Assessing Forest-based Rural Communities' Adaptive Capacity and Coping Strategies for Climate Variability and Change: The case of Vhembe District in South Africa

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Abstract
In this study, various coping strategies used by forest-based rural communities in Vhembe District of South Africa in response to climate variability and change challenges were investigated. The effect of community socio-demographic characteristics on the adaptive capacity and choice/effectiveness of coping strategies was examined. Household level data were collected from 366 respondents selected from 21 rural communities using the proportionate random sampling procedure. The Pearson Chi-square test was used to analyse the coping strategies. The effects of household and community socio-demographic characteristics on choice and effectiveness of coping strategies were determined using the binary logit model. It was observed that the respondents used diverse coping strategies, depending on the nature of climate variability and extreme weather events they were confronted with. Rainwater harvesting was the most popular strategy that the respondents in Makhado (90%), Mutale (96.3%), and Thulamela (50%) used to cope with erratic rainfall. Tree planting around houses and on farmland were the most popular strategies (90-100%) to counter the effects of extreme temperature. Furthermore, household and community demographic characteristics in particular education and skills levels, and forest products, institutional services and infrastructure available in the communities such as markets, and water supply facilities significantly ($p<0.05$) influenced the choice of households' coping strategies. Therefore, it can be hypothesized that efforts that enhance the household's capacity and community infrastructural development might be viable and sustainable ways of improving rural communities' resilience to climate change and variability challenges.

Keywords: Climate variability and change, community resilience, coping strategy, livelihood, adaptation, adaptive capacity

1. INTRODUCTION

Forest-based rural communities in Africa are increasingly becoming the focal point in climate change discourse, mainly due to their vulnerability to climate variability and change challenges (Coulibaly et al., 2015). This is due to their high level of dependence on forests and natural resources for livelihood (Robledo et al., 2012; Coulibaly et al., 2015). Prolonged impact of climate change might result in increased poverty and unsustainable rural development (Boon and Ahenkan, 2012; Hammil et al., 2013). Thus, there is a growing need to address vulnerabilities of rural people to climate change (Helgeson et al., 2013).

The 2015 Paris agreement, which is aimed at advancing and fostering international cooperation towards implementation of programs that might accelerate transition towards a low-carbon economy and climate-resilient society (Sebastian et al. 2015), added impetus to the many national and multilateral commitments, actions and initiatives that seek to address climate change through capacity enhancement (Viljoen, 2013). For many developing countries, particularly in Africa, this represents a unique opportunity for international cooperation and attracting technical and financial support towards establishment of an improved modality for reducing the vulnerability of communities facing climate

impacts. This will facilitate meaningful incorporation of rural communities in climate change adaptation and mitigation initiatives.

Residents of rural areas rely on their own coping mechanisms that help them to cushion the effect of climate variability and extreme weather events (Perlis, 2009; Coulibaly et al., 2015). Indigenous knowledge and utilization of natural resources such as non-timber forest products (NTFPs) as a safety net have been useful coping strategies (Valdivia et al., 2005; Shackleton et al. 2008; Angela et al., 2010; Locatelli et al., 2010; Pramova et al., 2012; Wilk et al., 2013). However, despite past success in dealing with climate variability and extreme weather events, there are concerns that the coping strategies in use could be less effective in handling the accelerated pace of climate change-induced occurrence of extreme weather events (Adger et al., 2007; Wilk et al., 2013). This highlights the need for determining whether the current coping strategies that rural households use can be transformed into sustainable adaptive strategies to ensure livelihood security under climate change challenges (Wall and Marzall, 2006; Thomas et al., 2007).

Coping strategies are short-term actions used to ward off immediate risk and are often not relevant in reducing vulnerability in the long-term (Turner et al., 2003I; The International Centre for Integrated Mountain Development: ICIMOD, 2007). Nevertheless, they provide useful insights on how to develop more practical, sustainable, and localised adaptation strategies (Twomlow et al., 2008; Fisher et al., 2010). Moreover, coping strategies are often location-specific. Thus, it is necessary to assess coping strategies specific to forest-based communities in order to develop appropriate location-specific policies and interventions (Williams and Kalamandeen, 2013; Nkomwa et al., 2014). In support of the Wilk et al. (2013) argument, interventions designed to enable adaptation are likely to be successful if they are localised. This originates from the fact that adaptation to climate change is inevitably and unavoidably local. Therefore, this study was based on the notion that incorporating current local coping strategies into climate change policies and interventions can lead to cost effective, participatory, locally relevant and sustainable interventions (Twomlow et al., 2008; Nkomwa, et al., 2014).

Past experience of manifestations of extreme weather events in rural communities suggest that: (a) not all households have the capacity to adapt to the challenges of climate change (CARE, 2011), and (b) not all households' current coping strategies are effective in combating the risks associated with climate change (Angela et al., 2010). In addition, several studies (Moghal, 2011; Goldman and Riosmen, 2013; Byrne, 2014; CARE, 2014; Egyir et al., 2015) have revealed that households, even within the same community adopt different coping strategies. Adaptive capacity is a consequence of the extent of vulnerability and/or resilience to climate change (Helgeson et al., 2013; Byrne, 2014). Joerin et al. (2012) found similar results in Chennai, India. In the latter study, despite the households' past experience of flood-related disasters, their resilience remained very low due to their limited adaptive capacity. This implies that without appropriate adaptive capacity, the resilience of households to climate disaster is limited to the cycle of absorbing, managing and bouncing back (Joerin et al., 2012; Robledo et al., 2012).

The extent to which households and communities adapt to the impact of climate change significantly affects sustainable development (Byrne, 2014). However, it does not mean that high adaptive capacity translates to improved resilience to climate change (Amisah et al., 2009). Sometimes, there are underlying socioeconomic conditions that either facilitate or hinder adaptive capacity (Hughey and Becken, 2014). Several authors (Adeniji-Oloukoi et al., 2013; Williams and Kalamandeen, 2013; Byrne, 2014; CARE, 2014) have reported that adaptive capacity at either household or community level depends on demographic factors such as access to information, social, human, institutional, natural and economic resources, and technologies. Thus, there is need for studies that identify attributes or socio-demographic factors that aid the climate change adaptation capacity of households (Panda et al., 2013).

Scholars such as Alberini et al. (2006) and Elrick-Barr et al. (2015) have pointed out the difficulty of identifying and carrying out empirical analyses of the relative importance of socio-demographic

factors in households' adaptive capacities. Moreover, most studies on capacity to adapt to climate change (Nzuma et al., 2010; Arnall, 2012; Lemos, 2013; Tembo, 2013) have focused mainly on national level assessments that utilize indicators and indices (Byrne, 2014). Yet national scale indicators of adaptive capacity are too broad for practical application at local community level (Tembo, 2013). Nevertheless, adaptive capacity assessment significantly contributes to climate change management at household or local community level (Elrick-Barr et al., 2014).

Taking into account the numerous issues highlighted above, this study was carried out to clarify the complex human-environment interaction in forest-based rural communities of Vhembe district in Limpopo Province of South Africa. The socioeconomic conditions that affected coping strategies that the communities used and adaptive capacity of households to climate change were investigated. Specifically, the study was designed to identify the coping strategies of the households to climate variability and the roles of forests in this regard. Additionally, it sought to establish the adequacy and effectiveness of the coping strategies. The following research questions anchored the study:

(i) How does a household respond to perceived climate variability and change?
(ii) Do forests play any role in the coping strategies that households choose and how effective are these?
(iii) Are there factors constraining or enhancing households' adaptive capacities?
(iv) Which attributes of adaptive capacity are crucial for the household coping strategies and should they be enhanced?
(v) Do the attributes of adaptive capacity influence households' choices of coping strategies?

2. METHODOLOGY

2.1 Study Area

As already revealed above, the study was conducted in Vhembe District Municipality, which is located in Limpopo Province of the Republic of South Africa (22° 56 S, 30° 28E, Figure 1). Makhado, Musina, Mutale and Thulamela municipalities constitute the district. In Vhembe district, there are approximately 1.2 million with females accounting for 54.4%. Most of the people (48.7%) are found in Thulamela local municipality. The rest of the population is distributed as follows: Makhado (41.4%), Mutale (6.6%), and Musina (3.3%) (Statistics South Africa: SSA, 2011). Tshivenda-speaking people make up 69% of the population, followed by the Xitsonga speakers (27%). In order to cover the various representations in the district in relation to the study objectives, vegetation type and dominant livelihood strategy were considered in the selection of Makhado, Mutale and Thulamela municipalities as the focal area of study.

The landscape of selected communities in Makhado, Mutale and Thulamela is made up of Savannah, semi-arid zones and woodland vegetation, respectively (Rosmarin 2013). Rainfall received in Makhado occurs mainly in the summer months, extending from November to March (Quinn *et al.*., 2011; Vhembe Biosphere Reserve: VBR, 2012; Turpie and Visser, 2013). Mutale municipality receives about 681mm of rainfall per year, with most of it occurring during mid-summer (Marrewijk, 2011; VBR, 2012). In Thulamela municipality, most of the rainfall falls between October and January (VBR, 2012). Projections in the South African National Climate Change Response Strategy reveal that in Vhembe district, temperature is expected to increase in the range 1^0C to 3^0C by the mid-21st century (Department of Environmental Affairs and Tourism: DEAT, 2004). Furthermore, it is projected that rainfall amounts will be reduced by 5% to 10% (DEAT, 2004). These changes in climate are likely to severely impact on rural livelihood strategies such as farming, livestock keeping and use of forest products, thereby increasing the vulnerability of the affected communities (Paumgarten and Shackleton, 2011; Turpie and Visser, 2013). Apart from this, in Vhembe District unemployment rates are high and most rural households depend on social grants (VBR, 2012). The

interconnectedness of social, ecological, and human systems makes these communities acutely sensitive to the impacts of climate change (Intergovernmental Panel on Climate Change: IPCC, 2007).

2.2 Sampling framework

In each of the selected municipalities, 7 rural communities were selected, implying that 21 rural communities constituted the overall sample for this study. The stratified proportionate random sampling procedure was used to select the 366 households that were interviewed. Enumeration area (EA) maps of the selected communities, which contained the total number of households and their location, were used to divide the communities into three strata. Thereafter, they were proportionately and randomly selected households from each stratum. The coordinates of the selected households were entered into Germain etrex30 GPS and used to track the location of each house during the questionnaire administration period. Each household was selected for questionnaire administration using a non-probability purposive sampling technique. Respondents in a household were supposed to (a) be more than 20 years old and (b) have lived in their community for more than five years.

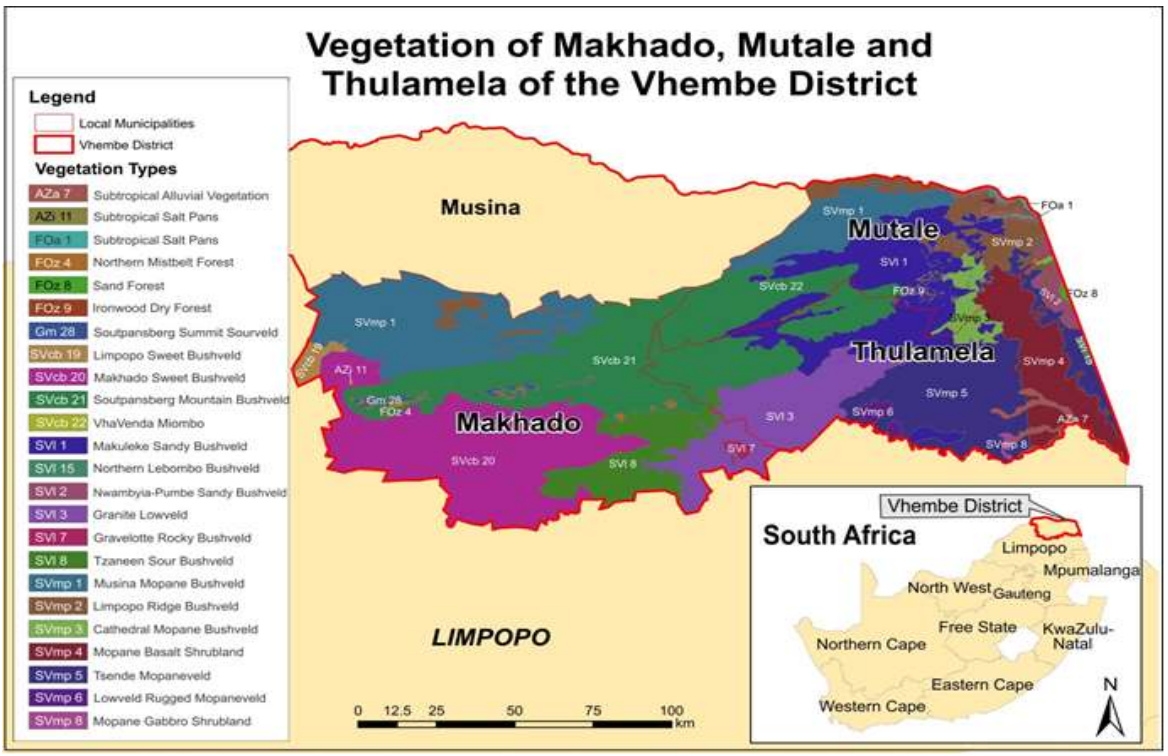

Figure 1: Map of Vhembe District showing the study communities (Source: SSA, 2011)

2.2.1 Data collection

Both primary and secondary data were collected. Primary data were collected through household surveys, discussions with leaders of villages and field observations. The household questionnaire was selected because it provided a quantitative way of measuring the coping responses and adaptive capacities of households in relation to climate change. Evidence from the literature suggests that this method has merit in providing baseline household data on the residents' ability to respond to and cope with climate change (McNamara, 2011). Secondary information was also used in the study and it entailed carrying out a critical review of relevant literature on the government's climate change programme as well as forest policy, legislation and relevant strategy documents.

Analysis of Coping Strategies

The coping strategies of households were analysed by asking questions on how the residents responded to climate variability and extreme weather events such as drought, erratic rainfall, extreme temperature, flooding and hailstones. The questions on effectiveness and sustainability of the coping

strategies were also asked. In this study, the average daily temperatures of at least 31.6°C were regarded as extreme. The information from literature, discussion with village heads, and reconnaissance survey were used to compile a list of coping strategies used. The respondents were then asked to indicate, among the pre-determined coping strategies listed in the questionnaire, those that they had used to counter the adverse effects of climate variability and extreme weather events. They were also asked whether they perceived any difficulties in coping with climate change. Empirical analyses were also used to examine the role of forest products in the coping strategies of the households.

Analysis of Adaptive Capacity

In this study, adaptive capacity refers to the potential of the people to adapt, rather than the actual actions taken in response to adverse conditions emanating from climate change. Socio-demographic characteristics such as access to services and infrastructure, and socioeconomic conditions affect the adaptive capacity of the households. In order to understand how adaptive capacity varied across rural communities, a framework (see Figure 2) was developed taking into account the guidelines of the Sustainable Livelihoods Approach (SLA). Questions included assessing the socioeconomic factors enhancing or hindering the adaptive capacity of the households (Mendis et al., 2003; Valdivia et al., 2005; Marshall et al., 2010; Adeniji-Oloukoi et al., 2013).

The socio-demographic factors influencing household adaptive capacity that were assessed in the study area included: (i) access to information; (ii) participation or support from community-based organisations within the community; (iii) acquired knowledge and skills; and (iv) access to infrastructure.

Access to Information explains availability of knowledge regarding coping strategies and provides a basis from which households can anticipate or react in order to minimize the impact of climate variability and change.

Participation or Support from Community-based Organisations within the Community: This describes the relationships of trust and exchange among community members. It is reflected in the community's ability to act as a collective. Thus, participation of a household in community support organisations was assessed. The attitude and perspective of the people with respect to their responsibility and action towards climate change adaptation was also investigated by asking respondents questions relating to who should be responsible for taking action against climate change. Questions were based on a Likert scale that ranged from 'strongly disagree' (equal to 1) to 'strongly agree' (equal to 5).

Acquired Knowledge and Skill: Knowledge and skills influence the adaptive capacity of households. They also enable the households to anticipate changes and appropriately modify their livelihood opportunities. Levels of education and skills of members of households were assessed together with their impact on the coping responses and adaptive capacity. Available literature was used to draw up a list of skills relevant for sustainable rural livelihoods, particularly focusing on forest-based livelihoods. Respondents were then asked to indicate the skills they possessed.

Access to Infrastructure: The role of institutions vis-à-vis access to infrastructure and facilities in determining adaptive capacity is a widely accepted notion (Adger et al., 2007). Therefore, households' satisfaction with vital services such as water facility, healthcare facility, and markets in their communities and their impact on coping responses and adaptive capacity were assessed.

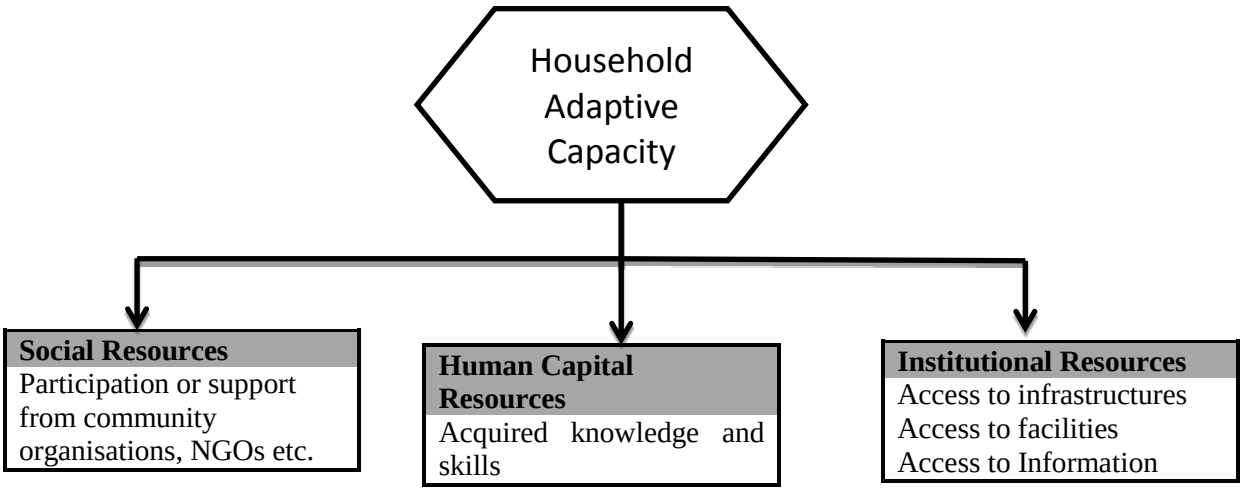

Figure 2: Household adaptive capacity analysis framework

2.2.2 Data analysis

Data collected using the questionnaire survey were subjected to weighting adjustment in order to correct for possible problems of either over- or under-representation of variables (Bethlehem, 2015). The sample was weighed against the actual population in order to arrive at the weighted sample. The weighted data were then analysed using the Statistical Package for the Social Sciences (SPSS) version 20 (Levesque 2007).

Discrete variables were summarised using the frequency of each code within the questionnaire. Summary statistics were computed for all numeric variables. Categorical data regarding the opinion of respondents were analysed taking individual responses into consideration. Descriptive statistics and Chi-square test were used to analyse the range of households' coping responses, current role of forest products in household coping strategies in response to climate variability and change, and influence of households and communities demographic characteristics on choice of coping strategies. Bonferoni's test was used to analyse differences across municipalities following the approach of Berg (2014). The Chi-square test was also used to determine whether there was any association between support from the social group and expressed difficulties in coping with climate variability and change. The Pearson Chi-square was used where the expected cell frequency was ≥ 5. The Maximum-Likelihood (M-L) Chi-square was used when the expected cell frequencies were lower than five (Turyahabwe et al., 2006).

Binary logistic regression was used to analyse the influence of social resources, human capital and institutional resources on household choice of coping strategies and challenges encountered. The binary logistic regression technique was used because predictor variables in the data collected were categorical. Odds ratios were used to measure the magnitude of strength of association or non-independence between two binary data values. If $p \leq 0.05$ (less than or equal to 0.05), was observed, it was concluded that there existed a statistically significant difference in what was being tested (Clewer and Scarisbrick, 2001).

Satisfaction with social and institutional resources was framed as a binary-choice model, which assumed that respondents were either satisfied or not satisfied with social resources and/or institutional resources in their communities. Human capital vis-à-vis educational level was framed as binary (educated or not educated). Satisfaction with social resources, institutional resources, and human capital were depended on identifiable characteristics. Thus, let T_i represent a dichotomous variable that equals 1 if respondents are satisfied with social, human and institutional resources in their communities, and 0 if they are not satisfied.

The probability of being satisfied with social and institutional resources, and human capital were in each case, Pr (T_i = 1), which is the cumulative density function F evaluated at $X_i \beta$, where X_i is a vector of explanatory variables and β is a vector of unknown parameters (Maddala, 1983). The cumulative density function was modelled using the following logistic probability function:

$$\Pr(Ti = 1) = \frac{\exp(Xi\,\beta)}{1+exp(Xi\,\beta)} \qquad (1)$$

Dependent variables were distinctly satisfaction with social and institutional resources, and human capital, which take the value of 1 if the respondents were satisfied and 0 if not. The social resources, human capital and institutional resources were separately analysed. In the case of social resources, satisfaction with the social support group in the community was used. For institutional resources, satisfaction with water supply was considered. Level of education of the respondent constituted human capital. The explanatory variables that were included in the model are presented in Table 1. The Chi-square test at p= 0.05 significance level was used to assess the goodness of fit of the models.

Table 1: Explanatory variables used in the binary logistic model

Explanatory variables		**Possible response**	
		1	**0**
a)	Employment status	employed	Not employed
b)	Farming skills	yes	no
c)	Livestock keeping skills	yes	no
d)	Carpentry skills	yes	no
e)	Education level	educated	Not educated
f)	Less than or equal to 38 years of residency in the community	yes	no
g)	39-52 years of residency in the community	yes	no
h)	53-65 years of residency in the community	yes	no
i)	66 years and above length of residency in the community	yes	no
j)	Respondents age category: ≤38	yes	no
k)	Respondents age category: 39-52 years	Yes	No
l)	Respondents age category: 53-65 years	Yes	No
m)	Respondents age category: 66 years and above	yes	No

3. RESULTS AND DISCUSSION

3.1 Coping strategies applied by local communities

In this study, it was observed that the residents of Makhado, Musina and Thulamela municipalities used various coping strategies to cushion the effect of climate variability and extreme weather events on their lives and livelihood. The strategies varied depending on the type of extreme weather event they were confronted with. Some of the strategies were not appropriate for long-term adaptation. For instance, a strategy such as growing crops around streams in response to erratic rainfall events may not be suitable for long-term adaptation. This is due to the fact that if erratic rainfall persisted for many seasons, streams might dry up. Likewise, a strategy such as migration to urban areas in search of employment opportunities used to cope with a drought event is an inappropriate long-term adaptation strategy. Rural-urban migration precipitates severe service delivery problems in the informal settlement areas in the urban areas. In order to draw better meaning from the results of the current study, the coping strategies were categorized as follows:

3.1.1 Coping strategies for dealing with erratic rainfall events

In Table 2, it is shown that the households in the surveyed communities relied on several livelihood strategies that helped them cope with the negative effects of erratic rainfall. It is shown that taking up off-farm activities was a strategy that was mainly confined to Mutale municipality. This practice mostly practiced in response to erratic rainfall. It entailed engaging in off-farm activities either within or outside the municipal area. Although this is effective in the short-term, limited opportunities for off-farm employment in the district make it unsustainable. This is particularly significant considering that Vhembe district is largely rural with high unemployment rate reaching 40% in some places (SSA, 2011). Because of this challenge, the continuous practice of 'taking off-farm activity' may lead to considerable rural-urban migration challenges and hinder local development. Thus, it is necessary to promote socioeconomic development of the communities as a way of reducing household dependence on off-farm activity to cope with erratic rainfall.

Table 2: Coping strategies for erratic rainfall among forest-based rural households' in Vhembe District of South Africa

Coping strategies	Responses	Proportion of respondents (%)		
		Makhado (n =156)	**Mutale (n = 110)**	**Thulamela (n =100)**
Shifts in planting period to coincide with the start of rainy season	Yes	51.6[a]	78.0[b]	38.0[a]
	No	48.4[a]	22.0[b]	62.0[a]
	Binomial test	0.4679[ns]	0.0000*	0.0105*
Taken off-farm activities	Yes	40.1[a]	65.1[b]	43.0[a]
	No	59.9[a]	34.9[b]	57.0[a]
	Binomial test	0.0014*	0.0016*	0.0284*
Depended on use and marketing of none timber forest products	Yes	41.0[a]	45.9[a]	13.0[b]
	No	59.0[a]	54.1[a]	87.0[b]
	Binomial test	0.0853[ns]	0.2543[ns]	0.0000*
Cropping around streams	Yes	50.6[a]	4.6[b]	22.0[c]
	No	49.4[a]	95.4[b]	78.0[c]
	Binomial test	0.2342[ns]	0.0000*	0.0000*
Use of dug out wells for irrigation	Yes	82.2[a]	96.4[b]	31.0[c]
	No	17.8[a]	3.6[b]	69.0[c]
	Binomial test	0.0000*	0.0000*	0.0000*
Planting drought resistant crop e.g. water melon	Yes	89.2[a]	92.7[a]	37.0[b]
	No	10.8[a]	7.3[a]	63.0[b]
	Binomial test	0.0000*	0.0000*	0.0105*
Rainwater harvesting	Yes	92.3[a]	96.3[a]	50.0[b]
	No	7.7[a]	3.7[a]	50.0[b]
	Binomial test	0.0000*	0.0000*	0.3822*

*Each subscript letter denotes a subset of community categories whose row proportions do not differ significantly from each other at the .05 level. Binomial test analysis of yes and no responses by respondents *significant at 0.05; ns=not significant at 0.05*

Shifting the crop planting period to coincide with the onset of the rainy season in response to erratic rainfall was more common in Mutale (78%) than Makhado (51.6%) and Thulamela (38%) municipalities. This was not surprising given the fact that Mutale is the driest part of Vhembe District. As a result, the residents of Mutale municipality are more exposed to direct and indirect consequences of erratic rainfall. Shifting the planting and transplanting seasons to cope with erratic rainfall has also been observed in the Mruthyunjaya and Selvaraja (2002) study in rural communities of Coastal Orissa, India. However, the effectiveness and efficiency of this strategy depends on the households' continued access to climate information required to make decisions. The information enables local people to schedule their planting operation in sync with prevailing climatic conditions.

Growing crops on stream banks was not significantly practiced in the three municipalities of Vhembe district. This was not surprising because there were no streams in most of the villages that were studied. In the villages where there were streams, crops were mostly plated in inaccessible terrains located far away from dwelling places.

Subsistence use and trade in non-timber forest products (NTFPs) were not common practices in all the three municipalities. In general, these strategies are not associated with the challenges of climate variability and change. This explains why it was not a significant coping strategy in the study communities. Another plausible explanation for the non-significant use of NTFPs as a coping strategy in the study communities could be the current poor development/organisation of the informal forest sector. As a result, the people did not derive maximum benefit from the sector, thus discouraging widespread participation in trade in forest products in the study communities.

Approximately, 50% to 96.3% of the household representatives indicated that rainwater harvesting was one of the coping strategies they relied on. Rain water harvesting has also been observed as a popular coping strategy among rural communities in Nigeria (Boon and Ahenkan, 2012) and Ghana (Ajani et al., 2013). The effectiveness and sustainability of rain water harvesting techniques often depend on the volume of the storage tanks that households install. Because of widespread poverty in the study communities, most households found it difficult to effectively utilise this strategy. The residents either installed small tanks or did not have storage tanks at all. They relied on few large containers they owned. As a result of this challenge, these households stored water that lasted a few days. This means that this strategy is inappropriate for dealing with prolonged, erratic rainfall events. Type of housing also affects the effectiveness of rain water harvesting. Most often, people living in a traditional thatched roof mud houses cannot effectively adopt this strategy. In general, lack of access to credit is a major constraint to coping and adaptation to climate change in rural communities of most African countries (Bryan et al., 2010; Chigavazira, 2012; Tembo, 2013).

Planting drought-resistant crops such as water melons and use of dug out wells for irrigation were some of the strategies used to cope with erratic rainfall. Perlis (2009) reported similar results from research on risks such as excessive or low rainfall, drought and crop failure in rural communities in the Chad Republic. The growing of crops that are resistant to erratic rainfall and drought challenges serves as a safety measure for facilitating household livelihood resilience. The effectiveness of this strategy is largely dependent on the financial capacity of households and their access to improved planting stock.

3.1.2 Coping strategies for dealing with drought event

There was a link between occurrence and coping with erratic rainfall and drought events in the communities in Vhembe district where this study was undertaken. The coping strategies are presented in Table 3.

Improved water storage and reuse were common in all the three municipal areas where the current study was carried out. In general, more people tended to conserve and reuse water in areas that experienced poor water supply. The storage and reuse enabled households to improve efficiency of water use and management in the communities. It is crucial to promote such strategies such that it becomes a regular practice.

Just as observed in the case of households' coping strategies to erratic rainfall, the dependence on use and trade in NTFPs as a strategy for coping with drought was uncommon. Nevertheless, it appeared there was potential for improved use and trade in NTFPs as an alternative strategy for strengthening household resilience to climate change-induced challenges. Furthermore, it was observed that crop irrigation was significantly practiced in Makhado municipality only. Presumably, this was so because of varying levels of functionality of water supply facilities in the municipalities. Migration to urban areas in search for work opportunities in response to drought challenges was not a common coping strategy in the studied communities. The non-significant practice of rural-urban migration as a coping strategy was an opportunity worth exploiting in the quest for local development. For example, because of limited outward migration, it was likely that developmental projects such as forest plantations established in the communities would not experience severe shortage of labour.

Table 3: Common strategies forest-based rural households in Vhembe District of South Africa used to cope with drought

Coping strategies	Responses	Communities		
		Makhado	Mutale	Thulamela
Improve water storage	Yes	77.1[a]	100.0[b]	21.0[c]
	No	22.9[a]	0.0[b]	79.0[c]
	Binomial test	0.0000*	0.0000*	0.0000*
Water reuse	Yes	82.1[a]	98.2[b]	56.0[c]
	No	17.9[a]	1.8[b]	44.0[c]
	Binomial test	0.0000*	0.0000*	0.0967[ns]
Depended on use and marketing of non-timber forest product	Yes	43.6[a]	49.1[a]	12.0[b]
	No	56.4[a]	50.9[a]	88.0[b]
	Binomial test	0.2342[ns]	0.4624[ns]	0.0000*
Migration to urban areas for work	Yes	15.9[a]	7.3[a]	6.0[a]
	No	84.1[a]	92.7[a]	94.0[a]
	Binomial test	0.0000*	0.0000*	0.0000*
Increase water capture e.g. borehole water, rain water harvest etc.	Yes	73.9[a]	87.3[b]	22.8[c]
	No	26.1[a]	12.7[b]	77.2[c]
	Binomial test	0.0000*	0.0000*	0.0000*
Water rationing e.g. reduce water use per person per day	Yes	96.2[a]	96.3[a]	76.0[b]
	No	3.8[a]	3.7[a]	24.0[b]
	Binomial test	0.0000*	0.0000*	0.0000*
Switch to planting drought resistant crop	Yes	84.0[a]	98.2[b]	31.7[c]
	No	16.0[a]	1.8[b]	68.3[c]
	Binomial test	0.0000*	0.0000*	0.0002*
Cropping around streams	Yes	59.0[a]	11.0[b]	21.0[b]
	No	40.4[a]	89.0[b]	79.0[b]
	Binomial test	0.0038*	0.0000*	0.0000*
Crop irrigation	Yes	66.9[a]	37.6[b]	28.0[b]
	No	33.1[a]	62.4[b]	72.0[b]
	Binomial test	0.0000*	0.0089*	0.0000*

*Each subscript letter denotes a subset of community categories whose row proportions do not differ significantly from each other at the .05 level. Binomial test analysis of yes and no responses by respondents *significant at 0.05; ns=not significant at 0.05*

3.1.3 Coping strategies for dealing with extreme temperature

Extremely high temperatures were recorded with varying consequences on lives and livelihood of residents of Makhado, Mutale and Thulamela municipalities. The strategies that the people developed to cushion themselves from the extreme temperatures are shown in Table 4.

More than 70% of respondents confirmed that members of their households either planted or retained trees around their homes and farms to provide shade. This helped to combat intense sunshine and associated extremely high temperatures that were expected to induce heat stress. As shown in Table 4, this practice was common in all the three municipal areas. The results confirm those of other author scholars who indicated that it was widely practiced in many developing countries. For example, Pramova et al. (2012) observed this practice in rural communities of Malawi, Zambia and also South Africa. Other than providing shade, retaining trees on farms and around the house also ensured that cultural, ecological and economic benefits that add to household resilience and adaptive capacity are enjoyed (Robledo et al., 2012).

Coping strategies such as staying in-doors to reduce the number of hours spent carrying out farming activities, as reported in Makhado and Mutale municipalities, result in loss of productive time and inability to take advantage of livelihood improvement opportunities. Consequently, it hinders the growth of the household economy. Because of this, it can be concluded that this is not a sustainable coping strategy.

Table 4: Common strategies forest-based rural households' in Vhembe District of South Africa used to cope with extreme temperatures

Coping strategies	Responses	Communities		
		Makhado (%)	Mutale (%)	Thulamela (%)
Plant trees on farm to shade crop	Yes	73.2[a]	97.2[b]	33.0[c]
	No	26.8[a]	2.8[b]	67.0[c]
	Binomial test	0.0000*	0.0000*	0.0004*
Plant trees around house to provide shade	Yes	98.1[a]	99.1[a]	89.0[b]
	No	1.9[a]	0.9[a]	11.0[b]
	Binomial test	0.0000*	0.0000*	0.0000*
Stay in-door (reduced the number of hours spent on farming activity)	Yes	64.7[a]	96.3[b]	44.0[c]
	No	35.3[a]	3.7[b]	56.0[c]
	Binomial test	0.0003*	0.0000*	0.2421[ns]
Bought air cooling appliance e.g. fan etc.	Yes	80.3[a]	99.1[b]	51.0[c]
	No	19.7[a]	0.9[b]	49.0[c]
	Binomial test	0.0000*	0.0000*	0.4602[ns]

Each subscript letter denotes a subset of community categories whose row proportions do not differ significantly from each other at the .05 level. Binomial test analysis of yes and no responses by respondents
**significant at 0.05; ns=not significant at 0.05*

3.1.4 Current role of forest in households coping strategy

Empirical evidence generated in this study revealed that forests and forest products played a wide range of roles in households' response to climate variability and extreme weather events. Firewood, wild fruits and food for example wild berries, thatching grass (*Hyparrhenia filipendula*), wild vegetables such as green amaranth (*Amaranthus hybridus)*, and game meat, edible wild insect species in particular Mopani worms (*Gonimbrasia belina*), locusts and white termites were some of the commonest forest products that the local households relied on to deal with climate variability and change. As has been revealed already, trees were also planted and retained around homesteads and croplands. The common tree species that were planted or retained included fruit bearing species such as mango (*Mangifera indica),* avocado (*Persea americana*); exotic timber species such as eucalyptus and pine, and indigenous species for example Mopane (*Colophospermum mopane*) and those used for firewood. Subsistence use and trade in forest products in the studied communities was viewed more as a livelihood strategy needed to enhance wellbeing. This means that they were less regarded as a strategy to combat the effects of climate change and variability challenges. These findings were in stark contrast to the situation in several rural communities in West Africa in which subsistence use and trade in forest products were regarded as strategies for coping with climate variability and change (Belcher et al., 2007).

Forests and associated products are commonly known for providing key goods and services that serve as safety nets to counter climate variability and extreme weather hazards. This makes them crucial assets for rural-based households. For instance, Paumgarten and Shackleton (2011) observed that 70% of households in the Eastern Cape and Limpopo provinces of South Africa used NTFPs to help cope with shocks, including those resulting from climatic variability. In addition, tree planting is widely used in many developing countries to cope with climate variability and change events. For example, in Ghana, farmers planted trees, including commercial timber species, on their farms to protect their crops from intense sunshine and also enhance their livelihood (Boon and Ahenkhan 2012). In Kenya, Bryan et al. (2011) observed that about 39% of respondents in their study identified tree planting as their most desired adaptation strategy. Similarly, rural communities in the Congo Basin were observed to use forests extensively to cope with the challenges of climate variability such as delayed onset of the rainy season (Belcher et al., 2007). However, in the current study in Vhembe district, forest products did not play a prominent role in this regard. Musyoki (2012) attributes this to poor access of forest products to markets and also the poor organisation of the informal sector.

In the current study, the influence of access to markets on popularisation of forest-based coping strategies and its implication for the development of enterprises in this sector were examined. Analysis of association between satisfaction with access to market and adoption of forest-based coping practices gave mixed results. Only 10% of the respondents were satisfied with access or nearness to markets for forest products as an opportunity that they could take advantage of to counter the effects of erratic rainfall and extreme drought events. Use of forest products as a coping strategy was not significantly associated ($p>0.05$) with erratic rainfall and extreme drought events. However, there was a significant association ($p<0.05$) between satisfaction with access or nearness to local markets and use of forest products to cope with effect of extreme temperatures. Thus, it was possible to maximize the benefit of using forests to enhance resilience of household livelihood. This means, also, that there is scope for adopting coping strategies that promoted the domestication of forest products, in particular NTFPs. According to Musyoki (2012), promotion of domestication of NTFPs is an important strategy for promoting forest entrepreneurship, green growth and enhancement of forest-based livelihood in the studied communities. These are all essential components of forest-based adaptation initiatives for strengthening livelihood resilience to climate change and variability challenges in the rural areas.

Table 5: Challenges or barriers to strategies used to cope with climate variability and change in some parts of Vhembe district of South Africa

Challenges	Response	Municipality		
		Makhado (%)	Mutale (%)	Thulamela (%)
Insufficient information about weather or long-term climate change	Yes	87.0[a]	75.0[b]	45.0[c]
	No	13.0[a]	25.0[b]	55.0[c]
	Binomial test	0.0000*	0.0000*	0.3086[ns]
Lack of knowledge/skill about appropriate coping strategy	Yes	80.4[a]	74.3[a]	41.0[b]
	No	19.6[a]	25.7[a]	59.0[b]
	Binomial test	0.0000*	0.0000*	0.0666[ns]
Lack of money or access to credit	Yes	87.0[a]	80.6[a,b]	71.0[b]
	No	13.0[a]	19.4[a,b]	29.0[b]
	Binomial test	0.0000*	0.0000*	0.0000*
Unavailability of desired forest product	Yes	76.6[a]	76.9[a]	41.0[b]
	No	23.4[a]	23.1[a]	59.0[b]
	Binomial test	0.0000*	0.0000*	0.0967[ns]
Poor of access to market	Yes	79.9[a]	72.2[a,b]	61.0[b]
	No	20.1[a]	27.8[a,b]	39.0[b]
	Binomial test	0.0000*	0.0000*	0.0105*
Change of farming practice	Yes	85.1[a]	75.0[a]	50.5[b]
	No	14.9[a]	25.0[a]	49.5[b]
	Binomial test	0.0000*	0.0000*	0.3822[ns]
Inadequate supply of improved planting materials	Yes	79.2[a]	75.9[a]	44.0[b]
	No	20.8[a]	24.1[a]	56.0[b]
	Binomial test	0.0000*	0.0000*	0.2421[ns]
Erosion of traditional skills and knowledge amongst younger generation	Yes	81.2[a]	75.9[a]	53.0[b]
	No	18.8[a]	24.1[a]	47.0[b]
	Binomial test	0.0000*	0.0000*	0.1841[ns]
Breakdown in communities' communal nature	Yes	77.9[a]	74.1[a]	48.0[b]
	No	22.1[a]	25.9[a]	52.0[b]
	Binomial test	0.0000*	0.0000*	0.5398[ns]

*Each subscript letter denotes a subset of community categories whose column proportions do not differ significantly from each other at the .05 level. Binomial test analysis of yes and no responses by respondents *significant at 0.05; ns=not significant at 0.05*

3.2 Perceived barriers or challenges to coping strategies

In this study, the respondents identified various issues that restricted implementation of effective coping strategies in dealing with climate variability and extreme weather events. It was observed that some coping strategies were widely used, while others were only relied on sparingly. In adition, they

yielded varying outcomes on household resilience. As shown in Table 5, there were many challenges that hindered success of commonly used coping strategies.

Poor access to markets and insufficient money and/or lack of access to credit were pronounced in all the three municipalities. More than 60% of the respondents identified these challenges as impediments to adopting strategies for coping with climate variability and change. This problem was slightly more pronounced in Makhado than in Mutale and Thulamela municipalities. Probably, this could be attributed to high unemployment rates and the difficulty of securing sufficient credit. Access to credit and markets severely limit household adaptive capacity. The need for funding to improve coping strategies cannot be underestimated. Additionally access to markets enables households to trade their produce in order to procure essential products needed to improve their resilience to climate risks (Egyir et al., 2015).

The inadequate supply of improved planting materials was another major challenge identified, especially in Makhado (79.2%) and Mutale (75.9%) municipalities. However, this was not a significant ($p>0.05$) challenge in Thulamela municipality. Access to improved planting materials such as drought-tolerant varieties can greatly improve rural households' livelihood resilience to erratic rainfall and drought (Quinn et al., 2011).

The lack or insufficient knowledge of traditional and/or modern coping strategies was widely identified as a challenge that curtailed the ability to effectively combat the negative effects of climate variability and change. Among the challenges that the respondents cited were insufficient location-specific information about weather or long-term climatic conditions, inadequate knowledge and skills to implement modern coping strategies such as switching to cultivation of drought-resistant crops, and erosion of traditional skills and knowledge resulting in the younger generation being ignorant of it. The lack or insufficient knowledge to aid effective and efficient implementation of traditional and/or modern coping strategies has also been reported in other rural communities in Africa and Asia (Nzuma et al., 2010; Chigavazira, 2012; Wilk et al., 2012). The lack of information on how to improve traditional coping strategies so as to make them relevant for climate change adaptation can exacerbate rural communities' vulnerability. It is also important to package climate information in a manner that is tailored to the need of forest-based rural communities. In the current study, the respondents were interested in the relevance of climate information to their livelihood improvement strategy. It seemed this was one of the reasons why most of the climate information that respondents harnessed was insignificant contributing to the improvement of households' livelihood practices for combating climate change challenges.

It was reported that the communities in the studied areas of Vhembe district tended to be more individualistic in their response to communal challenges. This contrasted past practices when communal challenges were approached collectively. The unavailability of desired forest products in coping with climate variability and change was also highlighted. The respondents opined that people's individualistic approach to forest use and uncontrolled management of communal resources primarily caused the scarcity of forest products. In support of this view, local traditional leaders confirmed that they no longer had regulatory control over forest product use and management in the communities. This has also been observed among rural communities in the Offin river basin of Ghana (Gyampoh et al., 2009).

Most of the challenges reported in this study are synergistic, implying that a common approach can be adopted to improve the adaptive capacity of people. For example, inadequate supply of improved planting materials is closely related with lack of access to credit facilities. Wilk et al. (2012) made similar observations among commercial farmers in South Africa. In the latter study, access to finance was reported to be contributing to farmers' resilience to drought because it enabled them to spend money on drought-resistant seeds, fertilizers and irrigation, among other inputs. Moreover, access to credit often enabled households to diversify into non forest-based livelihood activities and helped reduce their sensitivity to climate variability and extreme weather events.

3.3 Attributes of households adaptive capacity

The demographic characteristics of the communities in Vhembe district and how they influenced the strategies that households used to cope with adverse weather and climate change are presented. Although the households adopted diverse strategies for coping with the effect of climate variability and change, there were mixed results. Differences in the adaptive capacities of households to positively respond to adverse effects of climate variability and change depended on various factors, including institutional resources, social support and human capital. These are further elaborated below.

3.3.1 Institutional Resources

Institutional resources are known to considerably impact on households' coping practices and adaptive capacities in response to climate change and variability. It is shown in Table 6 that remarkably high proportions of respondents in Mutale (74.4%), Thulamela (59%) and Makhado (52.9%) municipalities were either very dissatisfied or dissatisfied with water supply facilities in their areas. The respective proportions of respondents who were also either very dissatisfied or dissatisfied with access or closeness to markets were 90.9% for Mutale followed by Makhado (67.3%) and Thulamela (60%) municipalities. The levels of satisfaction with communication serves also varied across the municipalities. The proportions of respondents who were either very dissatisfied or dissatisfied were 70.3%, 67.7% and 35.6% for Makhado, Mutale and Thulamela municipalities, respectively.

Table 6: Demographic factors influencing adaptive capacity in some areas of Vhembe district in South Africa

Attributes of households adaptive capacity	Response	Proportion of respondents (%) in		
		Makhado (n =156)	Mutale (n=110)	Thulamela (n =100)
Water supply services	Very dissatisfied	16.6[a]	60.6[b]	33.0[c]
	Dissatisfied	36.3[a]	13.8[b]	26.0[a,b]
	Neither satisfied nor dissatisfied	0.6[a]	0.9[a]	1.0[a]
	Satisfied	28.0[a]	10.1[b]	16.0[a,b]
	Very satisfied	18.5[a]	14.7[a]	24.0[a]
Access or closeness to market	Very dissatisfied	25.0[a]	68.2[b]	23.0[a]
	Dissatisfied	42.3[a]	22.7[b]	37.0[a,b]
	Neither satisfied nor dissatisfied	2.6[a]	0.9[a]	0.0[a]
	Satisfied	25.0[a]	3.6[b]	11.0[b]
	Very satisfied	5.1[a]	4.5[a]	29.0[b]
Communication services	Very dissatisfied	12.2[a]	51.4[b]	10.0[a]
	Dissatisfied	58.1[a]	16.3[b]	25.6[a,b]
	Neither satisfied nor dissatisfied	5.1[a]	0.0[b]	1.0[a,b]
	Satisfied	40.4[a]	14.7[b]	24.0[b]
	Very satisfied	42.7[a]	29.9[b]	27.4[c]

Each subscript letter denotes a subset of Community categories whose column proportions do not differ significantly from each other at the .05 level.

The results of the investigation of the relationship between satisfaction with institutional resources, water supply facilities and household adoption of various strategies to cope with climate variability are presented in Table 7

Table 7: Influence of satisfaction with water supply facilities on adoption of coping strategies for climate variability in some areas of Vhembe district in South Africa

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	0.1312	0.1895	0.4791	0.4888
Off-farm work	1	-0.5900	0.2358	6.2600	0.0123
Cropping around streams	1	0.5265	0.2493	4.4609	0.0347

It is indicated in Table 7 that satisfaction with water supply in a community decreased ($p<0.05$) the likelihood that the household would adopt off-farm activity as a coping strategy by 0.59. In addition, satisfaction with water supply facilities in a community increased by 0.52 ($p<0.05$) the likelihood that a household would adopt cropping around streams as a coping strategy. This implies that improved water supply facility has a positive impact on the resilience of a household's crop farming strategy. Ishaya and Abaje (2008) reported that access to improved functioning of institutional resources enhanced farmers' adaptive capacity. Improving institutional facilities in a community within the framework of climate change adaptation positively influences the realisation of sustainable development, and also reduces rural-urban migration. Therefore, in support of Goldman and Riosmen (2013), it can be posited that sound institutional facilities serve as a catalyst for promoting the adoption of effective coping strategies among rural households.

3.3.2 Social Support

The many social support mechanisms that existed in the studied communities are shown in Table 8. They provided assistance that helped local people cope with the vagaries emanating from climate variability and change.

Table 8: Functioning social support group in the study communities

Social group	Response	Municipality		
		Makhado (%)	Mutale (%)	Thulamela (%)
Family members living outside community	Yes	88.4^{a}	70.6^{b}	65.0^{b}
	No	11.6^{a}	29.4^{b}	35.0^{b}
	Binomial test	0.0000*	0.0000*	0.0000*
Neighbours	Yes	87.1^{a}	82.6^{a}	39.0^{b}
	No	12.9^{a}	17.4^{a}	61.0^{b}
	Binomial test	0.0000*	0.0000*	0.0000*
Local community organisation	Yes	79.4^{a}	67.0^{a}	20.0^{b}
	No	20.6^{a}	33.0^{a}	80.0^{b}
	Binomial test	0.0000*	0.0001*	0.0000*
The municipality	Yes	83.2^{a}	50.9^{b}	51.0^{b}
	No	16.8^{a}	49.1^{b}	49.0^{b}
	Binomial test	0.0000*	0.4248^{ns}	0.5398^{ns}
Provincial government	Yes	63.9^{a}	54.6^{a}	8.9^{b}
	No	36.1^{a}	45.4^{a}	91.1^{b}
	Binomial test	0.0000*	0.1713^{ns}	0.0000*

*Each subscript letter denotes a subset of Community categories whose column proportions do not differ significantly from each other at the .05 level. Binomial test analysis of yes and no responses by respondents *significant at 0.05; ns=not significant at 0.05*

Family members, neighbours, and local community based organisations were reported to be providing significant assistance to households. However, the support that municipalities and provincial

government departments provided was regarded not so important across all the studied communities. There is usually a concern that social support initiatives of either municipalities or provincial government departments are laden with political motives. Twomlow (2002) and David (2007) have also pointed out that political interests rather than the desire to cushion households against drought guides the launch governmental social support services.

The relationship between support from Family members, neighbours and local community-based organisations, and barriers to adoption of coping strategies at household level were investigated. There was a significant association ($p<0.05$) between assistance from neighbours and expression of difficulty in coping with climate variability and change. Apart from the challenge of lack of money or access to credit, which was not significant ($p>0.05$), all other expressed challenges observed in this study were significantly associated with assistance from neighbours as a support group. In most cases, less than 14% of the respondents that enjoyed support from neighbours expressed difficulty in coping with climate variability and change. Thus, social support groups such as neighbours are crucial in helping households cope with climate variability and change challenges in their locality.

The influence of support from local community organisations on respondents' expressed difficulty in coping with climate variability and change is shown in Table 9. Only three out of nine challenges to adopting coping strategies to counter the effects of climate variability and change that respondents revealed were statistically important. This meant that the households that enjoyed support from local community-based organisations coped well with climate variability and change. Moreover, the lack or insufficient access to credit facilities was observed to have a negative relationship with support from local community-based organisations. The lack or insufficient information on climate variability and change events and inadequate supply of improved planting materials were the only challenges that were significantly associated with support from local community-based organisations. Thus, the support from local community-based organisations was important in ensuring that households effectively coped with climate variability and change.

Table 9: Effect of support from local community-based organisations on households' strategies for coping with climate variability and change in some parts of Vhembe district in South Africa

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	2.4095	0.7873	9.3665	0.0022
Lack or insufficient information on climate variability and change event	1	1.3450	0.3995	11.3336	0.0008
Lack or insufficient access to credit facility	1	-0.9353	0.4311	4.7073	0.0300
Inadequate supply of improved planting materials	1	1.1964	0.3595	11.0737	0.0009

According to Robledo et al. (2012), there are many examples of how social support groups affect the capability of communities to adapt to risks related to climate change. This view finds support from an earlier Valdivia et al. (2005) study, which revealed that informal non-monetary arrangements and social networks helped rural communities in Samoa to cope with storm damage. Social support groups such as local community-based organisations, neighbours, and family members have significant capacity to enhance collective action and use of group advantage to access other capitals in facilitating the resilience of people to climate variability and change.

3.3.4 Human capital resources

The human resources development significantly impacts on people's ability to adapt efficiently to climate change challenges (Striessnig et al., 2013). In the current study, the effect of human resources such as farming skills and highest level of education, on coping efficiency and adaptive capacity were examined. It was found that the lack of access to credit facilities and break down in the communal

nature of society were not significantly associated ($p>0.05$) with farming skills. However, possession of farming skills was significantly associated ($p<0.05$) with the other challenges that local households experienced, viz. erosion of traditional skills and knowledge amongst the younger generation and inadequate supply of improved planting materials. These results imply that in general, households with inherent farming skills are less likely to experience challenges in coping with climate variability and change than those without. Thus, investment in appropriate skilling of residents of the studied communities would considerably help reduce the possibility of households coping with climate change.

The relationships between respondents' highest level of education and choice of strategy and challenges experienced in attempts to cope with changes in climatic are presented in Table 10.

Table 10: The influence of respondents' level of education on choice of and challenges to coping strategies used to counter the negative effects of climate change

Dependent variable	Independent variable	Odds ratio	Lower	Upper	P Value
Possession of academic qualification	Dependence on use and marketing of NTFPs in response to erratic rainfall event	2.622	1.080	6.361	0.033
	Migration for work as a coping response to extreme drought event	0.177	0.063	0.502	0.001
	Increased water capture in response to extreme drought event	2.189	1.059	4.525	0.035
	Planting drought resistant crop in response to extreme drought event	2.681	1.092	6.580	0.031
	Irrigation with stream water in response to extreme drought event	0.428	0.197	0.931	0.032
	Reliance on social group in response to flood event	0.469	0.230	0.955	0.037
	Sell of household asset in response to flood event	4.527	1.655	12.384	0.003
	Built flood control wall around homestead	2.534	1.213	5.294	0.013
	Possession of insufficient knowledge/skill about appropriate coping option	3.057	1.020	9.159	0.046
	Breakdown in community's communal nature	0.313	0.098	0.998	0.050

In the current study, it was observed that the level of educational attainment of an individual significantly impacted on his/her choice of coping strategy, including the types of challenges experienced during implementation. Out of eight coping strategies commonly used in response to erratic rainfall events, only two strategies are significantly practiced by more educated people. These are dependence on use and marketing of NTFPs. It was also observed that the more educated individuals relied mostly on four out of the nine coping strategies that could help counter the effects of extreme drought events. The more educated respondents tended to rely on non-forestry/agriculture-based livelihood strategies. Their strategies seemed to be few and more carefully selected, in contrast to their less educated counterparts who adopted multiple options.

The results presented above have highlighted that improving human capital in terms of skills and education would significantly reduce the challenges experienced in the studied communities as they attempt to cope with climate variability and change. According to David (2007), adequate human capital resources in terms of skills and educational level of the people allows for effective adaptation

to climate change. Apart from improved human capital, this allows households to effectively utilise available traditional coping strategies and enable them to explore alternative coping strategies based on new information and innovativeness (Egyir et al., 2015). Given the uncertainty regarding understanding of the impact of specific manifestations of climate change on the people's lives and livelihood at rural community level in South Africa (Striessnig et al., 2013; Turpie and Visser, 2013), human capital improvement seems to be the most sensible option for improving rural households' resilience to risks of climate change. Striessnig et al. (2013) noted that improved human capital implied better access to, and ability to utilize relevant climate information for example seasonal prediction of drought. Improved human capital also often leads to higher incomes at individual and household levels, and greater economic growth within communities (Striessnig et al., 2013; Patt et al. 2010). This yields indirect benefits climate change mitigation through decoupling of livelihood strategies from unsustainable forest use and management practices (Muyoski, 2012).

4. CONCLUSION AND RECOMMENDATION

It was observed that forest-based rural communities in Vhembe district of South Africa employed a diverse range of strategies to cope with the biophysical and socioeconomic effects of climate variability and extreme weather events. In most cases the respondents tended to use strategies that did not direct impact negatively on their livelihood. Although some of the coping strategies were effective, affected households encountered many challenges. In general, the choice, effectiveness and efficiency of adopting any coping strategy depend on the nature of communities in question and their socioeconomic characteristics. Poor markets for forest products and poor organisation of the informal forest sectors in the communities hampered widespread adoption of forest-based coping strategies. Similarly, lack of access to credit was a major barrier to effective adoption of most of the coping strategies that the study communities used. Institutional facilities, social support groups and human capital resources are crucial for the success and choice of household's coping strategies. More specifically, the people's skills and educational levels are the major determinants of choice of coping strategies and efficiency of adopting them. Inadequate skills and lack of education among residents in the study communities limit their ability to participate in the formal economic sector. This relegates them to subsistence farming and reliance on forest products as a means of earning secure livelihoods. Given the uncertainty surrounding the precise manifestations of climate change in specific areas, it may be better to invest in skills development and acquisition of education to increase the peoples' flexibility and ability to adapt effectively to risks associated with climate change. It can be hypothesized from the current study that development of a suite of support initiatives such as facilitating access to credit facilities for the rural poor, developing markets for forest products particularly the under-exploited NTFPs, and enhancement of capacities of residents or rural areas to do things for themselves are likely to improve their ability to cope with the adverse effects of climate change.

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