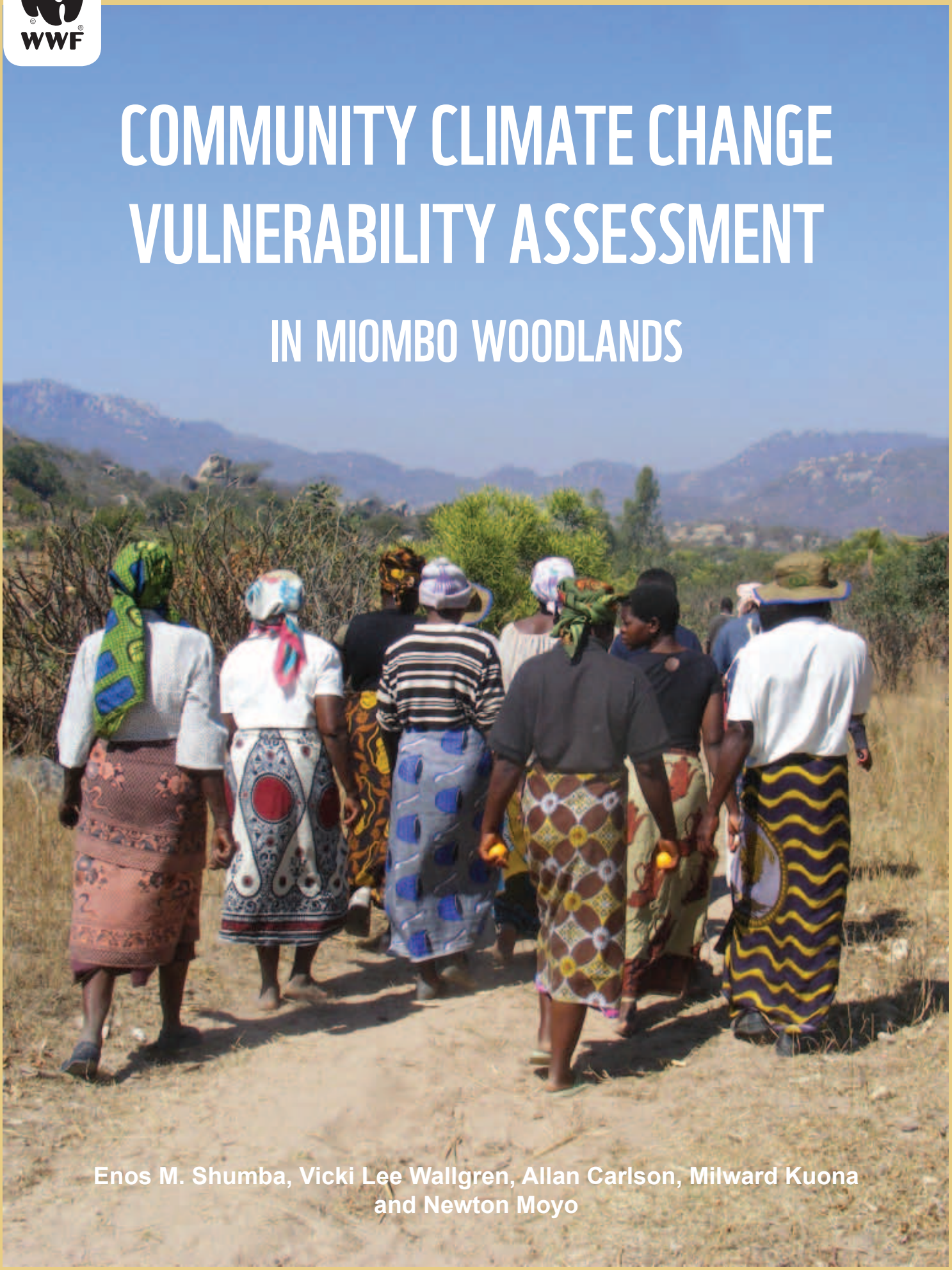
COMMUNITY CLIMATE CHANGE VULNERABILITY ASSESSMENT

IN MIOMBO WOODLANDS



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EXECUTIVE SUMMARY

Climate change models predict hasher weather conditions for Southern Africa. This could contribute to food insecurity and drive the region's predominantly subsistence farmers to open up marginal land for food production and to over rely on natural resources for survival. This might lead to increased deforestation, biodiversity loss and increased human wildlife conflicts hence the need to substantially increase the region's agricultural productivity and provide economically viable livelihood options to the region's citizens. This study assessed community vulnerability to climate change in three districts of Malawi, Zambia and Zimbabwe using informal and formal survey methods.

Key findings of the study are that:

- Communities in the study districts have a fair understanding of climate change. They generally associate it with rising temperatures; late start of the rainy season; and reduced rainy season length;
- Inhabitants of the study districts are predominantly smallholder farmers who depend on rain fed cropping and livestock rearing. Consequently, any adverse weather changes negatively impact on their livelihoods;
- Land clearing for agricultural expansion; tree cutting for firewood; and charcoal production are contributing to deforestation in the study districts. In addition, demand for land caused by low crop yields and increasing human populations has led to encroachment onto marginal lands;
- Study district farmers grow a wide range of food crops and a few cash crops and practise conservation agriculture to varying extents. For example, more households in Chikwawa and Mutoko have adopted soil and water management practices than those in Mpika which lies in a higher rainfall area. There is also greater use of improved maize varieties and inorganic fertilizer in Mutoko followed by Mpika and Chikwawa in that order. The use of improved crop inputs in the study districts is generally related to their availability and expected economic returns;
- Seed yields of major crops grown in the study districts are generally low and variable. For example, maize yields averaged 2.8t/ha in Mpika, 0.93t/ha in Chikwawa and 0.65t/ha in Mutoko. With an average family size of 4.9 people, and a maize area of 0.3 ha/household, it is difficult to achieve food self sufficiency in districts such as Chikwawa unless crop yields are substantially increased;
- There has been a general decrease in average annual rainfall and maize yields in Chikwawa and Mutoko and not in Mpika over the years. This confirms the notion that crop yields decline with climate change, thus exposing affected communities to food and livelihood insecurity. Most households in the study districts experience food shortages between October and March after grain from the previous harvest has run out and before the current crop is harvested;
- Households in the study districts bridge the October to March food insecurity gap by engaging in off-farm employment (to raise cash to buy in food) and natural resource exploitation. However, very few households in Mpika resort to off-farm income as the district is generally food self sufficient. Remittances from relatives working in urban areas and cities are an important income source for 49% of Mutoko households; and,
- A wide range of natural resources and their products are used to diversify livelihoods and hedge against climate change in the study districts. Firewood, wild fruits and caterpillars are among the important natural resources harvested for own use and for sale.

Key recommendations from the study were the need to:

- Identify/develop and promote robust agricultural technologies that increase and stabilize crop yields, thus reduce the urge to expand cropping into marginal areas. In addition, the soil and water conservation impact of current initiatives should be assessed at landscape/village level;
- Support the maintenance of as much forest cover as possible in well endowed districts such as Mpika by: supporting natural resource based value addition business activities like honey production; promoting sustainable and affordable soil nutrient sources to minimize shifting cultivation; and designing and piloting Reduced Emmissions from Deforestation and forest Degradation (REDD+) projects;
- Reduce over-reliance on wood energy by promoting alternative renewable energy solutions; and,
- Conduct a community climate change vulnerability assessment study with a natural resources focus.

INTRODUCTION

Climate change is about long term changes in weather conditions that differ significantly from previous averages. It manifests itself in droughts and floods that are caused by global warming or increases in temperature due to green house gas emissions. The emissions include carbon dioxide, methane and nitrous oxide resulting from human activities such as combustion of fossil fuels, industrial processes and deforestation. Climate change models predict a temperature increase of 1.5 to 2.5 degrees Celsius; condensed summer rainfall seasons; and a high frequency of flood events across the Zambezi river basin of Southern Africa within the next 40 years. Agriculture is the backbone of Southern Africa's economies and at least 65% of the region's citizens live in rural areas and rely on rain fed agriculture. However, the sector's performance is adversely affected by climate change. For example, drought reduced maize production to 37% of Malawi's total food requirements in 2004-5 and is expected to reduce rain fed crop yield by as much as 50% in some parts of Zimbabwe (Jain, 2007; Mika, 2010). Climate change can therefore contribute to food insecurity and drive the region's subsistence farmers to open up marginal land for food production and to over-rely on natural resources for survival. This could lead to increased deforestation, biodiversity loss and increased human wildlife conflicts. About 90% of Africa's forest destruction is closely associated with agricultural activities (SADC, 2011). There is therefore need to sustainably increase agricultural productivity and to provide economically viable livelihood options to the region's citizens.

Within Southern Africa, most pilot projects on climate change adaptation have focused on the agricultural sector. Some employ participatory approaches based on local knowledge and coping strategies and on the empowerment of communities to make decisions on technological choices and their implementation modalities. Conservation agriculture has been one of the most widely promoted adaptation measures with emphasis on water harvesting, micro irrigation, minimum tillage, agro-forestry, and drought tolerant crops and varieties. Although some of the measures have improved crop performance and food security, they have not adequately incorporated community vulnerability assessments and higher yielding and resilient agricultural technologies in their design. A well designed conservation agriculture initiative should embrace the following elements (Shumba and Carlson (2011):

- A clear understanding of the agricultural production system and related support services;
- A community climate change vulnerability assessment;
- A technical vulnerability assessment of the agricultural production systems; and,
- A systematic identification/development and infusion of technologies that enhance and stabilize agricultural production.

The above elements are intricately linked and provide information on a community's vulnerability to climate change and options that can enhance its adaptive capacity. Vulnerability is a dynamic process whose assessment requires knowledge of the prevailing situation, problems faced by vulnerable groups; and available resource choices. Pertinent issues covered under community climate change vulnerability assessments include the socio-economic status of the target community; existing agricultural production systems and their productivity; community understanding of and experience with climate change; impact of climate change on agricultural performance and community livelihoods; and community coping strategies.

This study assessed community vulnerability to climate change in three districts namely Chikwawa, Mpika and Mutoko in Malawi, Zambia and Zimbabwe respectively (Fig 1). They fall within the miombo woodlands high priority landscapes of the World Wide Fund for Nature's (WWF) Conservation Strategy of 2011 to 2020 (WWF. 2011). The landscapes are Shire Valley; Bangweulu Basin and Mid Zambezi valley respectively.

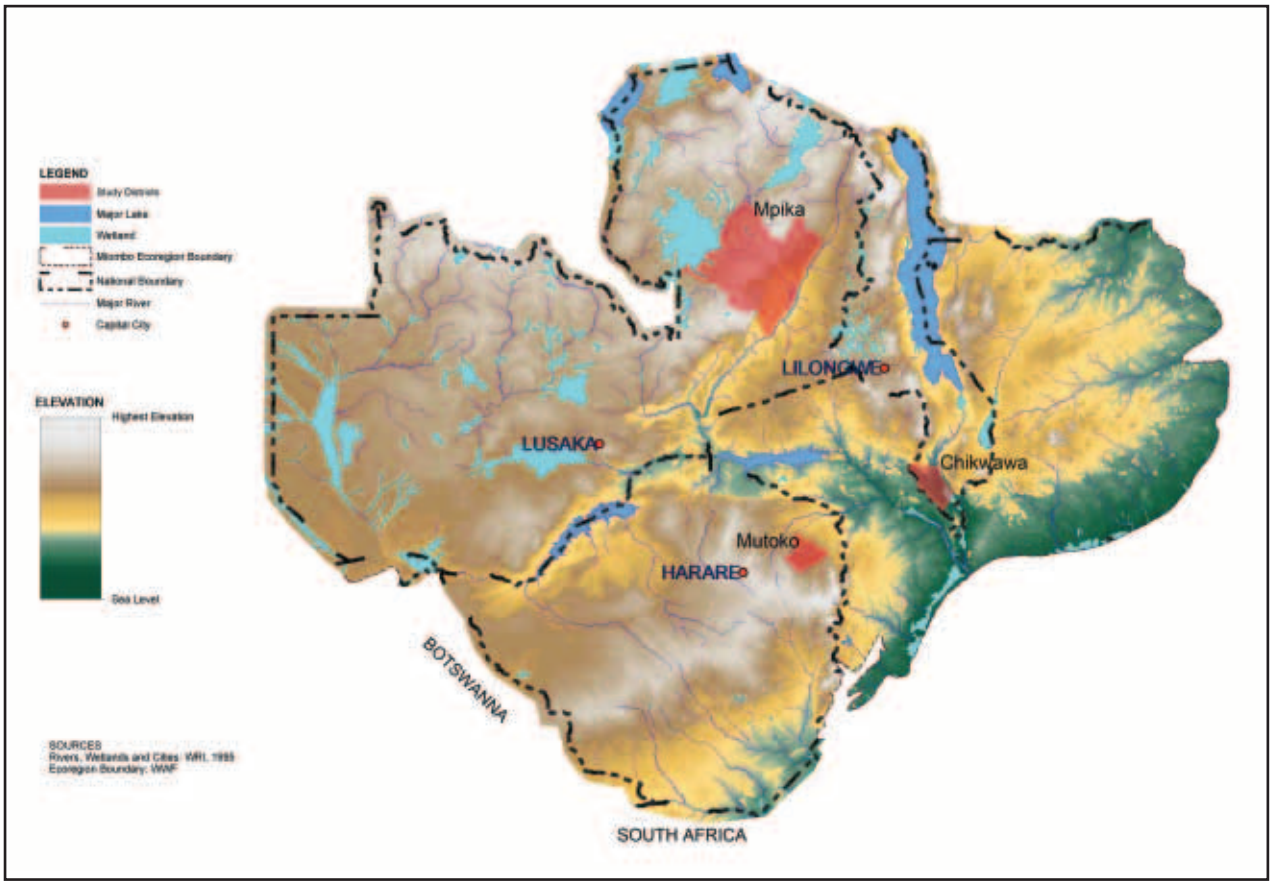

Figure 1: Location of the study districts

METHODOLOGY USED

Background papers on agricultural production systems were commissioned; and informal and formal surveys were conducted in the study districts. Agricultural experts resident in the districts produced the former papers which focused on each district's agro-ecological profile; socio-economic circumstances; farming systems and their performance; and food security situation. Informal surveys sought to obtain a broader understanding of climate change and livelihood issues from key informants and knowledgeable people in the study areas. They consisted of focused group discussions with key informants and opinion leaders such as traditional leaders, agricultural experts, school headmasters, business people and lead farmers. Formal surveys quantified and validated observations from the background papers and informal surveys. They were based on structured questionnaires administered to 120 randomly selected households in pre-selected villages of each study district.

Farmers participate in informal surveys

RESULTS

Understanding of climate change

Key features of the three study districts are given in Table 1. Chikwawa lies in the Shire river basin and Mpika and Mutoko are on much higher ground. Due to its lower altitude, Chikwawa is hotter than the other two districts. Mpika receives the highest annual rainfall, has the longest summer rainfall season and the least chance of experiencing mid season droughts. Chikwawa and Mutoko have a higher probability of experiencing shorter rainfall seasons of less than 110 days. With respect to soil type, Chikwawa has heavier and more nutrient rich vertisols while the other two districts have sandy loams. Mpika occupies the largest land area and has the lowest population density. In addition, it has the highest forest cover (66%) followed by Mutoko (47%) and Chikwawa (27%). The latter two districts are therefore under more climatic, land and natural resource pressure than the former.

Table 1: Key features of study districts

Parameter	Chikwawa	Mpika	Mutoko
Altitude, m	90-110	1 402	850-1 200
Average min temp, °C	27.0	10.0	14.0
Average max temp, °C	37.6	28.0	31.0
Average annual rainfall, mm	900.0	1 300.0	600.0
Average cropping season length, days	103.0	145.0	137.0
Probability of mid season drought, %	10.0	5.0	18.0
Probability of a rainy season of less than 110 days.	60.0	0.0	63.0
Land area, ha	475 500	4 100 000	429 083
Area under agriculture, ha	230 000	13 345	151 909
Forest cover, %	27	66	47
Human population	438 895	208 000	193 388
Population density, persons/sqkm	92	4	45
Soil type	Vertisol	Sandy loam	Sandy loam
Major rivers	Shire	Luangwa, Chambeshi	Nyadire, Mudzi

Source: Banda (2011); Makonyere 2011; Maluwa (2011)

Communities in the study districts have a fair understanding of climate change. They generally associate it with rising temperatures; late start of the rainy season; and a reduced rainfall season length as reflected by the following quotations (CURE, 2011: and Kuona, 2011):

"Instead of having the first rains in October, the onset of rainfall has moved to end November and early December. The rainfall period has become shorter and is characterised by intense falls and heat waves at the start of the rains" Village Headman Mafumbi of Chikwawa district.

"With both droughts and floods now occurring during the same year, it is difficult to decide on which crop to grow. In the past water streams flowed up to the end of July (dry season). Now they dry up in March (end of the rainy season), making it difficult to grow crops such as potatoes on wetlands and along stream banks" Mrs Sikelo, a business woman in Chikwawa district.

"Banana, sugarcane and general horticultural production has considerably declined as a result of inadequate water from perennial wells. This has made it difficult for some households to produce vegetables from their gardens. They now buy basic products like leafy vegetables and tomatoes from farmers with access to water during the dry season. We also used to grow rice on wetlands but this is now difficult since the crop experiences moisture stress" Mr Gurupira Chief of Mutoko district.

The majority of surveyed households felt that uneven rainfall distribution was a major indicator of climate change while 24% of Mpika farmers felt that climate was not changing. The late start of the rainy season was given as the second sign of climate change by Chikwawa farmers while those in Mutoko mentioned less overall rainfall (Table 2). These perceptions are consistent with climate information presented earlier.

Table 2: Farmer perceptions on climate change (n=120)

In what way is climate changing?	Chikwawa % farmers	Mpika % farmers	Mutoko % farmers
Not changing at all	2	24	5
Less overall rainfall	15	3	24
Uneven rainfall distribution	37	48	58
Frequent droughts	19	5	8
Frequent floods	4	0	0
Higher temperatures	0	19	3
Late start of rainy season	23	0	0
Other	0	2	2
Total	100	100	100

Source: Sukume (2012)

Weather information that can be accessed by communities fell into the following categories: start of the rainy season; extreme events; pest and disease out breaks; rainfall for the next 2-3 months; and rainfall for the next 2-3 days. The most popular source of this information was the radio which is widely accessible to most farmers. Other information sources included friends, relatives and neighbours; and government agricultural officers.

Farming systems

Inhabitants of the study districts are predominantly smallholder farmers who depend on rain fed cropping and livestock rearing. Consequently, any adverse weather changes negatively impact on their livelihoods. Crops are cultivated on individually owned plots and livestock is grazed on communal land. Key characteristics of study district farmers are given in Table 3. Most households are male headed and most household heads have at least basic/primary level education. Very few households own cattle in Chikwawa and Mpika districts. This delays land preparation and crop establishment as cattle are an important source of draught power in smallholder agriculture. In addition, cattle provide milk and manure; are a wealth symbol in some African societies; and are an integral part of the farming system. The cropping component produces crop residues, an important source of cattle feed during the dry season. Inadequate grazing and fear of disease out breaks discourage farmers from keeping cattle in Chikwawa and Mpika respectively. However, most households in the study districts keep goats and chickens. Both livestock species are easily convertible into cash (sold)

during food insecure periods.

Table3: Key characteristics of households in the study districts (n=120)

Parameter	Chikwawa	Mpika	Mutoko
Male headed households, %	80	81	64
Average family size, no.	4.9	6.3	5.4
Household heads with no formal education, %	10	8	2
Household heads with primary education (7 years), %	64	53	13
Household heads with secondary plus education, %	26	39	85
Average arable land size, ha/household	1.47	2.95	2.54
Households owning cattle, %	12	2	63
Households owning goats, %	31	41	72
Households with chickens, %	72	84	72

Source: Sukume (2012)

Small livestock are an integral part of smallholder farming systems

Land clearing for agricultural expansion; tree cutting for firewood; and charcoal production contribute to deforestation in the study districts. In addition, demand for land caused by low crop yields and increasing human populations leads to encroachment onto marginal lands. Table 4 shows that more households have increased the area planted to certain key crops compared to those who have reduced the planted areas. Apart from causing serious environmental degradation, such encroachment leads to human-wildlife conflicts as evidenced by an increase in reported cases of crocodile attacks on humans and livestock; and crop damage by hippos, especially on the Shire river in Chikwawa district. Furthermore, the district's two national reserves are adversely affected by massive tree clearing for settlements, agriculture, firewood and charcoal making. Regarding other natural resources, Mutoko has large reserves of black granite extracted by private companies. This causes serious environmental degradation as miners do not implement recommended rehabilitation measures.

Table 4: Expansion of crop production in study districts (n=120)

Parameter	Chikwawa, % HHolds	Mpika, % HHolds	Mutoko, % HHolds
Expansion of area under key crops			
-Maize	22	17	32
-Groundnuts	-	-	22
-Cassava	-	17	-
-Cotton	38	-	-
-Millet	-	4	-
Reduction of area under key crops			
-Maize	6	6	8
-Millet	-	10	9
-Groundnuts	-	-	10
-Cassava	-	6	-
-Cotton	4	-	-

Source: Sukume (2012)

Crop production

Study district farmers grow a wide range of crops. Based on the number of households growing particular crops and the areas planted, the top five crops are: maize, sorghum, finger millet, rice and cotton in Chikwawa; maize, cassava, finger millet, groundnuts and beans in Mpika; and, maize, cotton, groundnuts, sorghum and sunflowers in Mutoko (Table 6). Cropping patterns are biased towards food self sufficiency although there is significant cash cropping in Chikwawa and Mutoko districts. The limited focus on cash crops in Mpika partly reflects on the district's food self sufficiency situation and absence of ready markets for some cash crops. Poor road infrastructure raises transaction costs of bringing inputs to farmers and of transporting produce to markets. Consequently, most food crop sales in the study districts are between local communities largely through cash sales and barter deals. Poor external market access can therefore be a major disincentive to agricultural intensification and cash cropping in the study districts.

Mono-cropping is widely practiced in the study districts and some households in Chikwawa and Mpika intercrop cereals with legumes. Farmers also practice limited cereal-legume rotations. The practice is however constrained by limited land availability in the case of Chikwawa and Mutoko districts. Most farmers in Mpika practice shifting agriculture (slush and burn) on fields earmarked for millet planting. This leads to widespread deforestation despite the practice's short term soil fertility enhancement benefits. A shifting agriculture assessment study carried out in the Bangweulu Basin of Mpika district showed a strong relationship between the practice and lack of credit facilities for inorganic fertilizer purchase by farmers (WWF, 2011; Moyo, 2011). This highlights the need to provide affordable soil nutrient solutions if shifting agriculture is to be contained.

Shifting agriculture-a major driver of land use change!

Study district farmers practice conservation agriculture to varying extents (Table 5). For example, more households in Chikwawa and Mutoko have adopted soil and water management practices than those in Mpika which lies in a higher rainfall area. However, the conservation impact of such practices at landscape level has yet to be assessed as current emphasis is on crop yield on the individual farm plots. There is also greater use of improved maize varieties and inorganic fertilizer in Mutoko followed by Mpika and Chikwawa in that order. Pesticide use is highest in Chikwawa where farmers grow cotton. The use of improved crop inputs in the study districts is generally associated with availability and expected economic returns.

Table 5: Land, soil and water management practices used in the study districts (n=120)

Strategy	Chikwawa % Hholds	Mpika % Hholds	Mutoko % Hholds
Intercropping	56	10	25
Ridges or bunds	72	7	31
Mulching	31	2	65
Contour ploughing	28	1	54
Crop rotations	58	33	72
Manure/compost use	28	20	72
Maize fertilizer use	23	67	93
Pesticide/herbicide use	61	3	37
Integrated pest management	37	1	15
Integrated crop management	31	0	5

Source: Sukume (2012)

Seed yields of major crops grown in the study districts are generally low and variable (Table 6). Maize yields averaged 2.8 t/ha in Mpika, 0.93 t/ha in Chikwawa and 0.65 t/ha in Mutoko. With an average family size of 4.9 people, and a maize area of 0.3 ha/household, it is difficult to achieve food self sufficiency in districts like Chikwawa unless crop yields increase substantially.

Table 6: Five major crops grown and yields in the study districts*

Crop	Chikwawa		Mpika		Mutoko	
	Area,ha	Yield, t/ha	Area, ha	Yield, t/ha	Area, ha	Yield, t/ha
Maize	59 081	0.93	5 167	2.80	26 264	0.65
Sorghum	27 795	0.63	-	-	2 215	0.49
Groundnuts	-	-	1 287	0.96	3 073	0.67
Rice	3 229	2.68	-	-	-	-
Cotton	1 962	0.89	-	-	4 565	0.55
Sunflowers	-	-	-	-	1 122	0.53
Finger millet	11 804	0.62	1 734	0.80	-	-
Cassava	-	-	3 176	14.80	-	-
Beans	-	-	579	0.53	-	-
Pigeon peas						

**Average figures for 7 years for Chikwawa and Mutoko; and 5 years for Mpika*

Source: Banda (2011); Makonyere (2011); Maluwa (2011)

Maize is very sensitive to moisture stress

Food and livelihood security

Fig 2 shows that rainfall and maize yield figures in the study districts vary over time. There has been a general decrease in the two parameters in Chikwawa and to a limited extent in Mutoko. The picture is unclear in Mpika where total annual rainfall has remained relatively high. The Chikwawa scenario confirms the notion that crop yields decline with climate change, thus exposing affected communities to food and livelihood insecurity. The food security situation of communities in the study districts is given in Table 7. The following inferences can be made from the table:

- Chikwawa is the most food insecure district followed by Mutoko and Mpika in that order; and,
- Most households experience food shortages between October and March after grain from the previous harvest runs out and before the current crop is harvested. However, most households are food secure between April and September once the new crop is harvested.

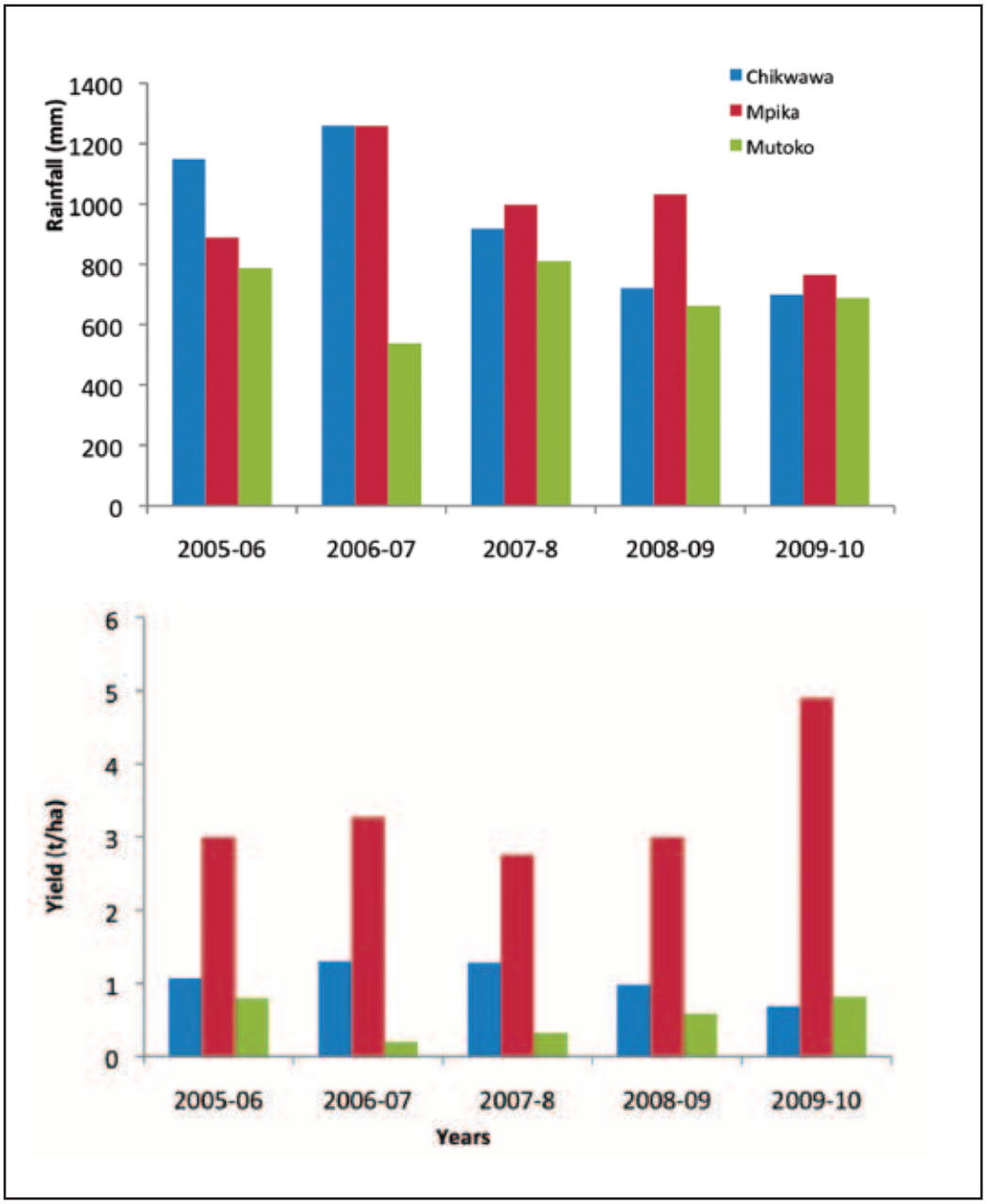

Fig 2: Rainfall and maize yield trends in the study districts

Table 7: Food security situation in the study districts

Crop	Chikwawa	Mpika	Mutoko
Households experiencing food shortages between April and September, %	24	3	4
Households experiencing food shortages between October and March	73	23	33
Livelihood source during food insecure period (October and March): -Off farm income, % HHolds -Off Farm remittances, % Hholds	 80 11	 14 11	 45 49

Source: Sukume (2012)

Communities in the study districts bridge the October to March food insecurity gap by engaging in off-farm employment (to raise cash to buy food) and natural resource utilization. Very few households in Mpika rely on off-farm income as the district is generally food self sufficient due to its relatively high rainfall situation. On the other hand, 80% and 45% of Chikwawa and Mutoko districts' households respectively, engage in off-farm employment within and outside the district. However, off-farm employment creates its own social problems such as marriage break ups as pointed out by Village Headman Mandele of Chikwawa district (CURE, 2011) "*Husbands migrate to areas where they can get casual labour; in the long run they marry other women there and become reluctant to return to their former wives. Sometimes the man gets married to a wife who has a rich father and refuses to go back to his village where there is hunger!*" Some 49% of Mutoko households receive remittances from relatives working in urban areas and cities such as Harare which is only 140 km away from Mutoko centre.

A wide range of natural resources and their products are used to diversify livelihoods and hedge against climate change in the study districts (Table 8). Firewood/charcoal and wild fruits are the most prominent natural resources harvested for own use and for sale. The former is the major energy source as alternative and conventional sources such as electricity and petroleum are beyond the reach of the study districts' predominantly poor households due to prohibitive costs and limited availability. For example, overall access to electricity is 14%, 25% and 34% in Malawi, Zambia and Zimbabwe respectively (Zhou, et al, 2011). The figures are much lower in rural areas.

Wild fruits ripen during the food deficit period (rainy season). They are therefore an important food and cash source in all study districts. The fruits are sold to middle men/women for resale in urban markets. Honey production for household use and sale is emerging as an important non-destructive non timber forest product in Mpika and Mutoko districts. In areas with opportunities for local value addition and good external market access, honey production can encourage good forest stewardship if it provides positive economic returns to households. For example, some beekeepers in the Bangweulu basin of Mpika district have set aside over 600 ha of communally owned forest land for deliberate community level management as bee forage areas (WWF, 2011). Another important activity in the Basin is caterpillar harvesting for subsistence and for sale. This is however associated with tree destruction especially by people from other villages and urban centres. To reduce such destruction, two beekeeping villages in the Bangweulu basin employed community forest scouts to monitor caterpillar harvesting in bee forage areas. The use of transacts and observation techniques showed that most trees in the monitored areas remained intact after the caterpillar harvesting period compared to those that were not monitored (WWF, 2011).

Charcoal selling - a brisk business!

Table 8: Food and income from natural resources in the study districts (n=120)

Crop	Chikwawa, % Hholds		Mpika % Hholds		Mutoko % Hholds	
	Harvesting	Selling	Harvesting	Selling	Harvesting	Selling
Timber/poles	3	0	6	3	71	7
Firewood	97	3	63	0	89	4
Charcoal	5	1	27	2	8	3
Honey	0	0	11	3	16	3
Mushroom	10	1	56	39	29	2
Wild fruits	64	3	56	39	90	5
Wild vegetables	48	3	18	4	2	0
Caterpillars	0	0	100	98	0	0

Source: Sukume (2012)

Trees cut down during caterpillar harvesting

CONCLUSIONS AND RECOMMENDATIONS

Most households in Chikwawa and Mutoko districts become food insecure from October to March each year. The intensity of this phenomenon has increased with climate change which reduces crop yields. Communities are adapting by increasing the area planted to food and cash crops; practising conservation agriculture; increasing dependence on natural resources for subsistence and income; and engaging in off-farm employment. There is therefore need to develop and promote robust agricultural systems that increase and stabilize crop yields. Thus, information generated by this study should be used to identify/develop and promote high yielding and resilient agricultural technologies for the study districts. In addition, the soil and water conservation impact of current initiatives should be assessed at landscape/village level. This could confirm that smallholder farmers are, in fact, contributing to a "global good" and thus justify the need for them to be financially supported by their national governments and/or international community.

Of the three study districts, Mpika is the least vulnerable to climate change. It has the highest average rainfall; lowest population density; largest arable land area per household; highest crop yields; and the least proportion of households experiencing food insecurity. Its farmers should therefore be able to intensify food and cash crop production for livelihood improvement. Unfortunately, they are constrained by poor infrastructure, inadequate credit facilities and mulfunctional input and output markets. Consequently, crop intensification and yield stabilization initiatives should be accompanied by improvements in non climate change related factors such as markets and social services. In addition, there is need to maintain as much forest cover as possible by:

- Promoting and/or up-scaling natural resource based value addition business ventures such as commercial honey production;
- Identifying and promoting sustainable and affordable soil nutrient sources to minimize shifting cultivation (e.g. agro-forestry practices); and,
- Designing and piloting forest carbon trading projects through the Reduced Emissions from Deforestation and forest Degradation (REDD+) mechanism. The mechanism recognizes that tropical forest destruction accounts for 20% of global carbon emissions. REDD+ can therefore create economic value for carbon locked up in standing trees and provide incentives to rural communities, governments and other forest land owners to practice good natural resource stewardship.

Over reliance on wood energy has contributed to deforestation and reduced the capacity of forests to sequestrate carbon dioxide and to reduce green house gas emissions in the study districts. In addition, households, especially women, now travel longer distances in search of firewood. There is therefore need to reduce community reliance on this energy source by identifying and promoting appropriate renewable energy solutions.

Most climate change adaptation work in Southern Africa has been in the agricultural sector where various assessment tools have been developed and made operational. This influenced the strong agricultural focus of this study. It is therefore recommended that a study with a natural resources focus should be commissioned using the following participatory steps (Lee Wallgren *pers com.*):

- Mapping the use of natural resources by communities (e.g. wood, water, non timber forest products, etc,);
- Assessing the impact of climate change on natural resources ; and,
- Developing strategies that reduce the vulnerability of communities and their natural resources to climate change.

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