to Climate Change and ariability in Manyoni District, Tanzania ." *Inter. J. Res. Methodol. Soc. Sci.,* vol. 2, no. 1 (Jan - Mar. 2016); pp. 19-29. ISSN 2415-0371.

1. INTRODUCTION

Agriculture is one of the sectors most vulnerable to climate change in Africa (Falaki *et al.,* 2012). Manifestations of the changing climate are being observed in the trend of increasing temperature, decreasing and variability in rainfall as well as extreme

1 ★Department of Community Development, University of Iringa. For email correspondence: andhansom@gmail.com
2 Centre for Sustainable Rural Development, Sokoine University of Agriculture
3 Development Studies Institute, Sokoine University of Agriculture

weather events. The Intergovernmental Panel on Climate Change (IPCC) fourth assessment report indicated that smallholder and subsistent farmers, pastoralists and artisan fisher folk will suffer complex, localized impacts of climate change (Boko *et al*., 2007).

Morlai *et al.* (2011) argue that countries in Africa are faced with high negative impacts of climate change as a result of low adaptive capacity of their growing population. Nyong (2005) asserts that farmers in Sub-Saharan African countries, Tanzania being one of them, are vulnerable to climate change because they lack the capacity to adapt. According to Yanda and Mubaya (2011), the impacts of climate change will severely damage social and economic systems of most developing countries. Vulnerability of smallholder farming to climate change and variability is caused by the intrinsic climate and weather-sensitivity of agricultural livelihoods and over-reliance on rain for the sustenance of farming coupled with low adaptive capacities.

According to IPCC (2001), adaptive capacity is the ability of farmers to adjust to climate change, to lessen potential damages, and to take advantage of opportunities or to cope with consequences. It is the sum of assets (tangible and intangible) such as financial, natural and human assets that a system has and the diversity of livelihood a system is endowed with. Assessing the adaptive capacity of smallholder farming systems therefore goes beyond an appraisal of their physical asset base.

Local adaptive capacity does not only depend on what a system has to enable climate change adaptation, but also on what it does and how it does it (Jones *et al.*, 2010). Researchers have demonstrated that many of the impacts of climate change as well as the determinants of people's ability to adapt are the outcomes of social processes (Jones and Boyd, 2011). Other studies, for example, Cooper *et al.* (2008) measured adaptive capacities of farmers by considering types of livelihood assets, namely social, human, physical and financial capital. The more varied the asset base, the greater is people's adaptive capacity and the level of security and sustainability of their future livelihoods. Along that line, Adger *et al.* (2007) and Ziervogel *et al.* (2006) assert that local-level adaptive capacity is context-specific and that adaptive capacity is also highly heterogeneous within a society or a locality.

A number of studies have been conducted on adaptive capacity to climate change and variability in Tanzania. Goldman and Riosmena (2013) assessed adaptive capacity in Tanzanian Maasai-land focusing on livestock keeping and found that adaptive capacity is unevenly distributed within communities. Ricci (2011) assessed peri-urban livelihood and adaptive capacity in Dar es Salaam. Several other studies such as by Lyimo and Kangalawe (2010) and by Mary and Majule (2009) have been done to asses climate change impacts, vulnerability, and adaptation strategies but with no focus on the levels of adaptive capacity of smallholder farmers under climate change variability. This study therefore aimed at determining the levels of adaptive capacity among smallholder farmers in the context of Manyoni, analysing the weights of adaptive capacity indicators and to determine the impacts of socio-demographic characteristics to adaptive capacity under the climate change variability.

2. DATA AND METHODOLOGY

The study was conducted in Manyoni District in Tanzania which has a surface area of 28,620 square kilometres that is 58% of the entire area of the Singida Region (URT, 2006). The district lies within the semi-arid areas of Tanzania where there are frequent food shortages due to uncertainty of rainfall (URT, 2005). The area has a

unimodal rainfall regime, which lasts from November to April. The mean annual rainfall is 624 mm with a standard deviation of 179 mm. The mean number of rainy days is 49 per year with a standard deviation of 15 days. In general, rainfall in the district is low and not reliable. Temperatures vary with altitude. The annual mean, maximum and minimum monthly temperature in the district is 22˚C, 24.4˚C (November) and 19.3˚C (in June) respectively (Mary and Majule, 2009).

A cross sectional research design was adopted whereby data were collected at a single point in time. The unit of analysis of the study was smallholder farmers. A multistage sampling was used to obtain four wards randomly selected wherein two villages were selected from each ward to make a total of eight villages. Guided by a sampling frame of smallholder farmers from villages' register books, a simple random sampling using a lottery method was used to obtain 30 households from each village. A total sample size of 240 households was therefore obtained for questionnaire survey.

Quantitative data were analysed using the Statistical Package for Social Sciences (SPSS) and Microsoft Excel. Adaptive capacity indicators (human, social, natural, financial capital and diversified IGAs) were assigned points, and all the points were summed up to get the overall scores on adaptive capacity. The overall score ranged from 4 to 15. This measure was then categorised into three categories after computing the mean scores (7.737), median (8), minimum (4) and maximum (15) scores. In view of this, the categories were low adaptive capacity (4-7), moderate adaptive capacity (8) and high adaptive capacity (9-15). The cut off points were chosen by using the computed median which was 8. To analyse the weights of adaptive capacity resources, all resources sub-indicators were given points that were summed up to compute to obtain the total score for all the resources and average scores for each resource. The mean percent of each resource was obtained by dividing the average score by the total scores of all the resources times a hundred.

The ordinal logistic regression was adopted to assess the impact of socio-demographic factors of the smallholder farmers on their adaptive capacity levels. The dependent variable (Y) was categorised into three levels namely low, moderate and high based on individual scores of adaptive capacity. The independent variables included socio-demographic variables as indicated in the ordinal logistic regression model below. The odds ratio in this model were calculated at 95% confidence interval as an estimate of determinants of adaptive capacity levels, and a p value of 0.05 was considered statistically significant. Ordinal logistic regression model was appropriate for this study since the dependent variable had ordered categories namely low, moderate and high. It was also the appropriate model because it estimates the effects of a set of explanatory variables on the dependent variable (Morgan and Teachman, 1988).

The ordinal regression model (Agresti and Finlay, 2009) used in this study was:

$$P(y) = \frac{e^{a} + \beta_1 X_1 + ... + \beta_k X_k}{1 + e^{a} + \beta_1 X_1 + ... + \beta_k X_k} \quad (1)$$

where $P(y)$ = probability of the success alternative occurring; e = natural log; α = the intercept of the equation; $\beta_1 ... \beta_k$ = coefficients of the predictor variables;

and $X_1 ... X_k$ = predictor variables entered in the ordinal regression model. Specifically, in this study: $P(y)$ = the probability of farmers being grouped in the highest level of adaptive capacity; α = the intercept of the equation; $\beta_1 ... \beta_k$ = Regression coefficients; $X_1 ... X_k$ = predictor or independent variables entered in the model, which were:

X_1 = Household head's year(s) of schooling;

X_2 = Total land size owned measured in acres;

X_3 = Land tenure measured by owning or not owning land;

X_4 = Household size measured by number of household members;

X_5 = Age of the household head in years; and

E = Error term representing a proportion of the variance in the dependent variable that was unexplained by the regression equation.

3.0 FINDINGS AND DISCUSSION

This section is comprised of four sub sections. The first subsection deals with socio-demographic characteristics of the respondents wherein respondents' demographic characteristics are described. The second subsection is on the adaptive capacity levels which determines the adaptive capacity levels as high, moderate and low. The third subsection shows the analysis of the weights of adaptive capacity indicators showing as to which is more important relative to others and the fourth sub section shows the influence of households' socio-demographic characteristics on adaptive capacity.

3.1 Socio-demographic characteristics of the respondents

Majority of the smallholder farmers (74.2%) included in the study were male household heads. This is traditionally the case because of the patriarchal culture whereby men are household heads. Under this culture, women become heads when men are not there due to for example, death or where women are single parents. The greatest proportion of the respondents (33.3%) belonged to the 51 and above years whereas 14.6% ranged between 20 and 30 years. Three fifths (60%) of the respondents were married. The rest were single, widowed, or separated. Table 1 further shows that 32.5% of the respondents had household sizes ranging between 5 and 6 members whereas 21.2% had 1 to 2 members and the majority (67.1%) of the respondents had non-formal education. About 87.5% of the respondents were owners of their farms (Table 2) out of whom 62.1% owned one plot. It was also found that 49.2% of the respondents that owned land had plots of less than one hectare.

3.2 Adaptive capacity levels among smallholder farmers

The study intended to determine the levels of adaptive capacity among smallholder farmers in the study area. Since there is no general rule for classifying adaptive capacity levels (Defiesta and Rapera, 2014), cut off points were based on previous studies (such as Eakin *et al.,* 2008 and Gbetibouo, 2010). It was also based on the median that was used as a moderate level. The cut-off point for each level was based on the dispersion of data by setting three intervals based on the median (8). These were namely: low, moderate and high adaptive capacity levels.

Table 1 indicates that 47.5% of the farmers interviewed belonged to low adaptive capacity category, while 40.8% belonged to moderate adaptive capacity category and only 11.7% of the respondents interviewed belonged to the high

adaptive capacity level. This finding is in line with the findings of Bello *et al.* (2013) who reported low adaptive capacity among smallholder farmers in semi-arid areas. The findings imply that majority of smallholder farmers in Manyoni District had a low capacity to climate change effects interventions given their low adaptive capacity. This made them more vulnerable to climate change and variability risks, hence impeding them from adapting. In line with this finding, Eriksen *et al.* (2005) and Paavola (2008) remark that local farmers with low adaptive capacity are more vulnerable to adverse effects of climate change, which contribute to the loss of their natural resources. This is because with low adaptive capacity which in this case is associated with low endowment with resources, smallholder farmers depend solely on the natural resources an option which in turn result into depletion of natural resources the result of which is more vulnerability.

Table 1: Levels of adaptive capacity $n = 240$

Levels	Scores	Frequency	Percent
Low adaptive capacity	4-7	114	47.5
Moderate adaptive capacity	8	98	40.8
High adaptive capacity	9-15	28	11.7
Total		**240**	**100.0**

3.3 Analysis of the weights of adaptive capacity indicators

Based on the analysis of scores of adaptive capacity resources as shown on Appendix 1, the most important indicator for adaptive capacity was financial resource that scored 24.8%. The highest score on the side of financial resource was caused by the fact that climate change adaptation requires monetary expenditures. This view was supported by the participants during focus group discussions. Along with this remark, one respondent in Kipondoda village asserted that:

> "...there is no way we can resist climate change without money. For example the government forces us to grow drought resistant crops, but we cannot afford buying seeds and fertilisers for these kinds of crops."

The forms of financial access that were measured in the study area were savings, access to remittances and credits which were reported to have been realised by the establishment of widespread informal micro credit schemes such as lending groups and revolving funds (locally known as *vicoba*[1]*/and or michezo*[2]) all of which facilitate savings and credits in an informal setup. Financial resource as an indicator of adaptive capacity represents the households' ownership of and access to financial assets. Household's better financial position indicates higher adaptive capacity.

Regarding the access to remittances, 52.5% o of the respondents reported to have been receiving remittances. The average amount of remittances amounted to 45 000 Tanzania Shillings per month obtained from their family members such as

[1] VICOBA is Village Cooperative Bank

[2] Michezo literary means sports but the word is used for rotating savings and credit Associations (ROSCA)

children and spouses working in other areas whereas only 26.2% of the smallholder farmers had access to credit.

The study further found that natural resources ranked the second with mean a percentage of 20.4%. The natural resource that was used in this study was land. The sub-indicators for this resource were land ownership and whether the entire owned land was cultivated. The findings show that 87.5% of the respondents owned land, whereas only 12.5% did not. Ownership of land by the majority of smallholder farmers was through the rural land ownership mode of inheritance whereby land is passed on from one generation to another. This is due to the fact that the majority (82%) of the respondets reported to have inherited land from parents and grandparents. Owning land implies that most households' access to land and ownership of decision to farming practices are within their households' mandate. Farm size is an important attribute that has to be considered along with land ownership as a natural resource. Farm size has an implication to adaptive capacity, all other things being held constant. It was found that, 49.2% of the smallholder farmers owned land of more than 3 acres.

Of all the respondents that owned land, 62.1% reported to have only one plot with only a few owning more than three plots. It was further noted that 49.2% of the respondents that owned land had plots of more than three acres, most (61.7%) of whom estimated that they used an hour to walk to their farmlands from their homesteads. However, it was only 37.1% of all the respondents that cultivated the entire land they owned due to limitation of resouces such as finances to cater for farm inputs and labour to cultivate all the land as it was reported in focus group discussions and key informant interviews.

Social capital ranked the third with a mean of 16.1%. This category was measured using the following sub-indicators namely membership in social groups by smallholder farmers and whether they practiced collective farming within and/or outside their households. On the membership to social groups, the majority (88.8%) of the respondents reported to be members of social groups in their areas. It was noted that most of these groups were informal social groups that ranged from voluntary based groups to those that were based on specific clans. In all cases it was reported in focus group discussions that it is inevitable to be in a group because in times of disasters or ceremonies these groups take a substantial role in assisting the members concerned. On this, a male from Mitundu village remarked that:

> *"…belonging to a group is compulsory, and this is what we teach our young men. If someone does not associate well with others there is a danger that he cannot even be buried upon his death".*

In addition, 88.8% showed that they did farming collectively in their households. This was done at the household level where every household member participated in farming as well as at the community level wherein members from several households organised groups for collective farming. Collective farming was made easier by the fact that 96.2% of the respondents stated that they had relatives within their villages. This finding was also confirmed in focus group discussions. A respondent in Zingilani village remarked that:

> *"…in our village we live as a family no matter the houses that we live in. We are relatives and support one another in all matters, especially when someone is more in need".*

These findings are supported by Morris *et al.* (2001) who assert that households encompass co-residence, sharing the same meals, cooking from one pot and undertaking joint or coordinated decision-making. Social capital is central to adaptive capacity, and it is a critical element in any strategy for adapting to changes in climate or climate related hazards (Adger, 2003; Yohe and Tol, 2002). The term social capital describes the relations of trust, reciprocity and exchange; the evolution of common rules; and the role of networks. In the context of adaptive capacity and climate change, the most important component of social capital is the ability of a society to act collectively (Adger, 2003).

Human capital ranked the fourth with 15.1% mean percentage, measured by education attainment, farming experience and extension services sub-indicators. Ellis (2000) reports that human resources pertain to the quality of labour and skills. High human resources such as more education and longer experience resulted to being knowledgeable and skilled to adapt to effects posed by climate change hence higher adaptive capacity.

The findings of the study also revealed that the majority of the respondents (67.1%) had non formal education whereas 22.5% had primary education. Having the majority with non formal education implies that majority of household heads had experiential knowledge a fact that could have a negative implication on their knowledge, perception and adaptive capacities. According to Davidson (2009), education has a key role to play in promoting understanding and helping individuals and communities to make informed choices to respond to challenges posed by climate change.

Also the average farming experience for the smallholder farmers was 30.16 years hence a relatively good experience in farming and climate change and variability. On extension services only 25.8% of the surveyed smallholder farmers had access to extension services. Lack of formal education by the majority of smallholder farmers partly impaired access to right climate and farming information as well as technical farming assistance to smallholder farmers from extension workers.

It was reported in FGDs that limited access to climate information is caused partly by insufficient extension workers, modality of operation of extension workers that does not reach many farmers and reliance on traditional farming by smallholder farmers that does not sufficiently recognize extension services. This was reported during focus group discussions and was emphasized by a discussant in Kapiti village who said:

> *"… Extension service in our area can be regarded as non-existent. Extension workers are nowhere to be seen; they are very few and the few that are present do not assist farmers in the villages. They are normally seen in demonstration plots that are not accessible to many farmers."*

Another discussant in Muhalala village noted that:

> *"…not every farmer knows the importance of extension services; most farmers rely on traditional farming techniques and that is why the government quarrels with us."*

Diversification of income generation activities scored 3.2% of mean score. The majority (74%) of the respondents were engaged in other income generating activities. The identified activities were beekeeping, petty trading and livestock keeping. These small activities are perceived as important to complement farming. Another is livestock keeping though it was not entirely commercialized, thus inhibiting its potential contribution to household income and adaptive capacity. A few respondents used cattle as a means of labour in the fields for cultivation and as a means of transport.

URT (2013) remarks that livelihood diversification can help communities adapt to impacts of climate change and other environmental shocks as it widens available options and reduces reliance on particular natural resources. Livelihood diversification strategies integrate farm and non-farm activities to enhance adaptive capacity and ensure sustainable livelihood in a changing climate.

In spite of the fact that financial resource was found to be an important resource other resources were also found to be important because taken together they facilitate households in terms of adaptive capacities to climate change variability. This is because resources are more useful when they are collectively used as they are interdependent.

3.4 The influence of household socio-demographic characteristics to adaptive capacity

To determine the impacts of some socio-demographic characteristic on the levels of adaptive capacity, ordinal logistic regression was applied whereby β-coefficients (positive or negative) were computed to obtain the directions of the predictor variables' impacts, as indicated in Table 3. Two variables out of five were found to be statistically significant, signifying that the variables strongly contributed to the chances of the households attaining high adaptive capacities.

The overall model fit containing all the socio-demographic characteristics was statistically significant ($p = 0.026$), indicating that the model was able to predict adaptive capacity as low, moderate and high (Table 1). The Nagelkerke R^2 was 0.160 implying that the independent variables entered in the model explained 16% of variance in the respondents' adaptive capacity.

The results in Table 2 show that household size ($p \leq 0.05$) was the strongest predictor. This is partly caused by rural household labour set up which relies on household members for production. Other studies such as that conducted by Kayunze (2000) show that household size is an important asset in terms of working together in household economic activities. Under this situation it implies that farming labour becomes sufficient depending on the number of household size. Findings in Table 3 further indicate that age of the household head had a negative β coefficients (-0.018) at $p \leq 0.05$ implying that the variable had negative impact on the chances of the surveyed households having adaptive capacities. This is caused by the fact that with the advance in age access to resources becomes limited given the fact that a household head becomes limited in terms of other livelihood strategies that would facilitate them in increasing their livelihood outcomes. And in other with advanced age household heads become dependants while remaining only decision makers based on the land

and households to which they own. The implication of this is that, having aged household heads means having heads with low adaptive capacity that is solely dependent on the number of other household heads in the creation of livelihood outcomes and in this case adaptive capacities of families.

Table 2: Determinants of adaptive capacity levels $n = 240$

Variables entered in the model	B	Std. Error	Wald	df	Sig.
Household head years of schooling	0.050	0.029	2.978	1	0.084
Household size	0.251	0.102	6.102*	1	0.014
Land size	-0.207	0.153	1.844	1	0.174
Age of the household head	-0.018	0.009	3.691**	1	0.050
Land ownership	0.099	0.382	0.068	1	0.795

Valid cases = 240, Goodness of fit: Pearson's Chi-square= 458.137 (0.214); Cox and Snell $R^2 = 0.152$; Nagelkerke $R^2 = 0.160$. Note: * and ** represent statistical significant levels at $p \leq 0.05$.

4.0 CONCLUSIONS

The study concludes that the majority of the surveyed smallholder farmers in Manyoni District have low level adaptive capacity to climate change adaptation. It further concludes that household size is the most important predictor with age of the household head having a significant negative implication. It further concludes that financial resources are the important resources that are required for enhancing adaptive capacity under climate change and variability in the study area. The study recommends that smallholder farmers and the District authorities strengthen household farming labour to achieve a higher adaptive capacity. This can be achieved by sensitization and strengthening farming subsidies for farming inputs in particular. The study also recommends that the government and financial institutions create a more conducive financial access to smallholder farmers such as friendly credit conditions that will facilitate a more access to finances.

REFERENCES

Adger, W. N. (2003). Social Capital, Collective Action and Adaptation to Climate Change. *Economic Geography* 79(4): 387-404.

Adger, W. N., Agrawala, S., Mirza, M. M. Q., Conde, C., O'Brien, K., Pulhin, J., Pulwarty, R., Smit, B., Takahashi, K. (2007). Assessment of Adaptation Practices, Options, Constraints and Capacity. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the 31 Intergovernmental Panel on Climate Change* (Edited by Parry, M.L., Canziani, O. F., Palutikof, J. P., Linden, P. J., Hanson, C. E.), Cambridge University Press, Cambridge, UK. pp. 717-743.

Agresti, A. and Finlay, B. (2009). *Statistical Methods for the Social Sciences* (Fourth Edition). Pearson Prentice Hall, New Jersey. 609pp.

Bello, M., Salau, E. S., Galadima, O. E. and Ali, I. (2013). Knowledge, Perception and Adaptation Strategies to Climate Change among Farmers of Central State Nigeria. [http://www.ccsenet.org/journal/index.php/sar/article/] site visited on 17/5/2014.

Boko, M., Niang, A., Nyong, A., Vogel, C., Githeko, M., Mednay, M., Osman-Elasha, B., Tabo, R. and Yanda, P. (2007). Africa. [https:// www. ipcc. ch/ pdf/ assessment-report/ar4/wg2/ar4-wg2-chapter9] site visited on 6/9/2015.

Cooper, P.J.M., Dimes, J., Rao, K.P.C., Shapiro, B., Shiferaw, B. and Twomlow, S. (2008). Coping better with current climatic variability in the rain-fed farming systems of sub-Saharan Africa: An essential first step in adapting to future climate change. *Agriculture, Ecosystems and Environment* 126: 24-35.

Davidson, K. (2009). Ethical concerns at the bottom of the Pyramid: Where Csr Meets BOP. *Journal of International Business Ethics* 2(1): 22-32.

Defiesta,G. and Rapera, C. L. (2014). Measuring Adaptive Capacity of Farmers to Climate Change and Variability: Application of a Composite Index to an Agricultural Community in the Philippines. *Journal of Environmental Science and Management* 17(2): 48-62.

Eakin, H. and Bojorquez-Tapia, L. A. (2008). Insights into the Composition of Household Vulnerability from Multicriteria. Decision Analysis. *Global Environmental Change* 18: 112-127.

Ellis, F. (2000). Rural Livelihoods and Diversity in Developing Countries. [http://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/] site visited on 4/9/2015.

Eriksen, S.H., Brown, K. and Kelly, P.M. (2005). The Dynamics of Vulnerability: Locating Coping Strategies in Kenya and Tanzania. *The Geographical Journal* 171(4): 287-305.

Falaki, A. A., Akangbe, J. A. and Ayinde, O. E. (2013). Analysis of Climate Change and Rural Farmers' Perception in North Central Nigeria. *Journal of Human Ecology* 43 (2): 133-140.

Gbetibouo, G.A., Ringler, C. and Hassan R. (2010). Vulnerability of the South African Farming Sector to Climate Change and Variability: An Indicator Approach. *Natural Resources Forum* 34: 175-187.

Goldman, M.J. and Riosmena, F. (2013). Adaptive Capacity in Tanzanian Maasailand: Changing Strategies to Cope with Drought in Fragmented Landscapes. *Global Environmental Change* 23: 588-597.

IPCC (2001). Climate Change 2001: Synthesis Report. [https:// www.ipcc.ch/pdf/climate- changes-2001/synthesis-syr/english/front] site visited on 2/9/2015.

Jones, L. and Boyd, E. (2011). Exploring Social Barriers to Adaptation: Insights from Western Nepal. [http:// www.odi.org/sites/odi.org. uk/files/odi-assets/ publications- opinion-files/] site visited on 7/9/2015.

Jones, L., Ludi, E. and Levine, S. (2010). Towards a Characterization of Adaptive Capacity: A Framework for Analyzing Adaptive Capacity at the Local Level. [http://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/] site visited on 3/6/2015.

Kayunze, K. A. (2000). Poverty disparities in small, large, male and female headed household in Rural Tanzania: a case study in Mbeya Region. *Tanzania Journal of Population Studies and Development* 7(1&2): 1-16.

Lyimo, J. G. and Kangalawe, R.Y.M. (2010). Vulnerability and Adaptive Strategies to the Impact of Climate Change and Variability. The Case of Rural Households in Semi-arid Tanzania. *Environmental Economics* 1(2): 89-97.

Mary, A. L. and Majule, A. E. (2009). Impacts of Climate Change, Variability and Adaptation Strategies on Agriculture in Semi arid areas of Tanzania: The Case of Manyoni District in Singida Region, Tanzania. *African Journal of Environmental Science and Technology* 3(8): 206-218.

Morgan, S. P, and Teachman, J. D. (1988). Logistic Regression: Description, Examples and Comparisons. *Journal of Marriage and the Family* 50: 929-936.

Morris, M., Butterworth, J., Lamboll, R., Lazaro, E., Maganga, F. and Marsland, N. (2001). Household Livelihood Strategies in Semi-Arid Tanzania [http://www.nrsp.org.uk/database/documents/] site visited on 4/5/2015.

Nyong, A. (2005). Technologies for adapting to climate change: water resources and agriculture. [http://slideplayer.com/slide] site visited on 6/9/2015.

Paavola, J. (2008). Livelihoods, Vulnerability and Adaptation to Climate Change in Morogoro, Tanzania. *Environmental Science and Policy* 11: 642-654.

Ricci, L. (2011). Autonomous Adaptive Capacity to Environmental Change in Peri-Urban Dar es Salaam: Urban Impact of Climate Change in Africa. [http://www.planning4adaptation.eu/Docs/newsInfoMaterial/] site visited on 2/9/2015.

URT (2005). *Singida Region Socio-Economic Profile*. National Bureau of Statistics, Dar es Salaam and Regional Commissioner's Office, Singida Region. 91pp.

URT (2006). *Singida Region Vision 2020*. President's Office Regional Administration and Local Government Singida Region. Regional Commissioner's Office. 91pp.

Yanda, P. Z. and Mubaya, C. P. (2011). Managing a Changing Climate in Africa: Local level Vulnerabilities and Adaptation Experiences. Mkuki na Nyota, Dar es Salaam. 190pp.

Yohe, G. and Tol, R.S.J. (2002). Indicators for Social and Economic Coping Capacity: Moving Toward a Working Definition of Adaptive Capacity. *Global Environmental Change* 12 (1): 25-40.

Ziervogel, G., Nyong, A., Osman, B., Conde, C., Cortés, S. and Downing, T. (2006). *Climate Variability and Change: Implications for Household Food Security*. AIACC Working Paper No. 20. International START Secretariat. Washington, District of Columbia. 34pp.

APPENDIX

Table 2: Mean adaptive capacity per each resource

Resources	Total scores	Average scores per Adaptive capacity category	Mean percentage per each category (%)
Human capital			
i. Education attainment	**79**		
ii. Farming experience	237	244.6	15.1
iii. Extension services	418		
Sub total	**734**		
Social capital		261	16.1

i. Relatives	**249**		
ii. Collective farming	**267**		
iii. Membership in social groups	267		
Sub total	**783**		
Natural capital			
i. Land ownership	270		
ii. Cultivation of all land owned	391	330.5	20.4
Sub total	**661**		
Financial capital			
i. Savings	437		
ii. Access to credit	417	402.7	24.8
iii. Remittances	354		
Sub total	**1208**		
Diversified IGAs	52	52	3.2
Sub total	**52**		
Total	**1622.2**		