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Assessing Contexualised Household Vulnerability and Coping Mechanisms to Drought in Traditional Authority Symon, Neno District, Malawi

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Abstract

This paper used the LVI Vulnerability Index (LVI), to assess contextualized contributing factors to household vulnerability to drought in T/A Symon, Neno District in Malawi. We interviewed 164 households from 2 villages of Ntingala and Mbemba and collected data on social demographic, Networks and relationships, knowledge and skills, livelihood strategies, food, health, water, forest and natural disasters as well as ex ante and ex post coping mechanisms. Results show Mbemba is relatively more vulnerable than Ntingala and the vulnerabilities in both villages is a contribution of various livelihood indicators. The study recommends that Livelihood Vulnerability Index can be applied to assess community vulnerability widely with contexualised livelihood indicators. It contributes to the body of knowledge on targeting vulnerable households with food or focus on interventions that empower the community to strengthen their adaptive capacity and resilience. The results can inform designing of specific interventions to build community resilience.

Keywords: vulnerability; exposure; sensitivity; adaptive capacity livelihood vulnerability index; sustainable livelihoods framework.

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1. Introduction

The Global environmental change and sustainability science increasingly recognize the need to address the consequences of changes taking place in the structure and function of the biosphere. These raise questions as to who and what are vulnerable to the multiple environmental changes underway and research demonstrates that vulnerability is registered not by exposure to hazards (perturbations and stresses) alone but also resides in the sensitivity and resilience of the system experiencing such hazards [1]. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity. Understanding these elements can help evaluate the nature and magnitude of the climate change threat, detect the key sources of vulnerability and identify actions to help reduce or deal with the threat under each element [2]. Evidence suggest that the frequency and severity of disasters has increased in Malawi. One of the major droughts occurred in 2004/2005 and since then, the country has been affected by recurrent food crises caused by erratic rain and regular flooding [3].

1.1 Measuring vulnerability

The IPCC [4] defines vulnerability as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity. However [5], identified 3 dimensions of vulnerability to climate change; the physical environmental dimension which account for biophysical impacts of climate change including agricultural productivity and distribution of disease vectors, social economic dimension with refers to region's or community's capacity to recover from extreme events and adapt to change over a long period of time and finance external assistance dimension which looks at the degree to which the region or community may be assisted in its attempt to adapt to change. Vulnerability assessment describes a diverse set of methods used to systematically integrate and examine interactions between humans and their physical and social surroundings. Various researchers have tried to bridge the gap between the social, natural, and physical sciences and contributed new methodologies that confront the challenge [6]. Although the community's exposure and experience with drought has become a familiar phenomenon in Mbemba and Ntingala villages, many households remain vulnerable to subsequent dry spells and droughts. Most research on adaptation to climate change has considered farmer's adaptation strategies as a response to single climatic stimulus without paying attention to other stressors [3]. Deficiency of contextualized information on household vulnerability, factors contributing to community's vulnerability and low adaptive capacity for households has resulted in households highly dependent on relief food. It is against this background that the study was conducted to identify contexualised factors contributing to household vulnerability to drought.

1.2 The Livelihood Vulnerability Index

A number of studies have been conducted to assess household vulnerability to climate change and extreme weather events. The Livelihood Vulnerability Index derives for the Sustainable Livelihood Framework Approach which to a certain extent addresses issues of sensitivity, exposure and adaptive capacity to climate

change and clearly describes the linkage between vulnerability, assets and transforming process [7]. The Sustainable Livelihood Approach was not developed specifically for the analysis of disasters like drought but, according to [8], a livelihood comprises the capabilities, assets and activities required for a means of living and a livelihood is sustainable [when it can] cope and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihoods for the next generation and which contributes net benefits to other livelihoods at local and global levels in the long and short term. The concept recognizes a variety of means through which an individual or a household can earn a living. Here, vulnerability is connected conceptually to external stresses and shocks and internal coping capacity [8]. The study modified the LVI developed by Hahn, to construct a contexualised index by combining various components and sub components which make up the capitals of the sustainable livelihoods to hypothesise the contribution to vulnerability on the communities of Mbemba and Ntingala. Livelihood Vulnerability Index (LVI) is one of the tools used by researchers to measure vulnerability. We developed a composite index to measure vulnerability using multiple indicators to access exposure to natural disasters and climate vulnerability, social and economic characteristics of households that affect their adaptive capacity and current food, health, and other related factors that determine sensitivity to future climate change impacts.The LVI index was developed using major components and subcomponents as variables based on review of literature in the study area. We used a balanced weighted average approach by [9] where each sub-component contributes equally to the overall index even though each major component comprise of a different number of sub-components. According to [10], the LVI is designed to provide development organisations, policy makers even public health practitioners with practical tool to understand demographic, social, and health factors contributing to climate vulnerability at district or community level.

2. Materials and methods

2.1 Area of study

The study was undertaken in Ntingala and Mbemba villages under Lisungwi Extension Planning Area (EPA) in Traditional Authority Symon in Neno District. The EPA lies within Shire valley agro-ecological zone within the low attitude of (250 – 500 msl) with flat valley floor. The area was chosen due to observed continuous vulnerability of the households to drought and dry spells experienced almost every year resulting in food shortage and growing dependence on food aid for the past five years [11].

2.2 Sampling and data collection

The study targeted all households residing in 2 villages of Mbemba and Ntingala. The household was the unit of observation and analysis for this study. A systematic simple random sampling was used whereby all households had equal chance of being in the sample. Once a required sample size of 170 households was determined at 95% confidence level (100 and 70 from Mbemba and Ntingala respectively). The total number of households as per household listing for each village was divided by the required sample to get the interval of 3. Therefore every third household was selected to participate in the study. Out of the 170 households which were sampled and interviewed, 164 questionnaires validated for capturing and analysis while six questionnaires were

rejected for either inconsistency or incompleteness of the information provided. An integrated household questionnaire was administered. The questionnaire was divided into 4 major components to collect data on social and demographic household characteristics, livelihoods, human and natural aspects, natural disasters. Focus group discussions with key informants were conducted to validate data collected through household survey. To understand and appreciate the extreme weather events, temperature and annual precipitation, for the past 5 years was collected from the department of metrological services.

2.3 Data analysis

Based on the available data collected on the 10 components and sub-components indicators, two types of analysis was conducted. Livelihood Vulnerability Index by calculating balanced weighted average LVI and calculation of LVI based on IPCC framework [12] .

2.3.1 Calculating the Livelihood Vulnerability Index

The Livelihood Vulnerability Index (LVI) included ten major components: demographic profile, networks and relationships, Knowledge and Skills, livelihood strategies, food, health, water, land, forest and natural disasters. Each major component had several sub-components (Table 1). These were developed based on reviewed literature prior to the study and their relevance to the study.

$$Index_X = \frac{X - Xmin}{Xmax - Xmin} \quad (1)$$

Or

Index = (observed value-minimum)/(maximum-minimum)

Xv = observed sub component indicator

X is the original sub-component, Xmin and Xmax are the minimum and the maximum values respectively for each sub component. These minimum and maximum values were then used to transform this indicator into a standardized index to integrate it into the major component of Demographic Profile for example. For the variables that measure frequencies, the minimum value is set at 0 and the maximum at 100. When each sub-component was standardized, they were averaged together to calculate the value of each major component as shown in equation 1, 2 and 3 [7].

$$M_v = \frac{\sum index_{z\,i}}{n} \quad (2)$$

Where M is one of the major components (Demographic Profile DP, Networks and Relationships (NR), Knowledge and Skills (KS), Livelihood Strategies (LS), Food (F), Health (H), Water (W), Land (L), Forest (FR), Natural Disasters (ND), for village z, $index_{z\,i}$ represents the sub-components, indexed by i. that make up each major component, and n is the number of sub-components in each major component. Once values of

each of the components were calculated, they were averaged using equation 3 to obtain LVI:

$$LVIz = \frac{\sum_{i=1}^{10} w_{Mi}\, M_{ri}}{\sum_{i=1}^{10} w_{M_i}} \qquad (3)$$

Or

$$LVI_v = \frac{w_{DP}{}^{DP}{}_v + W_{NR}{}^{NR}{}_v + W_{KS}{}^{KS}{}_v + W_{LS}{}^{LS}{}_v + W_F{}^F{}_v + W_H{}^H{}_v + W_W{}^W{}_v + W_L{}^L{}_v + W_{FR}{}^{FRv} + W_{ND}{}^{NDV}{}_v}{w_{DP} + W_{NR} + W_{KS} + W_{LS} + W_F{}^+ W_H + W_W + W_L + W_{FR} + W_{ND}}$$

LVI_{VI}*(village1)* is livelihood vulnerability index in a specific village, equals the weighted average of the 10 major components which are determined by the number of sub-components that make up each major component. For Example, DP has four sub components so W_{DP} will be 4. Weights for all sub-components are included to ensure that they contribute equally to the overall LVI. Therefore this study, scaled LVI from 0 as least vulnerable to 1 as most vulnerable.

Table 1: Capitals, major components and sub components comprising LVI Indicators.

CAPITAL ASSETS	MAJOR COMPONENTS	SUB COMPONENTS (INDICATORS)
Social Capital	Demography	Ratio of Population < 15 and over 65 years of age to the population between 19 - 65 year of age (Dependency Ratio)
		Percentage of Households where a household head is female.
		Average family members in a Household
		Percentage of households with orphans. (widowed Households)
	Networks and Relationships	Percentage of households who belong to any community group
		Percentage of Households who received support from relatives or friends to those who supported friends or relatives
		Percentage of Households that reported not to have gone to government for assistance in the last 12 months.
		Percentage of Households who have not received food assistance from government or NGO.
		Percentage of households borrowing money in the past months
		Percentage of households who does not belong to any community group?
	Knowledge and Skills	Percentage of households who have never gone to school?
		Percentage of households who have no TV
		Percentage of Households who have no Radio
		Percentage of households who have never gone for vocational skills training.
Financial Capital	**Livelihood strategies**	Percentage of households reporting at least one member working outside the community for their livelihood
		Percentage of households depending on subsistence farming as the main source of income.
		Percentage Households growing more than 1 type of crop.

Human Capital	Food	Percentage of households reporting livelihoods other than one source of income
		Percentage of households that get their food primarily from their garden (own production).
		Inverse of crop diversification index (cereals)
	Health	Percentage of Households with no food to last 12 months
		Percentage of Households who indicated that poor health was the biggest problem they encountered.
		Average time to health facility
		Most frequent health problems in the community (Malaria)
		Percentage of HH where a family member had to miss work or school in the last two weeks due to illness.
		Percentage of HH members who died in the last 12 months.
		Percentage of HH who sleep under mosquito nets for Malaria prevention.
Natural Capital	Water	Percentage of household reporting water conflicts
		Percentage of households that utilise unprotected water source.
		Average time to the water source.
		Percentage of HH that do not have a consistent water supply.
		Percentage of households whose water supply was badly affected with drought
	Land	Percentage of Households who owns land > than 1 hectare
	Forest	Percent of HHs using only Forest-based energy for cooking purpose
		Average time to fetch firewood.
		Percentage of HHs reporting that firewood is being scarce now in comparison to 10 years back.
		Percent of HHs using traditional cooking stoves
	Natural Disasters	Average number of floods, droughts and cyclone events In the past five years.
		Percentage of households that did not receive a warning about the pending natural disasters
		Percentage of households with property damaged due to recent natural disasters.
		Mean standard deviation of monthly average of maximum daily temperature (2011 - 2016)
		Mean standard deviation of monthly average of minimum daily temperature (2011 - 2016)
		Mean standard deviation of monthly average precipitation (2011 - 2016).

2.3.2 Calculating LVI-IPCC: IPCC framework approach

An alternative method for integrating the major components into a vulnerability index was explored that attempts to develop a formula to represent the IPCC definition of vulnerability as a function of system's exposure and sensitivity to climatic stimuli and its capacity to adapt to the adverse effects. Using the same data used in the composite index approach above, the major components were merged and grouped into three categories of exposure, sensitivity and adaptive capacity (see table 2). The results of this analysis are illustrated

in table 4.

Each of the IPCC factors is calculated based on the equation:

$$CFz = \frac{\sum_{1=1}^{n} W_{Mi}\ M_{zi}}{\sum_{i=1}^{n} {}^{W}M_i}$$

Where CF_z is IPCC defined contributing factor for village $_z$, M_{vi} are major components for village z indexed by i, W_{Mi} is the weight of each major component, and n is the number of major components in each contributing factor. Once exposure, sensitivity and adaptive capacity were calculated, the contributing factors were combined using the following equation:

IPCC-LVI= $(e_v - a_v)*s_v$

Table 2: Categorization of major components into contributing factors from IPCC vulnerability framework for calculation of IPCC- LVI.

IPCC CONTRIBUTING FACTORS TO VULNERABILITY	MAJOR COMPONENTS
Exposure	Natural Disasters and Climate Variability
Adaptive Capacity	Social Demographic Profile Livelihood Strategies Social networks
Sensitivity	Health, Water Food, Forest Water

3. Results and analysis

All the sampled 164 households agreed to participate in the interview. Out of the 164 households interviewed, 45.1% were female while 54.9% were male. The study also revealed that 34% of the interviewed households were female headed households while 10.3% were widowed. The average household size was 4.8 with the majority members of the family within the productive age of 28 – 45 years, while 24% of the respondents never attended school with only 1% having gone up to secondary school.

3.1 LVI: Mbemba vs Ntingala

Table 3 illustrates, the major components and the subcomponents indicators used, minimum and maximum values for each village, while the Indexed sub components, major components and overall LVI for Mbemba and Ntingala villages are shown in Table 4. The results revealed that on Social Demographic profile, Ntingala has higher vulnerability index value than Ntingala (SDP $_{\text{Mbemba:}}$ 0.359; SDP$_{\text{Ntingala}}$: 0.462) contributed by high scores in dependency ratio index$_{\text{Mbemba:}}$ 0.990: dependency ratio index$_{\text{Ntingala:}}$ 1.300). Ntingala has a higher proportion of female headed households at 36.2 percent compared to 31.6 percent for Mbemba, while 13 percent of households in Ntingala keep orphans compared to 8 .4 percent in Mbemba. On Networks and relationships, Mbemba has a higher vulnerability index score in networks and relationships than Ntingala (NR$_{\text{Mbemba}}$: 0.514; NR$_{\text{Ntingala}}$ 0.226). Only 11 and 21.7 percent of the households in Mbemba and Ntingala respectively did not receive food assistance from government, while the level of borrowing money from both villages is almost similar in the 2 villages with over 30 percent for Mbemba and 29 percent for Ntingala. Additionally, more households in Ntingala (65.2 percent) do not belong to any community group compared to Mbembas 48.4 percent. More households in Ntingala (62 percent) received support from relatives within the community compared to only 10 percent for Mbemba. Both villages showed high vulnerability scores in knowledge and skills with Mbemba being slightly higher than Ntingala (KS$_{\text{Mbemba}}$: 0.650; KS$_{\text{Ntingala}}$: 0.644), with 23 percent of the respondents in Ntingala never went to school compared to 22.1 percent for Mbemba, 95 percent the households have no television in Ntingala compared to 86 percent for Mbemba, while 64.3 percent of households have no radio in Mbemba against 53 percent for Ntingala. Furthermore, 87.3 percent of the population have never gone for any vocational skills in Mbemba against 86.6 percent for Ntingala. In livelihood strategies under financial capital the vulnerability index values are relatively high in both villages (LSindex$_{\text{Mbemba}}$: 0.537; LSindex$_{\text{Ntingala}}$: 0.557) respectively. Dependency on subsistence farming for income is low (farming Index$_{\text{Mbemba}}$: 0.274; farming Index$_{\text{Ntingala}}$: 0116) while diversifying income sources to compliment subsistence farming income has very high vulnerability scores (IncDIndex$_{\text{Mbemba:}}$ 0.905; IncD Index$_{\text{Ntingala}}$: 0.971)). Additionally Ntingala reported one or more family members working outside the community (WOindex$_{\text{Mbemba:}}$ 0.095; WOindex$_{\text{Ntingala}}$: 0.185). The vulnerability index value for food were (Findex$_{\text{Mbemba}}$: 0.359; F$_{\text{Ntingala}}$: 0.466). Over 80.2 percent of the respondents in Ntingala primarily get their food from own production compared to 29.8 percent for Mbemba. Over 76.8 percent of the households in Mbemba had no food to last for 12 months compared to 53.7 percent and only 5 percent in Ntingala grow more than 1 cereal compared to only 1percent. Mbemba has a higher vulnerability index value on health than Ntingala (H$_{\text{Mbemba}}$: 0.535; H$_{\text{Ntingala}}$: 0.457). Ntingala households were more vulnerable to Malaria than households in Mbemba based on Malaria prevalence index (MP$_{\text{Mbemba}}$: 0.494; MP$_{\text{Ntingala}}$: 0.562) and Malaria was the most frequent health problem encountered in both villages; 72.6 percent for Mbemba and 75.3 percent for Ntingala. In Mbemba, 50.51 percent reported one member of the family missing school or work due to illness against 75 percent for Ntingala. Mbemba recorded 3.1 percent deaths compared to 2.8 percent from Ntingala. Nevertheless, 56.2 percent of the respondents in Ntingala reported to have slept under mosquito net compared to 49.4 percent in Mbemba. People of Mbemba travel an average of 72 minutes to the nearest health facility compared to 46 minutes for Ntingala village. Long distance to hospital index for Mbemba, makes it difficult for people to access health services in time therefore a major contribution to higher vulnerability index on health. Water vulnerability in terms of access to portable water for drinking and

households use is relatively low in Mbemba and very low in Ntingala (W_{mbemba} 0.318; $W_{Ntingala}$ 0.116). Mbemba experienced more water conflicts 55 percent than Ntingala at 7 percent, while none of the households used unprotected source of water in Mbemba against only 1 percent in Ntingala. The people of Mbemba take an average of 19.7 minutes to access portable water compared to only 10.1 minutes for Ntingala while 29 percent of the respondents in Mbemba did not experience consistent water supply compared to 17 percent for Ntingala. Mbemba has a higher Land vulnerability score than Ntingala ($Lindex_{Mbemba}$: 0.968; $Lindex_{Ntingala}$: 0.140). Mbemba and Ntingala has the same forestry energy vulnerability index score on the use of forest based energy for cooking ($FEindex_{Mbemba:}$ 1.0; $FEindex_{Ntingala}$: 1.0) Mbemba households take an average of 14 minutes to fetch firewood while Ntingala took an average of 19.5 minutes. Both villages continue to use traditional cooking stove at 95 percent and 86 percent respectively. Natural disaster vulnerability score for Mbemba and Ntingala are relatively high ($NDindex_{Mbemba}$: 0.577); $NDindex_{Ntingala}$: 0.591). Proportion of households who did not receive any warning about the disaster is 63.7 percent in Ntingala against 57.8 percent in Mbemba ($DWindex_{Ntingala}$: 0.637; $DW_{Mbemba:}$ 0.578) while more households in Ntingala at 64.6 percent had their property damaged in the recent natural disaster against Mbemba 62 percent. The natural disasters that caused damage to property and crops were heavy winds and floods. The overall Livelihood Vulnerability Index results for the 4 capitals shows that Mbemba is more vulnerable to drought (0.517) than Ntingala (0.422). The higher vulnerability for Mbemba was highly contributed by Networks & relationships, Knowledge and skills, health, water, land and forest indicators. The results of the major component calculations are presented in a spider diagram (fig. 1) with a scale of 0 – to 1. From the centre of the web, 0 is equal to less vulnerable where 1 or more outside the edge represents more vulnerable. Fig.1 therefore shows that Mbemba is more vulnerable in terms of natural disasters, networks and relationships and land.

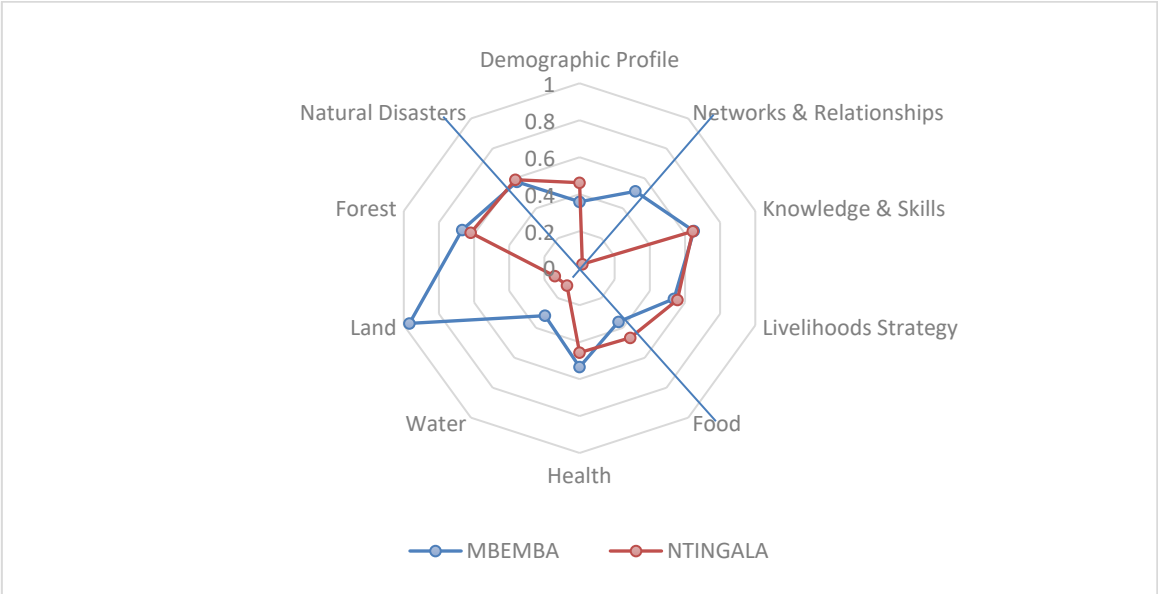

Figure 1: Vulnerability spider diagram of the major components of livelihood vulnerability index (LVI) For Mbemba and Ntingala villages

Table 3: Indexed sub components, major components and overall LVI for Mbemba and Ntingala villages, T/A Symon, Neno District.

SUB COMPONENTS (INDICATORS)	MBEMBA	NTINGALA	MAJOR COMPONENTS	MBEMBA	NTINGALA	LVI: MBEMBA	LVI: NTINGALA
Ratio of Population < 15 and over 65 years of age to the population between 19 - 65 year of age (Dependency Ratio)	0.99	1.3				0.517	0.422
Percentage of Households where household head is female.	0.316	0.362	SOCIAL DEMOGRAPHIC PROFILE	0.359	0.462		
Average family members in a Household	0.045	0.056					
Percentage of households with orphans. (widowed Households)	0.0845	0.130					
Percentage of Households who received support from relatives or friends to those who supported friends or relatives	0.100	0.620					
Percentage of Households that reported not to have gone to government for assistance in the last 12 months.	0.968	0.899					
Percentage of Households who have not received food assistance from government or NGO.	0.105	0.217	Networks and Relationships	0.514	0.226		
Percentage of households borrowing money in the past months	0.305	0.290					
Percentage of households who does not belong to any community group?	0.484	0.652					
Percentage of households who have never gone to school?	0.221	0.232					
Percentage of households who have no TV	0.863	0.950					
Percentage of Households who have no Radio	0.644	0.530	Knowledge and Skills				
Percentage of households who have never gone for vocational skills training.	0.874	0.866					
				0.650	0.644		

Percentage of households reporting atleast one member working outside the community for their livelihood	0.095	0.185			
Percentage of households depending on subsistence farming as the main source of income.	0.274	0.116	Livelihoods Strategies		
Percentage Households growing more than 1 type of crop.	0.874	0.957			
Percentage of households reporting livelihoods other than one source of income	0.905	0.971			
				0.537	0.557
Percentage of households that get their food primarily from their garden (own production).	0.298	0.802			
Inverse of crop diversification index (cereals)	0.011	0.058	Food		
Percentage of Households with no food to last 12 months	0.768	0.537			
				0.359	0.466
Percentage of Households who indicated that poor health was the biggest problem they encountered.	0.728	0.188			
Average time to health facility	0.723	0.462			
Most frequent health problems in the community (Malaria)	0.726	0.753			
Percentage of HH where a family member had to miss work or school in the last two weeks due to illness.	0.505	0.750	Health		
Percentage of HH members who died in the last 12 months.	0.031	0.028			
Percentage of HH who sleep under mosquito nets for Malaria prevention.	0.494	0.562			
				0.535	0.457
Percentage of household reporting water conflicts	0.550	0.070			
Percentage of households that utilise unprotected water source.	0.000	0.000			
Average time to the water source.	0.198	0.101	Water		
Percentage of HH that do not have a consistent water supply.	0.290	0.170			
Percentage of households whose water supply was badly affected with drought	0.550	0.230		0.318	0.116

Percentage of Households who owns land > than 1 hectare	0.968	0.11	Land		
				0.968	0.140
Percent of HHs using only Forest-based energy for cooking purpose	1.000	1.000			
Average time to fetch firewood.	0.0368	0.087			
Percentage of HHs reporting that firewood is being scarce now in comparison to 10 years back.	0.684	0.530	Forest		
Percent of HHs using traditional cooking stoves	0.950	0.860			
				0.668	0.619
Average number of flood, drought and cyclone events in the past five years.	0.020	0.020			
Percentage of households that did not receive a warning about the pending natural disasters	0.578	0.637			
Percentage of households with property damaged due to recent natural disasters.	0.620	0.646			
Mean standard deviation of monthly average of maximum daily temperature (2011 - 2016)	1.572	1.572			
Mean standard deviation of monthly average of minimum daily temperature (2011 - 2016)	0.629	0.629			
Mean standard deviation of monthly average precipitation (2011 - 2016).	0.0428	0.0428	Natural Disasters	0.577	0.591

3.2 LVI-IPCC: Mbemba vs Ntingala

Table 4: Results of contributing factors calculation for IPCC-VI Framework Approach

IPCC CONTRIBUTING FACTORS TO VULNERABILITY	**MBEMBA**	**NTINGALA**
ADAPTIVE CAPACITY	0.515	0.515
SENSITIVITY	0.501	0.383
EXPOSURE	0.646	0.550
LVI-IPCC(EI-AI)*SI	0.0656	0.0134

The study considered a second method of calculating vulnerability, using LVI-IPCC framework approach. The LVI-IPC analysis produced similar results ($LVI\text{-}IPCC_{Mbemba}$:0.0656; $_{Ntingala:}$ 0.0134) (Table 4) while Figure. 4 shows vulnerability triangle which plots contributing factor scores for exposure, adaptive capacity and sensitivity. The results shows that Mbemba may be more exposed (0.646) to drought than Ntingala (0.550), more sensitive to drought (0.501) than Ntingala ().383), while their adaptive level is almost the same (0.515) showing scores for exposure, adaptive capacity and sensitivity.

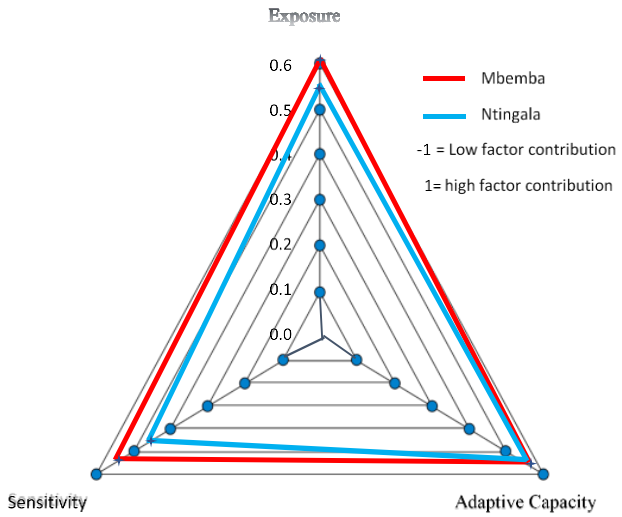

Figure 2: Vulnerability triangle diagram illustrates contributing factors of the IPCC-LVI for Mbemba and Ntingala villages

4. Discussion

4.1 Household vulnerability to drought

4.1.1 LVI: Mbemba and Ntingala

Although the overall outlook suggest that both villages are vulnerable to drought, the comparative results for both LVI composite index and LVI-IPCC presented in the vulnerability triangle signifies which household features are contributing more to the vulnerability of each village. Mbemba village is most vulnerable in networks and relationships, knowledge and skills, livelihood strategies, health, land, forest, and natural disasters, while Ntingala is most vulnerable in Social Demographics, livelihood strategies, forest and natural disasters. The discussion on the implication of these results is narrowed down to the 4 capitals in Sustainable Livelihood Approach which were used in this study.

Social capital: Social-demographic characteristics such as, high dependency ratio, low literacy rates make people more vulnerable whereas access to social networks play significant role in supporting rural households [13]. The relatively higher dependency ratio in Ntingala may reduce the potential for the households to generate enough income to meet household needs. However, further research is required to establish its contribution to vulnerability in this area. The author in [14], agrees that a high dependency ratio increases vulnerability both through the income channel (by reducing per capita income in the household) and through the diversification channel, while a research done in South Africa, found that households with high education level and more skills and knowledge scored low on vulnerability and were more resilient to drought impacts [15]. On the other hand, Mbemba recorded higher levels of vulnerability in social networks, knowledge and skills because of low levels of support for each other within the community and lower level of household members who have gone for vocational skills. Non participation to social networks in OR Tambo district exposed more households to drought impacts because they do not have any strategies to prepare for drought, neither do they have support from their social networks; hence, their coping capacity is severely undermined [15]. On the other hand, an increase in number of households with vocational skills, would have enabled the households to diversify sources of income at household level to reduce vulnerability in times of drought. High proportion of female headed families and households keeping orphans could contribute to vulnerability and affect coping capacities for the affected households in Ntingala. This is in agreement with [16], who found that divorced, widowed and women headed families in Turkana were most vulnerable to drought shocks and find it difficult to cope with drought, while the author in [16], mentions that married families manifests as a strength among couples during disasters while widows, widowers, divorced and single families are hard hit by shocks and loses.

Financial capital: Although both Mbemba and Ntingala have diverse sources of income, the moderate vulnerability scores in livelihood strategies for both villages were high largely because communities to a large extent are engaged in subsistence farming despite the area being prone to persistent dry spells and drought. Smallholder farmers have limited options on the type of enterprises they engage in to minimize impacts of drought. This is in agreement with [17] contribution in Sekhukhune District in Limpopo research that commercial farmers most of the time have wider choices during drought than subsistence and small scale

farmers because they have a strong financial backup and could easily switch their entreprises while subsistance farmers do not have enough financial resources.

Natural capital: Land contributed to high vulnerability score in Mbemba, while forestry contributed to high vulnerability scores for both Mbemba and Ntingala. According to [18], research findings in T/A Chitekwere, revealed that increase in the size of land and full utilisation increased probability of household moving from moderate to low vulnerability. Communities from both villages entirely depends on forestry products for energy and to a large extent as a source of income. The interviewed households indicated that forests and forest products are depleting each day therefore increasing the time women take to fetch firewood. The participants also mentioned that despite knowledge on the impact of cutting trees to the environment, the charcoal selling business increase during the drought period because of limitations in finding other sources of income. Non adoption of improved cooking stoves means that consumption of fuelwood is still very high and [19] indicates that fuelwood scarcity affects households because they may not have alternative energy source and may reduce time spent on productive activities. Vulnerability score for access to water for household use was very low in both villages. Although households experienced inconsistence in water supply due to drought, the impact was very minimal in that only 12% of the respondents reported to draw water further away from home due to effects of drought. For those farmers with irrigatable land, the streams dried up before crops reach maturity stage thereby affecting crop production. In a similar research, [20] reported that the average time spent to fetch water during drought years in India increased and communities especially women failed to meet their demand and experienced reduction in agriculture crop production.

Human capital: Long distance to the nearest health centres contributed to higher health vulnerability in both villages with an average of 72.3 minutes for Mbemba and 46 minutes for Ntingala with Malaria as the biggest health problem encounterd. According to [21], research agrees that the probability of health effects, among others also depends on access to health and sanitation infrastructure. Drought could also exerbate chronic illnesses that could also leave individuals unable to recover from another event. Both villages reported a considerable number of households who were absent from school or work due to illness which in away affected productivity. This is in agreement with [10], who concludes in his research that frequent illness have a negative impact on households income by limiting the number of work days. Malaria remains a major illness for those that were absent from school or work in both villages. The information collected from households is in agreement with HIMS health centre records from from Nkula, Zalewa and Lisungwi where 1083 and 925 Malaria cases were treated between Janaury and December from Mbemba and Ntingala respectively. Food vulnerability scores for Mbemba was lower than Ntingala. A high proportion of Mbemba households reported that they buy food from the market other than own production as compared to Ntingala. Over reliance on own food production in a drought prone area increased food vulnerability for Ntingala.

4.1.2 LVI-IPCC

The IPCC-LVI results revealed that households in Mbemba are relatively more vulnerable than Ntingala. The fact that the values are higher than 0 indicates that the community is more exposed to drought and climate extremes than its capacity to address adverse situations. In this study, Mbemba was more sensitive and highly

exposed with low adaptive capacty which contributed to high vulnerability while Ntingala has less sensitivity therefore reduces its vulnerability to climate impacts. In his research, [22] concludes that human and social sensitivity to hazards and the adaptive capacities of communities has a major contribution to overall vulnerability.

5. Conclusion

The study used Livelihoods Vulnerability Index (LVI) approach developed by [7] and LVI-IPCC methodologies to assess contextual factors contributing to household vulnerability in the two villages. The study concludes that both villages are relatively vulnerable to drought and that Mbemba village has a higher vulnerability score than Ntingala. Various factors contribute differently to vulnerability in the 2 villages. The study further concludes that major components of networks and relationships, knowledge and skills, livelihood strategies, health, land and natural disasters contribute to vulnerability in Mbemba, while social demographic profile, livelihood strategies, forest and natural disasters contribute to vulnerability in Ntingala. The results provides a further understanding on what contributes to vulnerability in this particular context to inform policy and better planning.

6. Recommendations

The LVI methodology should be replicated in the entire traditional authority or repeated in the study area after a number of years to measure changes in vulnerability and adaptive capacity of the community. Additional indicators which were left out can be included to ensure that the disaster risk management practices promoted address all factors that contribute to community's vulnerability to drought.

Appendices

Appendix D: Sample Calculation of Livelihood strategies major component for the LVI for Mbemba village In Neno District.

Sub-Components for Livelihood Major Component	Sub Component Value for Mbemba	Max Sub - Component Value for Study Population		Min Sub-Component Value for Study Population	Index Value for Mbemba	Livelihood Major Component Values for Mbemba
Percentage of households reporting at least one member working outside the community for their livelihood	9.473	100		0	0.095	
Percentage of households depending on subsistence farming as the main source of income.	27.368	100		0	0.274	0.537
Percentage Households growing more than 1 type of crop.	87.368	100		0	0.874	
Percentage of households reporting livelihoods other than one source of income	90.526	100		0	0.905	

Step 1 (repeat for all sub –component indicators):

$$Index_{livelihood1Mbemba} = \frac{9.473 - 0}{100 - 0} = 0.095$$

Step 2 (repeat for all major components

$$Livelihood_{Mbemba} = = \frac{\sum index_i}{n} = \frac{L1Mbemba + L2Mbemba + L3Mbemba + L4Mbemba}{4} = \frac{0.095+0.274+0.874+0.905}{4} = 0.537$$

Step 3 (repeat for all study areas):

$LVI_{Mbemba} = \quad LVIz = \frac{\sum_{i=1}^{10} w_{Mi}\, M_{ri}}{\sum_{i=1}^{10} {}^{w}M_i}$

=(4)(0.359)+(5)(0.514)+(4)(0.650)+(4)(0.537)+(3)(0.539)+(6)(0.535)+(5)+(0.318)+ (1)(0.968)+(4)(0.668)+(6)(0.577)=0.517

4+5+4+4+3+6+5+1+4+6

Appendix E: Example of calculating LVI-IPCC for Mbemba village

Contributing Factors (Mbemba)	Major Components	Major Component Value	Number of Sub Components	Contributing Factor Values	LVI (Vulnerability Value for Mbemba)
					0.0656
Adaptive Capacity	Demographic Profile	0.359	4		
	Networks and Relationships	0.514	6		
	Knowledge and skills	0.650	4		
	Livelihoods strategies	0.537	4	0.515	
Sensitivity	Food	0.359	3		
	Health	0.535	6		
	Water	0.318	5		
	Land	0.968	1		
	Forest	0.668	4	0.501	
Exposure	Natural Disaster		6	0.656	

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