PRINT: ISSN 0970-9274 ONLINE: ISSN 2456-6608
J Hum Ecol, 56(3): 335-353 (2016)
DOI: 10.31901/24566608.2016/56.03.12

Vulnerability to Climate Change Related Disasters in the Eastern Cape Province: An Application of the Household Vulnerability Index (HVI)

Leocadia Zhou[1], Melusi Sibanda[2], Lovemore Musemwa[3] and Simbarashe Ndhleve[4]

[1] Risk and Vulnerability Science Centre (RVSC), University of Fort Hare, P. Bag X1314, Alice 5700, RSA
[2] Department of Agriculture, University of Zululand, P. Bag X1001, KwaDlangezwa, 3886, RSA
[3]Department of Agricultural Economics, Education and Extension, Bindura University of Science Education, P. Bag 1020, Bindura, Mashonaland Central Province, Zimbabwe
[4]Risk and Vulnerability Science Centre (RVSC), Walter Sisulu University, P. Bag X1, UNITRA, 5117, RSA

KEYWORDS Climate Change. Disasters. Eastern Cape. Household. Vulnerability

ABSTRACT Globally there is now a consensus that extreme climatic events are occurring and pose significant challenges, particularly for resource poor rural households. This paper assesses household vulnerability to climate change related disasters in the Eastern Cape (EC) Province in South Africa. The Household Vulnerability Index (HVI) was used to determine the levels of vulnerability to climate change related disasters by households. Data from 1546 households was collected, however only 1510 questionnaires were used for analysis. The majority (83%) of the households were found to be moderately vulnerable to climate change related disasters. A Tobit censored regression, used to determine the factors influencing household vulnerability to climate change related disasters, established that socio-economic factors including age, marital status, highest level of education, employment status, health status, ownership of farm assets, receiving external support, income generating activities, livestock ownership and extension access were significant. The findings suggest that households need to be empowered in terms of their socio-economic attributes, a move that will enhance adaptation and resilience under extreme climatic conditions.

INTRODUCTION

Vulnerability is an important concept for examining a comprehensive set of environmental, socio-economic, institutional, and political occurrences such as climate change related disasters (Pricope et al. 2014). Blaikie et al. (1994) and Lavell et al. (2012) defined "vulnerability" to mean the qualities of a being or a population relative to their capability to foresee, manage, withstand and recuperate from the influence of natural disasters. In terms of climate change, vulnerability consists of three components namely exposure (the degree of climate variability and change); sensitivity (the strength of reaction to the impact of climate) and the adaptive capacity (being able to manage the undesirable effects and yield gain of any opportunities that arise) by a person or a community (CARE Poverty, Environment and Climate Change Network (PECCN) 2011; Intergovermental Panel on Climate Change (IPCC) 2014; Nelson et al. 2016). The precise impact of climate change is unclear, however recent evaluations predict adjustment in the occurrence, strength, duration and hydrometeorological impacts such as heat waves, heavy rains, drought and tropical cyclones (Lavell et al. 2012). This adjustment of increased vulnerability will intensify pressure on social and natural systems and increase susceptibility to the severity of outcomes in many areas globally.

Lavell et al. (2012) indicates that climate change will adversely affect "sectors such as water resources, agriculture, forestry, fisheries, human settlements, ecological systems and human health". Developing countries (particulary in sub-Sahara Africa) are more vulnerable due to a limited capacity to adapt, with the condition being most extreme among the poor (Juana et al. 2013). Agriculture, as the backbone of rural livelihoods, is the main source of food and a way of generating income by households (Celia et al. 2014). Rural households in most cases are located in areas that are naturally susceptible to shocks that negatively impact the household livelihoods. Such conditions include rustic shel-

Address for correspondence:
Dr. Melusi Sibanda
University of Zululand,
P/Bag X1001, KwaDlangezwa, 3886, South Africa
E-mail: <sibandamelusi@yahoo.co.uk>,
<SibandaM@unizulu.ac.za>

ter, no access to electricity and water services, limited resources and the population largely depend on the natural environment for essentials such as water, firewood, wild foods and building materials (Celia et al. 2014). As a result, the fate of these living conditions of rural households is closely linked with that of farming and a series of climate hazards such as unpredictable temperatures, rainfall patterns, droughts and flooding.

Apart from the political and economic improvements post 1994, South Africa is still faced with poverty and unemployment challenges (Musemwa et al. 2013; Lings 2015; Trading Economics 2016). Numerous factors have been accounted for increasing food prices and further aggravated poverty. Challenges in the electricity supply and increasing oil prices are some of the crucial issues that require attention. For example, the price of electricity increased by hundred percent between 2008 and 2011 (Inglesi-Lotz 2012). High energy costs in turn lead to an increase in food prices as a result of increased production and transport costs (Hanjra and Qureshi 2010). These unfavorable conditions have made the situation of rural South African households, already struggling to meet basic needs, more vulnerable (Labadarios et al. 2009; Makhubu 2016).

There is evidence to suggest that in the Eastern Cape (EC) Province of South Africa, climate change compounds to the increased vulnerability of households with regard to income losses, poverty and food insecurity (Bank and Minkley 2010; Ribbink 2012). Devastating scenes of climate change are a common feature of the rural Eastern Cape. Most of the people in the province are rural inhabitants dependent on agriculture as the main economic activity (Wenhold et al. 2007). However, this sector is dependent on climate, and climate change has put the lives of the rural poor people in South Africa at risk (Fraser et al. 2003). Various programmes have been introduced in the EC to try and ease poverty and food insecurity. However such programmes have not succeeded, with the number of abandoned farmlands increasing every year (Hebinck and Lent 2007; Bank and Minkley 2010; Hall and Aliber 2010). Extreme weather events including droughts, gradual temperature increases, greater variability in annual rainfall and the prevalence of events such as floods are becoming common. These changes have a negative impact on the poor as perpetual poverty is always reported in the province (Hall and Aliber 2010). Official statistics show that the situation in the EC has worsened and that poverty has increased, more so in the rural areas where the majority of the province's 6.3 million people reside (Department of Economic Development, Environmental Affairs and Tourism (DEDEA) 2013).

Numerous factors contribute to household vulnerability to climate change related disasters. Such factors weaken household capability for social protection, delay recovery or expose certain groups to increased or repeated hazards. According to Nkondze et al. (2013), factors influencing vulnerability to climate change related disasters comprise of "rapid population growth, poverty and hunger, poor health, low levels of education, gender inequality, fragile and hazardous location, and lack of access to resources and services, including knowledge and technological means and disintegration of social patterns (social vulnerability)". Coulibaly et al. (2015a) in their study also identified numerous similar socio-economic attributes that influence household vulnerability to climate change related shocks which are derived from the livelihood framework as indicators for adaptive capacity. Coulibaly et al. (2015a) characterised the factors that condition a household's capability to cope with climate change related disasters into four livelihood assets namely social, human, physical and financial capital. The exact factors used in their study include "education, age, farm income, land area, access to extension services, number of family members, farm income, housing quality and wealth assets".

Objectives

Climate change related disasters have an impact on human well being in many different ways. There is therefore a need to identify which households are vulnerable to climate change related disasters so that such households can be targeted when developing ways of reducing such vulnerability. This paper assesses the extent of household vulnerability to climate change related disasters using the Household Vulnerability Index (HVI) tool in the EC Province as a result of social, demographic, and resource conditions. In addition, the paper tries to establish a relationship between the household socio-economic attributes (encompassing the main five

livelihood assets) and household vulnerability to climate change related disasters. The recognition of the means by which the livelihoods of most households are sensitive to disaster risks is a crucial input in aiming for, creating, monitoring, and assessing adaptation measures. The paper also provides recommendations and policy measures to enhance the resilience of Eastern Cape households to climate change related disasters.

METHODOLOGY

Study Areas

The study was carried out in the Eastern Cape Province of South Africa in three Local Municipalities (LM) namely Nkonkobe, Instika Yethu and Umzimvubu. Nkonkobe Local Municipality is the second largest local municipality of the Amatole District Municipality. Umzimvubu is one of the four local municipalities of Alfred Nzo District Municipality. It is located in the north-west of the Eastern Cape province. Instika Yethu Local Municipality (IYLM) is the largest and most rural municipality within the Chris Hani District. According to Stats SA (2011), the majority of the population (74%, 72% and 95%) in Nkonkobe, Umzimvubu and Instika Yethu Local Municipalities respectively reside in rural settlements.

Nkonkobe Local Municipality is home to three educational institutions which are Fort Cox Agricultural College, Fort Hare University and Lovedale FET College. The Human Development Index (HDI) for Nkonkobe Municipality is sitting at 0.6 (Nkonkobe Municipality Integrated Development Plan (IDP) 2013/14). Umzimvubu Local Municipal area, the literacy rate is sixty-two percent (62%) which is less than the rate of 72.3 percent of the Eastern Cape Province (Spatial Development Framework (SDF) 2011). In 2010, IYLM's HDI was forecasted to be 0.3731 which is below the national and the provincial averages of 0.5501 and 0.4828 respectively (Intsika Yethu Local Municipality IDP 2013/14). This shows that the levels of human development are still very low.

There is a prevalence of high unemployment and a substantive proportion of the population who are not economically active in the EC Province. According to Nkonkobe Municipality IDP (2013/14), the unemployment rate in Nkonkobe Municipality is 57.8 percent. Umzimvubu Local Municipality's employment levels are low with a labour force participation rate of about 38 percent (Umzimvubu Local Municipality IDP 2013/14). In IYLM, the unemployment rate in 2009 was estimated at forty-four percent (44%) (Intsika Yethu Local Municipality IDP 2013/14).

Household income is a useful proxy for understanding levels of poverty. The income distribution pattern in the study areas shows that the majority of people live in poverty. However, the level of poverty in Nkonkobe is reported to be decreasing with less than 40% of the total population living in poverty (Nkonkobe Municipality IDP 2013/14). In Umzibumvu Municipality, about 31.3 percent of the population are dependent on social grants for survival (Umzimvubu Local Municipality IDP 2013/14). In IYLM, an estimated fifty-six percent of households were classified as poor or living in poverty (Intsika Yethu Local Municipality IDP 2013/14).

Due to the rural nature of the province, subsistence agriculture (both crop and livestock production) is the main form of primary industry. Nkonkobe Local Municipality is estimated to produce about thirty percent of its food requirements, despite the availability of arable land (Architects, Planners and Urban Designers (ARG Design) 2010). Agriculture in Umzibumvu forms one of the Local Economic Development (LED) focus areas, as agriculture proves to have great potential in this area. The Umzibumvu Municipality has agriculture activity in terms of both crop farming and animal husbandry due to the suitable climatic conditions and the availability of water supply. The soils have high potential for growing various crops (Umzimvubu Local Municipality IDP 2013/14). Agricultural activities taking place in Umzibumvu Municipal area are in the form of livestock farming (sheep, goats and cattle) and crop farming (maize, potatoes, cabbage and spinach) at a subsistence levels. Agriculture is the largest primary industry in IYLM. However this sector is still small and underdeveloped in comparison to the entire economy of the municipality. It is noted that the agricultural sector in IYLM is declining with regard to the absolute proportion that it contributes to the IYLM economic output.

Sampling Procedure

The study employed a multi-stage sampling procedure. Nkonkobe, Instika Yethu and Umz-

imvubu Local Municipalities were purposively selected. Nkonkobe was selected due to its close proximity to the University of Fort Hare while Umzimvubu and Instika Yethu were selected because of the existence of National Agricultural Marketing Council (NAMC) livestock improvement projects in the indicated areas. These three municipalities were also chosen due to the fact that they are regarded as highly susceptible to disasters, highly impoverished and with high unemployment levels. The households in the selected local municipalities are mainly rural and very dependent on government social grants and rain-fed agriculture. In total, 1546 households from the study areas were randomly selected and interviewed.

Data Collection

A total of 1546 pre-tested structured questionnaires were administered during November 2013. Personally administered questionnaires were used. The questionnaires collected data on household demographics and information on vulnerability to climate change related disasters based on the five livelihood capital assets (natural, physical, financial, human and social).

Data Analysis

Data from 1510 questionnaires were analysed after 33 incomplete questionnaires were discarded. Descriptive statistics such as frequencies and percentages were computed to understand the socio-economic attributes of the interviewed households. The HVI index was computed, in order to quantify the level of household vulnerability to climate change related disasters.

Household Vulnerability Index (HVI)

The paper quantifies household vulnerability by utilising the HVI, which is an anylitical tool created by the Food, Agriculture and Natural Resource Policy Analysis Network (FANRPAN). The HVI tool consists of 24 indicatiors (dimensions) of household vulnerability. A statistical score, based on the 24 indicators, is computed for every household. The resulting score/ index is used to categorise households into seperate vulnerability levels. The HVI tool is rooted on the Sustainable Livelihoods Framework (SLF) created by the Department for International Development (DFID 2000). The SLF formulates a clear analysis of poverty by understanding the livelihoods of the poor.

The HVI estimates "external" vulnerability (brought about by a defined shock) and "internal" vulnerability (inability of a household to resist shocks). The aim of the index is to enhance planning and direction of humanitarian and development interventions. The HVI assesses vulnerability on the basis of a household's ability to access the five livelihoods of capital, which are:

- natural assets (biological assets, produced or wild, for example land, soil and water);
- physical assets (economic value of tangible and/or material assets owned, for example livestock and equipment);
- financial assets (intangible assets that are more liquid that tangible assets, for example savings, salaries, remittances or pensions);
- human capial assets (value of health, knowledge and skills competencies, for example labour, gender composition and dependents); and
- social assets (linkages between individuals and entities that can be economically valuable, for example information, relatives' support, community support and formal or informal social welfare support).

Using statistical equations and distributions, data collected on each household is used to compute a statistical score that ranges from 0 to 100, with 0 representing no vulnerability, and 100 representing full impact of a given shock. The HVI uses a combination of statistical procedures (Principal Component Analysis, Fuzzy Logic and Gaussian Distribution Functions) to approximate the level of vulnerability associated with each household, and the source of that vulnerability. After a household's vulnerability level has been determined, it is possible to classify each household according to its level of vulnerability. Households can be grouped into three classes, namely:

- Low vulnerability: households have the capacity to adapt to shocks and triumph on their livelihoods with minimal change in their way of life. These households can be described as needing less external support to cope.

- Moderate vulnerability: imply that the households would need a certain amount of external support to cope with any given shock.
- High vulnerability: such households require special support in order to recuperate from the effects of shocks. These households are also described as welfare cases, they may with time cease to exist if appropiate assistance is not received promptly.

The HVI however does not explain the reasons for variations across households. A Tobit model was therefore employed to determine the attributes which affect household vulnerability to climate change related disasters in the Eastern Cape.

The Tobit model

The HVI lies between 0 and 1. Formulation of a regression equation with a truncated continuous dependent variable (HVI) may have resulted in a predicted output that lay beyond the interval 0-1. A Tobit model, suggested by Tobin (1958) to explain the association of a non-negative dependent variable y_i and an explanatory variable x_i, was adopted in this paper.

In order to elicit the factors that effect the household's vulnerability to climate change related disasters, the Tobit regression model was used. According to Carson and Sun (2007), the Tobit model is mathematically presented as indicated in equation 1:

$$Y_i^* = \alpha + X_i\beta + \varepsilon_i, \qquad i = 1,2,3,\ldots,n \tag{1}$$

where, Y_i^* is a latent response variable;XI is an observed 1 x k vector of explanatory variables; and ε_i is an error term and is not associated with X_i. As an alternative to observing Y_i^*, Y_i is observed. "Y^* is a latent variable that is unobservable" (Carson and Sun 2007). Given that the dependent variable is beyond the limiting factor (which is zero in this instance), Y is treated as a continuous variable. In the case were Y is at the limiting factor, it is kept at zero. This correlation is expressed as follows (equation 2):

$$Y_{i}^{*} = \begin{cases} y_i^* & \text{if } y_i^* > y \\ 0, & \text{if } y_i^* \le y \end{cases} \tag{2}$$

where, ã is a non-stochastic constant. The value of is missing when it is less than or equal to ã. In the standard Tobit model, the assumption is that ã is usually unobserved in economic data and is usually hypothesised to be zero in empirical applications where γ_o is the limiting factor. The above equation denotes a censored dispersal of data. The Tobit model is thus employed to elicit the predictable value of as a function of a set of independent variables (X) subjective by the probability that $Y_\iota > 0$. The expected intensity of vulnerability, E(Y), is expressed as follows (equation 3):

$$EY = X\beta F(z) + \sigma f(z) \text{ and } z = X\beta / \sigma \tag{3}$$

where, F(z) is the cumulative normal distribution of z; f(z) is the value of the derivative of the normal curve; z is the Z-score (area under the normal curve) and is the standard error of the error term. The coefficients for the explanatory variables in the Tobit model, β, do not signify marginal outcomes directly, instead the sign of the coefficient is useful to show the direction of the effect.

In the Tobit regression model, household vulnerability index scores computed from the five types of household assets were used as the dependent variable. Variables that were anticipated to influence household vulnerability to climate change related disasters included age; gender; marital status; highest education; employment status; health status; own tractor-drawn implements; own ox-drawn farm implements; household possession of skills; receive food support; receive non-food basic support; receive health support; receive financial support; receive farming inputs support; receive social support; receive spiritual support; have income-generating activities; own land; crops production; vegetable production; own livestock and extension access. Table 1 briefly summarises the variables, how they were measured (measurement type), and their expected outcomes.

RESULTS AND DISCUSSION

Shocks Experienced by Households in 2013

Climate change related extreme events seem to present negative impact on the livelihoods and well-being of primarily the poor people in developing countries (Ngigi and Birner 2013). Poor rural farming households which depend extensively, for example on crop and livestock farming, may experience the adverse effects of climate change related disasters making them vulnerable to food insecurity and limited water resources. The increased occurence of climate related shocks, for example droughts, floods, landslides and soil erosion impacts food pro-

Table 1: Variable description, measurement type and their expected outcomes

Variable	*Variable description*	*Type of measure*	*Expected outcome (+/-)*
Dependent	Household Vulnerabilty Index score, between 0 and 1		
HVI score			
Explanatory			
Age	Age of respondent	Continuous	+/-
Gender	Gender of respondent	Dummy (1=male, 0 = female)	+/-
Marital status	Marital status of respondent	Categorical	+/-
Highest education	Highest education of respondent	Categorical	-
Employment status	The employment status of the household head	Categorical	-
Health status	Health status of the respondent	Categorical	-
Own tractor-drawn implements	Does the household own tractor drawn implements?	Dummy (1=yes, 0 = no)	-
Own ox-drawn farm implements	Does the household own ox-drawn implements?	Dummy (1=yes, 0 = no)	-
Household possession of skills	Does any member in the household possess any skills?	Dummy (1=yes, 0 = no)	-
Receive food support	Does the household receive any food support?	Dummy (1=yes, 0 = no)	-
Receive non-food basic support	Does the household receive any non-food basic support?	Dummy (1=yes, 0 = no)	-
Receive health support	Does the household receive any health support?	Dummy (1=yes, 0 = no)	-
Receive financial support	Does the household receive any financial support?	Dummy (1=yes, 0 = no)	-
Receive farming inputs support	Does the household receive any farming input support?	Dummy (1=yes, 0 = no)	-
Receive social support	Does the household receive social support?	Dummy (1=yes, 0 = no)	-
Receive spiritual support	Does the household receive spiritual support?	Dummy (1=yes, 0 = no)	-
Income-generating activities	Does the household have any income generating activities?	Dummy (1=yes, 0 = no)	-
Own land	Does the household own arable land?	Dummy (1=yes, 0 = no)	-
Crops production	Does the household grow crops?	Dummy (1=yes, 0 = no)	-
Vegetable production	Does the household grow vegetables?	Dummy (1=yes, 0 = no)	-
Own livestock	Does the household own livestock?	Dummy (1=yes, 0 = no)	-
Extension access	Does the household have access to extension?	Dummy (1=yes, 0 = no)	-

(+/-) positive or negative sign of the coefficient shows the direction of influence of the variable on the HVI
Source: Authors

duction, and is a threat to food security as well as people's livelihoods (Kathmandu 2009). Households from the sampled communities experienced a range of challenges which have direct bearing on their livelihoods and welfare. The results in Table 2 show that the most highly ranked shocks experienced during the year 2013 included the increase in food prices (46%), death of family member (13%), theft (about 12%) and low yields due to drought or floods (about 11%). The volatility or increase in food prices ranked first in the climate related shocks experienced by households in 2013. According to Celia et al. (2014), despite the fact that most rural households do not produce for markets, some households may sell some of their products to compensate for the expenses of inputs and the basic household requirements. Such households would, at a certain point in time, run out of their reserves and would have to buy back food from the market, often at higher prices. Volatile food prices therefore increase the vulnerability of such households when they have to buy food to feed their families at higher prices as this reduces their ability to purchase food. These findings are in harmony with those of Coulibaly et al. (2015b) who assessed that extreme climate change related events, for example drought,

flooding and the unusual distribution of rainfall, will unfavorably affect agricultural production and seriously undermine the livelihoods of rural households.

Table 2: Shocks experienced by households in 2013

Shocks experienced by households in 2013	*Percentage (%)*
Increase in food prices	46.1
Death of a family member	13
Theft	11.7
Low yields (drought/floods)	10.6
Damaged shelter	9.7
Death of working member of a household	9.4
Livestock diseases or pests	9.1
Illness or accident of a household member	8
Death of a household head	7.6
Crop diseases or crop pests	6.7
Loss of salaried employment	5.8
Fall in prices of livestock or crops	3.3
Non-payment of salary	2
End of regular assistance	0.9
Failure of household business	0.9

Source: Authors

Household Vulnerability Index

In order to quantify household vulnerability to external shocks in the study areas, the HVI tool was employed to classify the vulnerability status of the sampled households. Households were categorised into three classes namely low vulnerable (households that are exposed to climate change related shocks but are able to cope); moderately vulnerable (those households that require immediate but temporary assistance with regard to the experienced shocks); and highly vulnerable (households that have reached a point of no return). Findings presented in Table 3 indicate that the majority (about 83%) of the sampled households in the Eastern Cape were moderately vulnerable to climate change disasters and five percent had low vulnerability to climate change disasters. Those that were highly vulnerable to climate change related disasters constituted twelve percent of the interviewed households. The household vulnerability index scores ranged from 0 to 0.8. The mean household vulnerability score was 0.6 with a standard deviation of 0.099 implying that the majority of the households encountered moderate vulnerabilities to climate change related disasters. The findings show that the majority of households require external support when experiencing extreme climate change related events. These findings suggest that households are not able to cope on their own when climate shocks occur and would require government intervention in support. These findings are in harmony with those of Nkondze et al. (2013) who assessed that most households residing in rural areas are poverty stricken and are vulnerable to climate change related shocks.

Table 3: Household vulnerability status

Vulnerability category	*HVI range*	*Frequency*	*Percentage (%)*
Low vulnerable	0-1.4	76	5
Moderately vulnerable	1.5-2.5	1253	83
Highly vulnerable	2.5-3.5	181	12
Total		1510	100

Source: Authors

Household Vulnerability by Age

According to Smith et al. (2015) age is one commonly cited variable that influences socio-economic vulnerability. Usually those at the end of the age spectrum such as the elderly are regarded as the most vulnerable group. The average age of household heads for the highly vulnerable households was 62.9 while for the moderately vulnerable group was 57.7. This implies that the elderly are more likely to be vulnerable to the effects of climate change related disasters. The low vulnerable households were headed by members whose average age was 54.9 as shown in Table 4.

Table 4: Vulnerability status by the age of household heads

HVI category	*N*	*Minimum*	*Maximum*	*Mean*	*Std. deviation*
Low vulnerability	76	18	89	54.61	14.432
Medium vulnerability	1253	12	96	57.71	15.997
High vulnerability	181	25	95	62.97	14.587

Source: Authors

Household Vulnerability by Gender

According to CARE PECCN (2011), both sexes (male/female) contribute differently in terms of their roles with regard to household livelihoods. It then follows that the effect of climate change related disasters can be experienced differently by women and men. The reason for this is because men and women have differing abilities to respond to climate change related threats impacting on their lives and livelihoods. It was observed in this study that about seventy percent of female-headed households were highly vulnerable to climate change disasters than male headed households (Table 5). These findings vindicate CARE PECCN (2011) that women may be a more vulnerable group with regard to climate change vulnerability and adaptation. This finding is supported by Nkondze et al. (2013) and Tibesigwa et al. (2015) that climatic related shocks and weather variability has disproportionately made female-headed households vulnerable in sub-Saharan Africa.

Household Vulnerability by Marital Status

According to Chauke et al. (2014), married couples are ussually stable in their agricultural production as compared to their unmarried counterparts. A household with married couples may suggest that the sharing of economic and social resources takes place within the household, and as such provides a risk-sharing protection against unpredicted events such as extreme climate related disasters. When the household heads were grouped by marital status (Table 5), it was observed that most of the single (about 43%) and widowed (36%) headed households were highly vulnerable to climate change disasters. This suggests that the households with married household heads are less likely to be vulnerable and are better able to cope with disasters, food and water insecurities than households with a single household head.

Household Vulnerability by Highest Level of Education

According to Striessnig (2013), investment in education is an important strategy for preparing communities to cope with unclear disasters as a result of future climatic events. Education empowers people and subsequently reduces vulnerability to climate change related disasters. A household with a better education status may suggest that such a household has quality access to appropiate climatic information, for example early warnings for disasters and/or seasonal projections for drought periods (Moser and Ekstrom 2010 in Striessnig 2013). It was noted from this study that a significant number of highly vulnerable household heads had low education levels for twenty four percent never went to school and fifty two percent had only attained primary education (Table 5). The findings suggest that household heads with low levels of education may be more vulnerable to climate change related disasters, such as food and water insecurities, than households headed by educated people. These findings are in line with those of Baiyegunhi and Fraser (2010) that household heads with less or no formal education are the most vulnerable groups.

Household Vulnerability by Employment Status

Employment status is another variable that can affect household vulnerability to climate change related shocks. Households with employed members or heads are in a more secure situation in the sense that the household would have a consistent flow of income (Nkondze 2013). It then follows that having a steady flow of income in a household is an important aspect of financial capital in coping with climate change related disasters, because income empowered households absorb and recuperate from losses more swiftly (Coulibaly et al. 2015a). The results show that most (about 99%) of the highly vulnerable households were headed by unemployed heads (Table 5). Other groups were less vulnerable, for example subsistence farmers (about 1%), artisans (about 2%), petty traders (about 3%), formal employment (about 27%) and harvesting natural resources (about 5%). This shows that being unemployed has a negative impact in terms of increasing a household's vulnerability and reducing its coping ability. According to Frye (2006), being unemployed has adverse effects on economic welfare and erodes human capital.

Household Vulnerability by Health Status

Low access to basic services, for example health care, presents health and security risks

Table 5: Household vulnerability status (n = 1510)

Variable	*Low vulnerability (%)*	*Medium vulnerability (%)*	*High vulnerability (%)*
Gender	Male (66.7); Female (33.3)	Male (40.4); Female (59.6)	Male (29.8); Female (70.2)
Marital status (Household head)	Married (64); Single (20); Widow (10.7); Divorced (2.7); Separated (1.3); Consensual (1.3)	Married (34); Single (33.7); Widow (28.3); Divorced (1.4); Separated (1.8); Consensual (0.7)	Married (18.8); Single (42.5); Widow (35.4); Divorced (1.7); Separated (1.1); Consensual (0.6)
Education (Household head)	Never went to school (2.7); Primary (8); Completed primary (8); Secondary (22.7); Completed secondary (12); High school (20); Professional college (13.3); University (13.3); Other (-)	Never went to school (12.6); Primary (30.9); Completed primary (12.2); Secondary (21.2); Completed secondary (11.3); High school (7.1); Professional college (3.6); University (1.2); Other (0.1)	Never went to school (24.4); Primary (51.9); Completed primary (9.9); Secondary (11); Completed secondary (1.7); High school (1.1); Professional college (-); University (-); Other (-)
Employment status (Household head)	Unemployed (61.3); Subsistence farmer (1.3); School child (-); Artisan (2.7); Petty trade (2.7); Formal employment (26.7); Harvesting natural resources (5.3)	Unemployed (87.8); Subsistence farmer (0.6); School child (-); Artisan (0.6); Petty trade (1.2); Formal employment (5.2); Harvesting natural resources (2.7)	Unemployed (99.4); Subsistence farmer (-); School child (-); Artisan (-); Petty trade (-); Formal employment (0.6); Harvesting natural resources (-)
Health status (Household head)	Good (69.3); Infrequent sick (29.3); Regularly sick (1.3); Bed ridden (-)	Good (48.1); Infrequent sick (38.7); Regularly sick (13); Bed ridden (0.2)	Good (17.1); Infrequent sick (48.1); Regularly sick (32.6); Bed ridden (2.2)
Own tractor drawn implements	Yes (2.7); No (97.3)	Yes (1.1); No (98.9)	Yes (0.6); No (99.4)
Own ox-drawn implements	Yes (6.7); No (93.3)	Yes (1.3); No (98.7)	Yes (0.6); No (99.4)
Household skills possession	Yes (20); No (80)	Yes (14.8); No (85.2)	Yes (7.7); No (92.3)
Receive farm input support	Yes (2.7); No (97.3)	Yes (0.5); No (99.5)	Yes (0.6); No (99.4)
Receive social support	Yes (40); No (60)	Yes (34.1); No (65.8)	Yes (34.8); No (65.2)
Receive spiritual support	Yes (54.7); No (45.3)	Yes (46.6); No (53.5)	Yes (42); No (58)
Household has income generating activities	Yes (21.3); No (78.7)	Yes (6.2); No (93.8)	Yes (1.7); No (98.3)
Household head owns land	Yes (6.6); No (93.3)	Yes (7.2); No (92.8)	Yes (3.3); No (96.7)
Household head own livestock	Yes (64); No (36)	Yes (20.4); No (79.6)	Yes (6.1); No (93.9)
Household has access to extension services	Yes (28); No (72)	Yes (12.3); No (87.7)	Yes (3.3); No (96.7)

Source: Authors

that further worsen alternatives for empowering and expanding livelihoods to cope with climate related risks (CARE PECCN 2011). Climate change related disasters may worsen the already vulnerable health conditions of rural households, who may already be having limited access to health services (Kathmandu 2009). Climate change may revive and intensify some water borne diseases, for example malaria. Health risks significantly affects the stress levels and workload of household heads and thus further exposes them to climate related disasters. When the household heads were grouped by health status (Table 5), it was noted that the majority (about 69%) of the least vulnerable group had good health. Good health is essential in terms of coping with climate change related disasters.

Household Vulnerability by Asset Ownership

Another factor that escalates households' vulnerability to climate change related disasters is the lack of assets (implements) (Blaikie et al. 1994). Examples of implements include access to machinery such as tractor and ox drawn implements. Blaikie et al. (1994) in Olmos (2001) indicated that households with lack of access to resources and implements are more vulnerable than households with access to resources and implements. Olmos (2001) suggests that resource-rich households may be less vulnerable because they may be better resilient in the sense that they can recover quickly from shock. With limited implements, households may not be able to meet their basic needs. The implication is that it becomes hard for resource-poor households to think beyond their direct needs, and therefore much less effort is directed to making plans for future long-term climate adaptation. In this study, it was found that the majority (about 99%) of the highly vulnerable households did not own a tractor-drawn farm implement or an ox-drawn farm implement (Table 5). This implies that owning assets such as tractor or an ox-drawn implement reduces the level of household vulnerability to climate change related disasters.

Household Vulnerability by Skills Possession

According to Piya et al. (2012), skills possession is a crucial human asset that can be determined by the highest level of educational attainment and/or training received by the household head or members of the family. Human development by acquiring the skills through vocational trainings or formal education makes it possible for households to earn income by taking part in skilled non-farm activities. Such activities may be deemed less climate sensitive in contrast to farming which is a climate dependent activity. Having diversified skills among households therefore may help households to avert climate risks in times of shocks. When the household heads were grouped by whether a household possessed any skill, the majority (about 92%) of the highly vulnerable household heads did not have any skills (Table 5). Lack of skill is an obstacle to household development. Therefore lack of skills by household heads increases their chances of being vulnerable to disasters, food and water insecurities.

Household Vulnerability by Receiving External Support

In most cases, rural households have limited or lack formal safety nets and therefore external support becomes critical. According to Celia et al. (2014), during times of climate change shocks, households may look to immediate family members and/or friends for assistance (borrowing cash, obtaining assistance in rebuilding destroyed shelter, and food) and also from local organisations such as work programmes and in turn receiving food and other support. When the households were grouped by whether a household head received external support in the form of farm inputs, social and spiritual support; the majority (about 99%, 65% and 58%) of the highly vulnerable group did not receive any farm inputs, social and spiritual support respectively (Table 5). This finding suggests that household heads receiving external support during climate related shock periods can assist them and their households to better cope with the associated stress.

Household Vulnerability by Income Generating Activities

According to Kathmandu (2009), rural households in most cases rely substantively on farming (crop and livestock production) for the sustenance of livelihoods. Households with diversified income-generating activities may be less

vulnerable to climate related disasters in contrast to households with limited income generating activities. Diversified livelihood sources help households to minimise the threats presented by extreme climatic events on farm income. The results show that the majority (98%) of the highly vulnerable group did not have income generating activities (Table 5). About ninety-four percent of those who did not have income generating activities were moderately vulnerable. The findings imply that households without income generating activities may be vulnerable to climate change related disasters. Households with income generating activities can reduce their vulnerability by safeguarding existing income and developing measures around assets that generate important non-monetary resources (Moser and McIlwaine 1997).

Household Vulnerability by Land Ownership

Although smallholder farmers may own or have access to land for cultivation, the poorest households in most cases have very small land holdings or are completely landless (CARE PEC-CN 2011). This in turn limits their production potential. This makes such households and farming families more vulnerable to any decrease in crop productivity (Celia et al. 2014). People may not be having land tenure rights which further exacerbates their vulnerability. Insecurity of tenure restricts the ability of poorer households to invest in longer-term strategies such as crop and livestock production that goes beyond household consumption to produce surplus for sale. When the household heads were grouped by whether they owned land, the results show that the majority (about 97%) who were highly vulnerable to disasters, food and water insecurities did not own land (Table 5). Land ownership is therefore an important factor in the resilience of households to natural disasters (Brown 2006). This is because owning land can encourage the landowner to invest in necessary infrastructure such as windbreaks, flood barriers and better home structures as land can provide collateral to make such investments.

Household Vulnerability by Livestock Ownership

Livestock ownership is also an important aspect that can benefit households during times of shock - for example households can get food from animals and also income from the sale of their livestock (Coulibaly et al. 2015a). Most (about 94%) of the highly vulnerable group did not keep any livestock (Table 5). About eighty percent of the households without livestock were also noted to be moderately vulnerable. These results indicate that livestock ownership can be crucial in terms of coping with household disasters, food and water insecurities. Livestock rearing therefore is an important livelihood strategy.

Household Vulnerability by Extension Access

Access to extension represents the human capital that is paramount to coping with climate change related disasters. With improved extension services, households can receive climate change information and get to know about "climate smart" technologies that can reinforce their capacity to better cope with climate change related shocks (Coulibaly et al. 2015b). About ninety seven percent of household heads who did not have extension access were found to be in the highly vulnerable group, and about eighty eight percent were in the moderately vulnerable group (Table 5). This shows that extension access is important in terms of reducing risks and uncertainty with regard to household disasters, food and water insecurities. Better access to extension services is likely to improve the yields of a household. Hassan et al. (2013) support this assertion and state that with improved extension services, household productivity is improved through increased farmer knowledge, testing and experimenting, awareness and farmer adoption of climate smart technologies.

Factors Affecting Household Vulnerability to Climate Change Related Disasters

The main objective of using the Tobit censored regression was to determine the factors that cause variation in household vulnerability to climate change related disasters. According to literature, numerous factors can influence household vulnerability to external shocks, for example, climate change related disasters. This paper utilises several factors affecting vulnerability to climate change related disasters derived from the five livelihood assets (human, natural, physical, financial and social). Table 6 shows

that household vulnerability in the study areas is influenced by age; marital status of the household head; highest education of the household head; employment status of the household head; health status of the household head; own tractor-drawn farm implements; receiving farm input support; receiving social support; having income generating activities; owning livestock and extension access.

The findings show that age ($p \leq 0.05$) significantly affects the vulnerability of households to climate change related disasters as shown in Table 6. The negative coefficient of this variable suggests that an increase in age is associated with lower household vulnerability to climate change related disasters. The age of a household head is a vital aspect as it determines the knowledge of the social and physical environments. The effects of age are however complex as these could either be positive or negative (Zavale et al. 2005; Smith et al. 2015). Aged people in this case may be less vulnerable to the impact of extreme climatic and weather events because they have more resources at their disposal (which include capital in the form of livestock, agricultural implements and assets). However, other studies have shown that the elderly can be more vulnerable to the impact of extreme climatic and weather events because they are more susceptible to diseases; the negative stresses on food and water supply; and the decreased ability to recover swiftly from shocks (Filiberto et al. 2010). Younger household heads may be deemed less vulnerable to climate related disasters because they may be willing to try out new coping strategies and innovations as compared to the elderly (Adesina and Baidu-Forson 1995).

The results reveal that marital status (being single ($p=0.000$); widowed ($p = 0.000$) and separated ($p \leq 0.10$)) significantly affects household vulnerability to climate change related disasters (Table 6). The positive coefficients for the marital status parameters suggests that unmarried household heads are associated with increased vulnerability to climate change related disasters than married household heads. This finding is in agreement with the prior expectation and desriptive results that showed that significant proportions of the highly vulnerable households to climate change related disasters were headed by single and widowed individuals.

The results show that a higher formal educational attainment of a household head is linked with a lesser vulnerability to climate related shocks. Highest education levels (that is having completed primary ($p \leq 0.05$); secondary ($p = 0.000$); completed secondary ($p = 0.000$); high school ($p = 0.000$); professional college ($p = 0.000$) and university ($p = 0.000$)) by household heads were found to be significant on household vulnerability to climate change related disasters (Table 6). The negative coefficients on the education level parameters suggests that households that are headed by those that are functionally literate are less vulnerable than those households whose heads are not. Education determines the level of human capital and the capacity to interpret information. The findings imply that households becomes less vulnerable with increased educational attainment by the head or members. This is in line with other studies that education attainment reduces vulnerability such as that of the World Bank (2002) and Lokonon (2015). It can then be inferred that a household head with a higher educational attainment could secure a job and be better positioned to cope with risk and uncertainty. Education also assists households with access to information which is appropriate for adaptation measures needed to cope with climate change related shocks.

According to Pauleit et al. (2015), employment status is also an important indicator of social vulnerability. The parameters; being a subsistence farmer ($p \leq 0.05$); school child ($p \leq 0.05$); having formal employment ($p = 0.000$) and harvesting natural resources ($p = 0.000$) were found to be significant on household vulnerability to climate change related disasters (Table 6). The negative coefficient of the employment status' parameters suggest that households with employed heads or members are less vulnerable compared to those households with unemployed heads or members. This is because unemployed household heads and/or members are more likely to receive lower income, this implies that they have little or no monetary resources to spend on prevention and for supplies during emergency or disaster periods associated with extreme climate related events. Most of the household heads in rural areas are not employed and do not own land and other resources or assets. They rely on government grants as sources of income.

Table 6: Factors affecting household vulnerability to climate change related disasters

Variable	*Coef.*	*Std. err.*	*t*	*P>|t|*
Constant	0.6450721	0.0128587	50.17	0.000
Age of Household Head	-0.0004097**	0.0001605	-2.55	0.011
Gender of Household Head	-0.0003332	0.0046262	-0.07	0.943
Marital Status of Household Head				
Single	0.0420785***	0.0053247	7.90	0.000
Widow	0.0234987***	0.0058028	4.05	0.000
Divorced	0.0260186	0.0169614	1.53	0.125
Separated	0.0273461*	0.0156266	1.75	0.080
Consensual	-0.0182416	0.0236058	-0.77	0.440
Highest Education of Household Head				
Primary	-0.0023209	0.0065457	-0.35	0.723
Completed primary	-0.0255074***	0.0080894	-3.15	0.002
Secondary	-0.0441286**	0.0073463	-6.01	0.000
Completed secondary	-.00647041***	0.0086842	-7.45	0.000
High school	-0.0913689***	0.010125	-9.02	0.000
Professional college	-0.1235264***	0.0123015	-10.04	0.000
University	-0.1595126***	0.0175979	-9.06	0.000
Other	-0.0165334	0.0779439	-0.21	0.832
Employment Status of Household Head				
Subsistence farmer	-0.0679686**	0.0273601	-2.48	0.013
School child	-0.1018413**	0.0350095	-2.91	0.004
Artisan	-0.0062512	0.0143585	-0.44	0.663
Petty trade	-0.0288502	0.0189828	-1.52	0.129
Formal employment	-0.0647039***	0.0097602	-6.63	0.000
Harvesting natural resources	-0.0677818***	0.0129658	-5.23	0.000
Health Status of Household Head				
Infrequent sick	0.0233851***	0.0048275	4.84	0.000
Regularly sick	0.0479562***	0.0064931	7.39	0.000
Bed ridden	0.0607753**	0.0294192	2.07	0.039
Own tractor drawn farm implements (yes/no)	-0.0142959**	0.0074887	-1.91	0.056
Own ox drawn farm implements (yes/no)	-0.0160769	0.0120028	-1.34	0.181
Household members possess skills (yes/no)	0.0001789	0.0023526	0.08	0.939
Household receive food support (yes/no)	-0.0024746	0.0051296	-0.48	0.630
Household receive non-food basic support (yes/no)	-0.0042056	0.003242	-1.30	0.195
Household receive health support (yes/no)	0.0006587	0.0043043	0.15	0.878
Household receive financial support (yes/no)	0.006364	0.0059279	1.07	0.283
Household receive farming inputs support (yes/no)	-0.0804099**	0.0260814	-3.08	0.002
Household receive social support (yes/no)	-0.0092666**	0.0045829	-2.02	0.043
Household receive spiritual support (yes/no)	-0.0063456	0.0042851	-1.48	0.139
Household has income generating activities (yes/no)	-0.0308432***	0.0080958	-3.81	0.000
Household own land (yes/no)	0.0017716	0.0057191	0.31	0.757
Household involved in crop production (yes/no)	-0.0078746	0.009447	-0.83	0.405
Household involved in vegetable production (yes/no)	-0.0016259	0.0015455	-1.05	0.293
Household own livestock (yes/no)	-0.0322313***	0.0038565	-8.36	0.000
Household has extension access (yes/no)	-0.0293812***	0.0065596	-4.48	0.000
/sigma	0.0766788	0.0013961		

***, **, * Statistically significant at 1%, 5% and 10% levels
Number of observations =1510
LR Chi2 (40) = 782.13
Pro > chi2 = 0.0000
Pseudo R2 = -0.2917
Log Likelihood = 1731.7278
1 left-censored observation at hvi<=0
1509 uncensored observations
0 right-censored observations
Source: Authors

Climate change and related disasters and/or extreme weather events are projected to bring about both direct and indirect negative impacts on the health of humans. Direct effects may include human injuries, illnesses and even deaths, and indirect impacts such as food and nutrition insecurity due to losses in crop yields and livelihoods. The parameters for a household head's health status; being infrequently sick (p= 000); regularly sick (p= 000) and bed ridden (p= 000)

were found to be significant on household vulnerability to climate change related disasters (Table 6). The positive coefficient of the household head's health status parameters suggests that household heads exposed to shocks such as illnesses and diseases are more vulnerable. This is because ill-health will weaken the households' economic base and drain its resources. The finding is supported by Nkondze et al. (2013) and Akerlof et al. (2015) that populations or household with sick members or those at higher risk of health exposure are more vulnerable to the impact of climate change related disasters.

The variable 'own tractor-drawn farm implements' was used as a proxy for farm asset ownership. This variable was found to be statistically significant ($p \leq 0.10$) and negatively related to household vulnerability to climate change related disasters (Table 6). Farm asset ownership by a household can affect the strength of the impact of climate change related disasters on a household. Therefore farm assets are a crucial source of mitigating risk and vulnerability as households can diversify risk during disaster times, for example they may sell the assets to mitigate the effect of the prevailing shock (Bayrau et al. 2015). Again improved access to farm assets, for example tractor-drawn farm implements, can positively influence net farm revenue for farming households. Net farm revenue largely depend on factor endowments that farming households are exposed to (Seo and Mendelsohn 2007; Nhemachena 2009). This therefore supports the notion that ownership of farm assets can reduce a household's vulnerability to climate change related disasters.

The variables 'receive farming inputs support ($p \leq 0.05$) and social support (p d" 0.05)' were used as proxies for receiving external support by a household and were found to be significant and negatively affected households' vulnerability to climate change related disasters (Table 6). This implies that households who receive support of farm inputs and social support are less vulnerable to climate change disasters. Increased external support enhances household welfare that could significantly influence a household's income, thereby increasing household resilience to climate change related disasters and hence less impact. Households with external support from various stakeholders which include the government, civil societies, and non-governmental organisations and communities may be better off with regard to accessing services such as the social protection grants and the incorporation of comprehensive climatic adaptation and disaster management systems necessary for poor households to diversify climate risk (Dulal et al. 2010).

The variable 'having income-generating activities ($p = 0.000$)' was found to be significant in influencing household vulnerability to climate change related disasters. The negative coefficient suggests that having an income-generating project reduces the vulnerability of a household to climate change related disasters (Table 6). This finding is in agreement with the prior expectation and the descriptive results that revealed that the majority (98%) of the highly vulnerable group did not have income-generating activities. Households with less income-generating activities may suggest that government grants and farming becomes the major sources of income for such households. Farming is an activity that is very sensitive to climatic change (temperature and rainfall). During extreme climatic events, both crop and livestock production and productivity (especially where traditional agriculture dominates), makes production difficult (Bayrau et al. 2015). Under such circumstances, households may fail to cope with the climate change related shocks.

Livestock ownership is another crucial livelihood aspect for rural households. Households use livestock both as source of income from the sale of live animals and its products and also as an input in crop production, for example by providing draught power when ploughing (Bayrau et al. 2015). The assessment of the ownership of livestock by households is therefore important with regard to climate change related disasters. Ownership of livestock ($p = 0.000$) was significant and found to be negatively related to climate change related disasters (Table 6). This implies that owning livestock may reduce the household's vulnerability to climate change related disasters. This is in agreement with the prior expectation as well as the descriptive results that revealed that households highly vulnerable to climate change related disasters were those who did not own any livestock. Livestock keeping is an important livelihood strategy as a drought adaptation and coping mechanisms (Opiyo et al. 2015). Livestock keeping therefore becomes a coping strategy against cli-

mate change related shocks and other stresses, as it can be a source of social security capital.

Agricultural extension represents the human capital important to cope to climate change related disasters by households (Coulibaly et al. 2015b). Extension access ($p = 0.000$) was found to significantly affect household vulnerability to climate change related disasters negatively (Table 6). This implies that an improvement in extension access by households may reduce the household's vulnerability to climatic shocks. Due to the fact that access to extension services is expected to influence farming household choices among the available alternatives, extension plays a crucial role in empowering households with current and topical farming knowledge, information and technical skills required to cope with or respond to climate change related disasters (Maponya and Mpandeli 2013).

CONCLUSION

Most households in the Eastern Cape are vulnerable to climate change related disasters. Negative impacts of climate change related shocks for the province include food insecurity arising from occurrences of droughts and floods such as famine, malnutrition, low and non-production of crops and vegetable and a lack of marketable livestock herd and flock sizes. The impacts of climate change related shocks create challenges and impose severe losses and hardships on the poorest households as their livelihoods are more sensitive to adverse climate change. Agriculture plays a significant role in most rural households. It provides food with essential nutrients needed for human and animal growth, in addition to the provision of additional household income. However, this activity is highly vulnerable to climate issues. Climate change related shocks therefore become the main causes of crop failure and increased food prices. The results suggest that the majority of households in the EC Province would need external assistance with regard to climate change related disasters.

RECOMMENDATIONS

Based on the findings, the following are recommended:

Youth Participation in Agriculture

Farming, one of the major livelihood strategies in rural areas is labour intensive and usually done by the elderly as the youth migrate from rural areas to the urban cities. Although the results revealed that old age is associated with less vulnerability to climate change related shocks. This activity requires able-bodied men and women, not the elderly who may not be capable of doing farming activities. A comprehensive model of entrepreneurial training for the youth is essential whereby there is provision of training, guidance and adequate support such as loans and assistance in searching for markets.

Education and Training

Results showed that households with higher formal education are less likely to be vulnerable to climate change related disasters than their counterparts because household heads who are educated are more likely to acquire climate change knowledge and can be more adaptive. This therefore calls for the need for educational programmes that can enhance climate change knowledge among households. Education coupled with skills training are probably the most powerful tools to combat the effects of climate change related outcomes.

Off-farm Employment and Income Generating Projects

Increased off-farm employment is also encouraged as it would help preserve livelihoods. In order to achieve positive benefits from income generating projects, it is essential to develop vocational skills, knowledge, attitudes, and values that will foster income generation and assist households to buffer the risks posed by climate change related disasters.

Asset Ownership and Farm Input Support

The findings revealed that asset onwership and receiving external support by a household are important in lowering household vulnerability to climate change related disasters. This means that programmes designed to assist households improve their asset base are critical in strengthening the resilience of households with regard to external shocks caused by cli-

mate change. Government's social-protection programmmes such as social grants and input support for farming may play a positive role if targeted properly.

Livestock Production

Agriculture is often referred to as crop production; however livestock is also of paramount importance. Livestock ownership is also crucial in reducing vulnerabity to climatic shocks as indicated by the results. Livestock production with improved productivity in the communal sector can also be emphasised through increasing overall efficiency, improved calving rates, decreased mortality, reduced age at sale, increased slaughter mass high grades and the adoption of local breeds such as Nguni cattle which have improved productivity and condition at slaughter.

Extension Services

If agricultural production under extreme climatic conditions by rural households is to be promoted, it should be complemented with a strong extension service in order for it to yield positive results. Extension officers can also play a role using the recent extension approaches, for example of participatory rural appraisal, through engaging with farming households and capacitating them with the identification of their agricultural climate related problems and possible solutions.

Policy Implications

Extreme climatic events and/or climate change related shocks present significant future policy challenges, not only for South Africa but internationally. In the face of ever increasing climate change and variability, adaptation strategies and mechanisms must be formulated and emphasised. Governments and policymakers must place poor rural households at the centre of such strategies and mechanisms as they are the most vulnerable social group. This however cannot be done by the governments alone and will need active collaboration and co-ordination of all stakeholders involved. Although good programmes by government may exist, there is a lack of a systematic approach to enhance co-ordination of climate change related programmes. There is a need therefore to develop an integrated approach to tackle the challenges of climate change related disasters with joint efforts by government departments, local municipalities, affected communities and the private sector. Combined efforts to adapt to climatic change will assist to improve the resilience of poor rural households. In addition, more research is deemed necessary to guide the formulation of appropriate policies and adaptation programmes.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge Development Data for technical assistance in computing the HVI scores; National Agricultural Marketing Council (NAMC) – for providing additional enumerators and transport during data collection in Instika Yethu and Umzibumvu Local Municipalities; and the University of Fort Hare Risk and Vulnerability Science Centre. Lastly, sincere gratitude to FANRPAN for their good work in co-ordinating the project and the Financial and Fiscal Commission (FFC) and International Development Research Centre (IDRC) for financing the project.

REFERENCES

Adesina AA, Baidu-Forson J 1995. Farmers' perceptions and adoption of new agricultural technology: Evidence from analysis in Burkina Faso and Guinea, West Africa. *Agricultural Economics*, 13: 1–9.

Akerlof KL, Delamater PL, Boules CR, Upperman CR, Mitchell CS 2015. Vulnerable populations perceive their health as at risk from climate change. *Int J Environ Res Public Health*, 12(12): 15419–15433.

Architects, Planners and Urban Designers (ARG Design) 2010. Alice Regeneration Programme. High Level Feasibility Assessment Report. From <http://www.aspire.org.za/reports/Alice%20 Regeneration% 20%20High% 20Level% 20Feasibility% 20Assessment%20-%20Final.pdf> (Retrieved on 22 August 2016).

Baiyegunhi LJS, Fraser GCG 2010. Determinants of Household Poverty Dynamics in Rural Regions of the Eastern Cape Province, South Africa. *Poster Presented at the Joint 3rd African Association of Agricultural Economists (AAAE) and 48th Agricultural Economists Association of South Africa (AEASA) Conference*, Cape Town, South Africa, 19 September - 23 September.

Bank L, Minkley G 2010. *Going Nowhere Slowly? Land, Livelihoods and Rural Development in the Eastern Cape*. Fort Hare: Fort Hare Institute for Social and Economic Research, Centre for African Studies at the University of Cambridge.

Bayrau A, Bekele F, Assefa B, Hagos A 2015. Characteristics of Climate Change Risk, Vulnerability and

Adaptation in Cotton and Sugarcane Producing Regions of Ethiopia: Discussions from a Household Survey. *Research Report 20*. Ethiopia, Addis Ababa: Ethiopian Development Research Institute.

Blaikie P, Cannon T, Davis I, Wisner B 1994. *At Risk: Natural Hazards, People's Vulnerability, and Disasters*. London: Routledge.

Brown O 2006. Addressing Land Ownership after Natural Disasters. An Agency Survey: Published by the International Institute for Sustainable Development. From <https://www.google.co.za/url?sa=tandrct=jandq=andesrc=sandsource= webandcd=1andcad=rjaanduact=8andved=0CC4QFjAA and url=http%3A%2F%2Fwww.iisd.org%2 Fpdf% 2F2006%2Fes_addressing_ land. pdfandei= EWgd U57oKqOV7Q a99o CwCgandusg=AFQj CNFW1M HVZKGQEr5MTCB Qwtovz_gmdwandsig2= CMd K9OtOFdIDpivsQZ6oww> (Retrieved on 9 March 2014).

CARE Poverty, Environment and Climate Change Network (PECCN) 2011. Understanding Vulnerability to Climate Change: Insights from Application of CARE's Climate Vulnerability and Capacity Analysis (CVCA) Methodology. From <https://www.google.co.za/url?sa=tandrct=jandq=andesrc= sandsource= webandcd=2andcad=rja anduact= 8andved = 0CCEQFjABah UKEwiJz67 amKPHAhXDVxQ KHfAgBHMandurl =http%3A% 2F%2Fwww.dmru.org%2Ffileadmin%2FFiler%2 FDoku-menter%2FR BA_links%2 FMiljoe_og_ klima%2F5_CARE-Understanding_ Vulnerability-2011.pdfandei=vwzL VcnzOMOvUfDBkJgHandusg=A FQjCNGRmON t8WskcNmuZyqpoSgXURx2 CAandbvm=bv.99804247,d.d24> (Retrieved on 12 August 2015).

Carson RT, Sun Y 2007. The Tobit model with a non-zero threshold. *Econometrics Journal*, 10: 488–502.

Celia A, Harvey CA, Rakotobe ZL, Rao NS, Dave R, Razafimahatratra H, Rabarijohn RH, Rajaofara H, MacKinnon JL 2014. Extreme vulnerability of smallholder farmers to agricultural risks and climate change in Madagascar. *Phil Trans R Soc B*, 369:20130089.http://dx.doi.org/10.1098/rstb.2013.0089

Chauke PK, Anim FDK, Pfumayaramba TK, Nekhavhambe TD 2014. An assessment of factors affecting income generation from crop production under irrigation in the Limpopo Province of South Africa. *J Hum Ecol*, 45(1): 1–6.

Coulibaly YJ, Mbow C, Sileshi GW, Beedy T, Kundhlande G 2015a. Mapping vulnerability to climate change in Malawi: Spatial and social differentiation in the Shire River Basin. *American Journal of Climate Change*, 4: 282–294.

Coulibaly JY, Gbetibouo GA, Kundhlande G, Sileshi GW, Beedy TL 2015b. Responding to crop failure: Understanding farmers' coping strategies in Southern Malawi. *Sustainability*, 7: 1620–1636.

Department for International Development (DFID) 2000. *Sustainable Livelihoods Guidance Sheets*. UK: Department for International Development, Natural Resources Policy and Advisory Department.

Department of Economic Development, Environmental Affairs and Tourism (DEDEA) 2013. The Eastern Cape Socio-economic Review and Outlook. From <http://www.dedea.gov.za/research/Research/Eastern%20Cape%20Socio-Economic%20 Review% 20and%20Outlook%202013.pdf> (Retrieved on 10 April 2016).

Dulal HB, Brodnig G, Onoriose CG, Thakur HK 2010. Capitalizing on Assets: Vulnerability and Adaptation to Climate Change in Nepal. *Social Development Papers: Social Dimensions of Climate Change. Paper No. 21*. Washington, DC: The World Bank.

Filiberto D, Wethington E, Pillemer K, Wells NM, Wysocki M 2010. Older people and climate change, vulnerability and health effects. *Journal of American Society on Aging*, 33(4): 19–25.

Fraser G, Monde N, Van Averbeke W 2003. Food security on South Africa: A case study of rural livelihoods in the Eastern Cape Province. In: Lieb Nieuwoudt, Jan Groenewald (Eds.): *The Challenge of Change: Agriculture, Land and the South African Economy*. Pietermaritzburg: University of Natal Press, pp. 171–183.

Frye T 2006. Ownership, voting, and job creation in Russia. *European Journal of Political Economy*, 22(2): 452-471.

Hall R, Aliber M 2010. The Case for Re-Strategising Spending Priorities to Support Small Scale Farmers in South Africa. *Working Paper 17*, Institute for Poverty, Land and Agrarian Studies (PLAAS), University of the Western Cape, South Africa.

Hanjra MA, Qureshi ME 2010. Global water crisis and future food security in an era of climate change. *Food Policy*, 35: 365–377.

Hassan FM, Imai KD, Sato T 2013. Impacts of Agricultural Extension on Crop Prodcuvity, Poverty and Vulnerability: Evidence from Uganda. From <http://www.rieb.kobe-u.ac.jp/academic/ra/dp/English/DP2012-34.pdf> (Retrieved on 12 August 2015).

Hebinck P, Lent PC 2007. *Livelihoods and Landscapes: The People of Guquka and Koloni and their Resources*. Leiden: Brill.

Inglesi-Lotz R 2012. The Sensitivity of the South African Industrial Sector's Electricity Consumption to Electricity Price Fluctuations. *Working Paper 2012-25*, University of Pretoria Department of Economics, Pretoria.

Intergovermental Panel on Climate Change (IPCC) 2014. Climate Change 2014: Impacts, Adaptation and Vulnerability, Summary for Policy Makers. Working Group II Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. From <http://ipcc-wg2.gov/AR5/images/uploads/WG2AR5_SPM_FINAL.pdf> (Retrieved on 10 April 2016).

Intsika Yethu Local Municipality Integrated Development Plan (IDP) 2013/14. Intsika Yethu Local Municipality Integrated Development Plan 2013-2014 Financial Year. From <http://www. intsikayethu. gov.za/sites/default/files/filepicker/1/IYM%20Final%20IDP%202013-2014.pdf> (Retrieved on 23 March 2016).

Juana JS, Kahaka Z, Okurut FN 2013. Farmers' perceptions and adaptations to climate change in Sub-Sahara Africa: A synthesis of empirical studies and implications for public policy in African agriculture. *Journal of Agricultural Science*, 5(4): 121–135.

Kathmandu BL 2009. Gender and Climate Change in the Himalayas. Background Paper for the e-Discussion from 5 to 25 October 2009 organised by ICIMOD and APMN. From <https://www. google.co.za/url?sa=tandrct= jandq= andesrc= sandsource=webandcd=7andcad=rjaanduact= 8andved= 0CEwQFjAGahUKEwjOnOf-h9jHAhVCshQKHQbg Ca Aandurl= http%3A%2F%2 Fwww. icimod.org%2Fresource% 2F455andusg= AFQj CNFOHCt 1LC3 0cyK-57_BkE7RUXvbq Aand bvm=bv.101800829, d.ZGU> (Retrieved on 2 September 2015).

Kelly M, Adger N 2000. Theory and practice in assessing vulnerability to climate change and facilitating adaptation. *Climatic Change*, 47: 325–352.

Labadarios D, Davids YD, Mchiza Z, Weir-Smith G 2009. *The Assessment of Food Insecurity in South Africa*. Unpublished. Centre for Poverty, Employment and Growth, Human Sciences Research Council, Pretoria/South Africa.

Lavell A, Oppenheimer M, Diop C, Hess J, Lempert R 2012. Climate change: New dimensions in disaster risk, exposure, vulnerability, and resilience. In: CB Field, V Barros, TF Stocker, D Qin, DJ Dokken, KL Ebi, MD Mastrandrea, KJ Mach, GK Plattner, SK Allen M Tignor, PM Midgley (Eds.): *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC)*. Cambridge, UK/New York, USA: Cambridge University Press, pp. 25–64.

Lings K 2015. In SA 1 in 4 Still Unemployed – Youth Crisis as 63.1% Remain Jobless. From <http://www.biznews.com/thought-leaders/2015/07/29/sa-q2-unemployment-eases-to-25-but-63-1-of-youth-remain-jobless/> (Retrieved on 23 March 2016).

Lokonon BOK 2015. Building Resilience to Climate-Related Shocks: Farmers' Vulnerability to Climate Shocks in the Niger Basin of Benin. *Paper presented in the African Economic Conference 2015, Addressing Poverty and Inequality in the Post 2015 Development Agenda*. Government Building/ African Union Building Kinshasa, Democratic Republic of Congo, 2 November – 4 November.

Makhubu N 2016. Food Insecurity Now a Reality in SA. *IOL, Business News*, March 04, 2016.

Maponya P, Mpandeli S 2013. The role of extension services in climate change adaptation in Limpopo province, South Africa. *Journal of Agricultural Extension and Rural Development*, 5(7): 137–142.

Moser C, McIlwaine C 1997. Household Responses to Poverty and Vulnerability; Confronting Crisis in Commonwealth, Metro Manila, the Philippines. *Urban Management Policy Paper 23*. Washington DC: World Bank.

Musemwa L, Zhou L, Ndhleve S, Aghdasi F 2013. Factors affecting household access to enough food in the Eastern Cape Province of South Africa. *Journal of Development and Agricultural Economics*, 5(3): 84-91.

Nelsona MC, Ingram SE, Dugmore AJ, Streeter R, Peeples MA 2016. Climate challenges, vulnerabilities, and food security. *PNAS*, 113(2): 298–303.

Ngigi MW, Birner R 2013. Shocks, Livestock Assets and Climate Change Adaptation in Kenya. *Paper prepared for presentation at the 4th African Association of Agricultural Economics, AAEA/AEASA Conference*. Hammamet, Tunis – Tunisia, 23 September – 25 September.

Nhemachena C 2009. *Agriculture and Future Climate Dynamics in Africa: Impacts and Adaptation Options*. PhD Thesis, Unpublished. Pretoria: University of Pretoria.

Nkondze MS, Masuku MB, Manyatsi A 2013. Factors affecting households' vulnerability to climate change in Swaziland: A case of Mpolonjeni Area Development Programme (ADP). *Journal of Agricultural Science*, 5(10): 108–122.

Nkonkobe Municipality Integrated Development Plan (IDP) 2013/14. Nkonkobe Local Municipality Integrated Development Plan. From <http://www.nkonkobe.gov.za/?q=system/files/filedepot/2/FINAL%20IDP%202013%2014.pdf> (Retrieved on 23 March 2016).

Olmos S 2001. Vulnerability and Adaptation to Climate Change: Concepts, Issues, Assessment Methods: For the Climate Change Knowledge Network (CCKN). From <http://www.start.org/Projects/AIACC_Project/meetings/Trieste_02/trieste_cd/Resource_Materials/CCKN.pdf> (Retrieved on 10 April 2016).

Opiyo F, Wasonga O, Nyangito M, Schilling J, Munang R 2015. Drought adaptation and coping strategies among the Turkana pastoralists of northern Kenya. *International Journal of Disaster Risk Science*, 6(3): 295–309.

Pauleit S, Coly A, Fohlmeister S, Gasparini P, Jorgensen G 2015. *Urban Vulnerability and Climate Change in Africa: A Multidisciplinary Approach*. Switzerland: Springer International Publishing.

Piya L, Maharjan KL, Joshi NP 2012. Vulnerability of Rural Households to Climate Change and Extremes: Analysis of Chepang Households in the Mid - Hills of Nepal. *Selected Paper Prepared for Presentation at the International Association of Agricultural Economists (IAAE) Triennial Conference*. Foz do Iguaçu, Brazil, 18 August - 24 August.

Pricope N, Pardo L, López-Carr D 2014. Vulnerability to Climate Change. From <http://geog.ucsb.edu/~carr/wordpress/wp-content/uploads/2014/08/Vulnerability-to-Climate-Change-Geography-Oxford-Bibliographies-.pdf> (Retrieved on 10 April 2016).

Ribbink AJ 2012. The Impact of Climate Change on Food Security among Coastal Communities of Keiskamma, in the Eastern Cape, South Africa. Final Project Report for 2011 START Grants for Global Change Research in Africa. From <http://start.org/download/gec11/ribbink-final-report.pdf > (Retrieved on 10 April 2016).

Seo N, Mendelsohn R 2007. Climate Change Adaptation in Africa: A Microeconomic Analysis of Livestock Choice. *Policy Research Working Paper 4277, Development Research Group, Sustainable Rural and Urban Development Team*. Washington DC: The World Bank.

Smith EF, Keys N, Lieske SN, Smith TF 2015. Assessing socio-economic vulnerability to climate change impacts and environmental hazards in New South Wales and Queensland, Australia. *Geographical Research*, 53(4): 451–465.

Spatial Development Framework (SDF) 2011. Alfred Nzo Spatial Development Framework. From <http://www.umzimvubu.gov.za/Municipal_ documents/SDF/Documents/UMZIMVUBU% 20FINAL%20SDF.pdf > (Retrieved on 22 August 2016).

Stats SA 2011. Census 2011 Statistical Release - Statistics South Africa. From <www.statssa.gov.za/publications/P03014/P030142011.pdf> (Retrieved on 9 March 2014).

Striessnig E, Lutz W, Patt AG 2013. Effects of educational attainment on climate risk vulnerability. *Ecology and Society*, 18(1): 16.

Tibesigwa B, Visser M, Hunter L, Collinson M, Twine W 2015. Gender Differences in Climate Change Risk, Food Security, and Adaptation: A Study of Rural Households' Reliance on Agriculture and Natural Resources to Sustain Livelihoods. From <http://www.rff.org/files/document/file/EfD-DP-15-20.pdf> (Retrieved on 10 April 2016).

Tobin J 1958. Estimation of relationships for limited dependent variables. *Econometrica*, 26(1): 24–36.

Trading Economics 2016. South Africa Unemployment Rate 2000-2016. From <http://www. tradingeconomics. com/south-africa/unemployment-rate> (Retrieved on 23 March 2016).

Umzimvubu Local Municipality Integrated Development Plan (IDP) 2013/2014. Umzimvubu Local Municipality Integrated Development Plan 2013/2014 Financial Year: 1st IDP Review for the Period: 2012 – 2017. From <https://www.google.co.za/url?sa=t&rct=j&q=&esrc=s&source=w eb&cd= 2& cad=rja&uact =8&ved=0ah UKEwjB_ cm7qrn PAhUpB MAKHWZGA3c QFggg MAE &url=http%3A %2F%2 Fwww. umzimvubu. gov. za%2F Municipal_ documents %2 Fidp%2 FDocuments% 2FIDP %2520 2013 % 2520-2014.pdf& usg=AFQjCN Fvx 2AV4Kh1a1 CdhvLZeoYFMHps MQ&sig 2=JQJ1TJ X5cdMt OWoe 7u7tAQ> (Retrieved on 23 March 2016).

Wenhold FAM, Faber M, Van Averbeke W, Oelofse A, Van Jaarsveld P 2007. Linking smallholder agriculture and water to household food security and nutrition. *Water SA* (Special Edition), 33(3): 327–336.

World Bank 2002. *Pakistan Poverty Assessment – Poverty in Pakistan: Vulnerability, Social Gaps and Rural Dynamics*. Washington, DC: World Bank.

Zavale H, Mabaya E, Christy R 2005. Adoption of Improved Maize Seed by Smallholder Farmers in Mozambique. *Staff Paper SP 2005-03*. Ithaca, New York: Cornell University, Department of Applied Economic and Management.

Paper received for publication on November 2015
Paper accepted for publication on November 2016