Perceptions, vulnerability and adaptation to climatic change and variability in Masvingo Province

By

David Chikodzi
Farai Malvern Simba
Talent Murwendo
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David Chikodzi*, Farai Malvern Simba*, and Talent Murwendo*

Faculty of Science, Great Zimbabwe University

ABSTRACT
Most farmers in Masvingo Province are subsistence farmers who rely on rain fed agriculture that is becoming unreliable. The study assessed the perceptions, vulnerability and adaptation options of the farmers in Masvingo province to climate change. A quantitative questionnaire was administered, places sampled were randomly chosen in a GIS. Climatic data over 60 years was used to derive temperature and rainfall trends and for dry spell analysis. Results show that the Province is increasingly vulnerable to climate change and vulnerability as seen in the increase in the severity and length of dry spells, increase in temperatures and a late start of the rainy season. The farmers also show that they correctly perceive climate change to be occurring but they lack the means and know how to adopt. The farmers need to utilise the water bodies in the province, plant indigenous crop species and adopt drought resistant and short season variety seeds.

KEYWORDS: climate change, climatic variability, seasonal drought, perception, vulnerability, adaptive capacity, adaptation, Masvingo Province.

INTRODUCTION
Climate change has become a threat to rain fed agriculture yet rain fed agriculture is an important economic activity in the developing world. Globally, rain fed agriculture is practiced in 80% of the total physical agricultural area and generate 62% of the world’s staple food (FAOSTAT, 2005; Bhattacharya, 2008). In sub-Saharan Africa, 93% of cultivated land is rain fed (FAO, 2002) thus playing a crucial role in food security and economic development. Masvingo province in Zimbabwe is a predominantly rural province made up of mainly communal farmers. These farmers are key stakeholders in the climate change debate because it directly affects their livelihood source. However, knowledge of rural farmers on climate issues is sometimes limited. Perceptions of communities on climate change and variability are important because they can be used to produce effective participatory methodology for climate change adaptation and capacity building. Communities are not homogeneous; each has got its own unique set of problems, beliefs and perceptions, so any community level intervention meant solving problems should be community specific (Turton, 2002; Sundbland, 2008; Nzeadibe and Ajaero, 2010). Consequently, understanding the perception of climate change by farmers, is important as perception can shape the preparedness of these actors to adapt and change their practices, (Speranza 2010).

Climate change vulnerability varies from one community or group of people to another depending on resources they can access. McCarthy et al. (2001) described vulnerability to climate change as a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity and its adaptive capacity. Vulnerability is therefore exposure of individuals or collective groups to livelihood stress as a result of the impacts of such environmental change (UNDP, 2005; Kaspersion et al., 2000 and Adger, 2006). This was based on cause-effect relationship in the vulnerability assessment. However, there is consensus across climate change researchers that these definitions have led to fragmented conceptual frameworks especially in the vulnerability assessment to climate change (O’Brien, et al., 2004; Füssel, 2007)

The risk associated with climate change for any region is a product of the region’s exposure to climate change and the vulnerability of societies within the region to the event. Farming in most parts of Africa depends on rain fed agriculture. With other environmental factors assumed to be fair and good, dry spells are considered to be the major cause of poor crop production, hence a study on dry spell analysis is important in determining the impacts of climate change and variability on crop production. The success and failure in crop production during rainy seasons is dependent on the frequency and length of dry spells and these have been on the increase in terms of frequency and length. Knowledge on dry spell distribution within a rainy season plays a vital role in trying to maximise benefits in rainfed agricultural regions and adaptation to climate change. In addition, deciding on suitable crop variety to be considered in a particular area can be done reliably with the knowledge on dry spell
distribution. In irrigation schemes, planning for supplementary irrigation during a rainy season as well as forecasting irrigation demand can only be reliable with the knowledge of dry spell distribution. Dry spells also affect fisheries, human health and generation of hydroelectricity; so their analysis is also crucial in various decision making processes related to climate change, (Mathugama, 2011). The adaptive capacity of a community is assumed to be a function of wealth, technology, available infrastructure, institutions and natural resources. Wealth enables communities to absorb and recover quickly from shock. However, adaptation to climate change requires that farmers first notice climate change occurrence, and then identify useful adaptation strategies to implement, (Maddison, 2006).

Climate change has altered the rainfall patterns, amplified drought cycles, increased the frequency of severe weather conditions and increased agricultural pests and diseases (Unganai, 1996; Makhadh, 1996; UN, 1998; Yanda, 2010 and Hewitson, 2010). More importantly climate change has resulted in declining farm productivity not only in Zimbabwe but in the whole of the Southern African Development community (SADC), (Russel, 2008; Mutekwa, 2009; Makungwa, 2010). Smallholder farmers have become vulnerable to climate change (Care, 2009). Cotton production in Zimbabwe has been on the decline mainly due to climate change and variability. Maize production and other small grains like sorghum have also been on the decline (Gwimbi, 2009; Jerie and Ndabaningi, 2011; Makadho, 1996; Mutekwa, 2009). Climate change has therefore affected staple crops, subsistence production and livestock production in general. The above has made communal farmers vulnerable and hence the need for adaptation.

Very little work has been carried out by the academia specifically on vulnerability of different social groups to climate change in Zimbabwe, except a few uncoordinated work by non-governmental organisations.

Adaptation measures or options vary depending on many factors. Alternatively, adaptation measures can be classified based on the timing, goal and motive of their implementation. Accordingly, adaptation can include reactive or anticipatory actions, or can be planned or autonomous (UNFCC, 2006 and TERI, IPCC, 2007).

Adaptation is the adjustment of natural or human systems in response to actual or expected climate change which moderates harm or exploits beneficial opportunities (IPCC, 2007). Resilience of a social or ecological system enables it to absorb disturbances while retaining the same basic and ways of functioning and the capacity to adapt to change. Methods of adaptation include diversifying crops, planting different crops or crop varieties, replacing farm activities with non-farm activities, changing planting and harvesting dates, increasing use of irrigation, increasing the use of water and soil conservation techniques, collective action in income generating activities and access to markets, credit and relief, cash transfers and remittances, exchange of labour for food, it includes dry and early planting, winter ploughing, short season and drought resistant crops varieties, multiple cropping (Paavola, 2003; Tillya and Mhita, 2006, CwD, 2007).

A major problem for any adaptation initiative, particularly at the local level is insufficient information about what to adapt to. This often results from a lack of awareness of how the climate has changed in the past (and how social systems have responded), how it is expected to change in the future and if observed changes are consistent with projected changes based on models of the climate system, (Hewitson and Crane, 2006; Jones et al., 2004; Tadross et al., 2005). This is further complicated by the need to interpret changes from meteorological analyses (typically expressed as monthly or seasonal averages) in terms of an impact on a particular sector. For the agricultural sector, which is the main source of livelihood for the majority of the region's population, it is crucial to understand how rainfall characteristics are changing, particularly those affecting planting dates and the crop growth cycle, e.g. the start of the rains or frequency and intensity of dry spells and daily rainfall, that can destroy crops if they occur at critical stages of plant growth (Dennet, 1987; DFID, 2001, Ati et al., 2002; Usman et al., 2005).

Problem Statement

Climate change impacts are varied depending on the scale at which it is being assessed. In this case the study mainly focuses on climate change at Provincial scale. Most studies on climate change take a look at its impacts at Country level and Regional level ignoring the local level impacts which are more important if adaptation is to occur. Assessing the vulnerability and perceptions of communities to climate change is the first towards crafting appropriate mitigation options based on knowledge of communities. This is the knowledge void that this study seeks to fill.

Objectives

- The overall objective of this paper is to assess the perceptions, vulnerability and adaptation to climate change by farmers in Masvingo Province. Specifically, the research seeks to ascertain farmers' perception of climate change in Masvingo province, assess Masvingo province's vulnerability to climate change and variability and examine the adaption measures and barriers to adaptation to climate change and variability in Masvingo province.

Study area

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Figure 1 shows the location of the study area. Masvingo province is divided into seven districts which are; Gutu, Masvingo, Bikita, Zaka, Chivi, Mwenezi and Chiredzi. Masvingo province occupies the drier lowveld area in the south of Zimbabwe. Most of the area in the province is devoted to cattle ranching, subsistence crop farming, with mining and irrigated sugar growing also significant. Rainfall is highly variable and uncertain, making the province prone to droughts hence unfit for reliable arable agriculture (Makadho, 1996).

The province has an area of 56,566 km² and a population of approximately 1.3 million in 2002,(CSO, 2002). The province is largely populated by members of the Karanga tribe, who are the most populous tribe in Zimbabwe, and are a sub-group of the Shona speaking tribes that also include the Zezuru, Manyika and Ndau.

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The Save, Runde, Mwenezi, Mutirikwi and Limpopo river systems dominate the drainage system in the province. Kopjes, hills and mountain ranges dot the countryside. Miombo woodlands dominate the wetter parts while Mopani trees, which are drought tolerant and sturdy, are found throughout the province.

**MATERIALS AND METHODS**

Materials used in the study include the following:

1. **Daily Climatic Data** obtained from Zimbabwe Meteorological Services Department (ZMSD). The daily rainfall and temperature data used was obtained from Masvingo Airport, Zaka, Buffalo Range, Chisumbanje and Makoholi weather stations.

2. The study also used a coded questionnaire, focus group discussion and interviews with key informants. The data was then processed and analysed in the following ways:

   a) The data were used to determine climate trends for Masvingo province. Climate data was used to determine climate change, variability in order to assess vulnerability.

   b) A questionnaire survey was used in the study to solicit information related to farmer’s perception on climate change and variability. The survey targeted farmers that were mostly the oldest people of a selected community because these are the one that were considered to give a pattern of weather changes over a longer period of time which was considered to give a more reliable picture of changes in climate. Sometimes for comparative purposes of changes of perception with age, any person of twenty years and above in age was also considered suitable. Considering the population (the most useful of the population), 200 was confidently selected as the best sample size that would give the best tradeoffs between cost (time taken) and representativeness of the sample.

   c) About 53 villages were visited in the province. A base map of Masvingo province was imported onto a Geographical Information Systems (GIS) then followed by the generation of 200 random points.
coordinates of the generated points were then loaded into a hand held Global Positioning Systems (GPS) which was then used to navigate to the selected areas.

d) Focus group discussions were also done to discuss with farmers environmental changes, crop productivity and adaptation strategies. These were held at two places which are Chief Nemamwa’s homestead and Matibi 2 Area and in close to Gonarezhou National Park.

e) Key respondents at key institutions with specialised knowledge on climate change were selected and targeted for interviews. The interviews were carried out the same period with the questionnaire survey. The interviewees were mostly chief researchers at Makoholi Research Station in Zimuto, Agricultural extension officers in Chibi and Triangle Sugar Estates in Chiredzi. In general information solicited from these interviews was on climate trends, vulnerability, adaptation options and farmers’ perceptions.

f) Questionnaire data was entered and analysed using Statistical Package for Social Scientist (SPSS) package (Miller et al., 2006). Data was entered into tables with a Likert scale with 1 for strongly agree and 5 for strongly disagree.

Validation of Findings

As a way to validate and understand the issues arising from the participatory focus group discussions and questionnaire we undertook discussions with key informants, literature review and climatic data analyses.

RESULTS

Community perception on climate Change

This part deals with what Farmers perceive to be the local manifestations of climate change and variability basing on what they have observed on their farms.

The elements of climate change that were asked include how temperatures are varying in winter and summers, times when rainfall are beginning and ceasing, a check on whether rainfall is supporting crop production and changes in forest resources.

About 57% of the farmers observed that winters are becoming warmer, 86% observed hotter summers. About 86.6 % of the Farmers observed that rainfall is no longer supporting viable crop yields, there are no significant increases in flood incidents notable in the province with of 24.6% of the farmers observing increased flooding incidences. The majority of the Farmers, 73.3% observed that rainfall seasons have become shorter with rains coming late and ceasing early. Onset of rains is delayed to mid November and cessation time ended early in mid February. About 71.4% of farmers have observed significant disappearance and damage to forests due to adverse climatic conditions. In all the districts most of the farmers, about 73.1% have observed an increase in pests and diseases that attack their cattle and crops in the field.

The general responses indicated that the rainfall patterns were now erratic and no longer supported viable crop production and that rainy seasons have become shorter. Farmers are also observing increasing ambient temperatures especially in summer which are responsible for high evapotranspiration rates.

Vulnerability

Vulnerability was measured in terms of annual rainfall patterns, dryspell events, temperatures as these are the factors which influences farm productivity.

Masvingo Climatic Trends

The rainfall patterns in Masvingo province shows extreme deviations from the mean. Years in which there was significant rainfall above normal are 1973 to 1978 and also from 1996 to 2000. However, occurring more frequently and in increased magnitude are the of years below normal. Notable extreme below normal rainfall episodes occurred in 1963/64, 1967/68, 1972/73, 1982/83, 1986/87 and 1991/92 which point to severe drought periods in the province. Figure.2 summarises the extreme rainfall events in Masvingo province.
Climatic records prove that there was an increase in variability of seasonal total rainfall from 1950 to 2007. Figure 3 summarises the seasonal total rainfall for Masvingo Province from 1910 to 2007. The trend line is indicating a slight decrease in the total rainfall over the years as given by the negative gradient in the linear equation.

While the rainfall trends show a decrease with time, temperature trends are indicating an increasing trend as shown by figure 4 and 5. Figure 4 shows rising winter temperatures for Masvingo province. Winters (May to July period) are apparently becoming warmer starting from 1950 to 2002. The variations of winter temperatures are between 13 and 17°C.
Figure 4: Mean winter temperatures for Masvingo Province for 1951 to 2002

![Image of winter temperature graph]

Figure 5: Mean summer temperatures for Masvingo Province for 1951 to 2002

![Image of summer temperature graph]

Figure 5 indicates an increasing trend in summer temperatures as given by the positive trend line equation. The variations of maximum temperatures are narrow i.e. between 22 and 24°C.

Trends in frequency and severity of dryspells for Zaka station

This section deals with dryspell analysis for Masvingo and Zaka stations in terms of seasonal maximum dry spell length (SMDSL) and seasonal number of dry spell periods (SNDSP) using time series plots.

Figures 4 (a) and (b) shows increases in both the dryspell length and in the number of dryspell periods. There is however no incidences of dryspells from season 1 up to season 16(1960-1977) dryspells only started from season 17 and have increased in length and frequency ever since. This means there is an increased exposure and vulnerability of Farmers in this district to the negative impacts of climate change and variability.
Trends in frequency and severity of dry spells for Masvingo station

Figure 7 (a) and (b) show increases in the dry spell length and in the number of dry spell periods. Dry spell events are in line with huge variations of seasonal total rainfall resulting in dry spell events (figure 3).

Discussion

Masvingo province is vulnerable to the negative impacts of climate change. The rainfall shows a negative trend which proves that it is declining with time. At the same time the rainfall seasons are now starting early and ending earlier, this is further coupled by the increase incidents of mid season drought both in terms of increased number of dry spells and their maximum length. The above proves that rainfall in the province is no longer enough to support rain fed crop production and confirms that Zimbabwe especially Masvingo province will be a non-maize producing region in the future (UN, 1998).

The maximum temperatures around the province have also been on the increase. This has an effect of increasing evapo-transpiration making crop vulnerable to moisture stress during the dry spell periods.
Increasing temperatures will also increase the rate of evaporation from the surface water bodies in the province which offer the greatest adaptation option against the negative impacts of climate change. The dry spell analysis for two stations in Masvingo, Zaka and Masvingo show that there is an increase in the lengths of dry spells and in the number of dry spell periods with time. The trends are also reinforced by the apparent decrease in the seasonal total rainfall for the province. The two variations are giving evidence to climate variability and erratic rainfall which does not support crop production. Generally the dry spell lengths and frequencies can be predicted and this information can be used profitably by a farmer in rain fed crop production.

Farmers have indicated that they perceive changes in the seasons with rainfalls beginning late and ceasing early and other studies by (de Jonge, 2010) have indicated similar trends. Farmers also observed high ambient temperatures in the province as other studies have shown (Fischer et al., 2005). Generally farmers are observant of changes that have taken place in the climate and their surrounding environment. Farmer’s perceptions on climate change are important in strategizing the adaptation and mitigation changes (Mutekwa, 2011; Makungwa, 2010). The observations are also indicative of the farmer’s preparedness to harness new farming methods and techniques. Farmers have to react to climate change relying on the local knowledge and the scientific data from the ZMSD.

There is need for communal farmers in Masvingo Province to shift from rain fed agriculture to irrigated farming. Masvingo is a province endowed with numerous water bodies by virtue of being located in the low lying region of the country and receives water from different surrounding uplands. Investing in effective irrigation technology can go a long way in improving crop productivity in the province (Simba et al., 2012). Farmers should also tap into ground water harvesting to supplement water in open bodies.

Drought resistant crops like most small grains guarantee food security and must be adopted by farmers in the province. In the face of dry spells, farmers should adopt staggered planting which reduce on risk of losing out completely in the event of protracted absence of rain during the season. Early maturing seed varieties can help as an adaptive measure in light of the shortened rain seasons.

There is need for communal farmers to seek advice from agricultural extension officers on when to plant, which seed varieties, soil nutrient analysis for better soil management and the expected climate for the season ahead of them.

CONCLUSION

The paper demonstrated that perceptions of communities to climate change are important in terms crafting participatory mitigation options for the problem. The paper shows that most communities perceive climate change to be occurring. The paper also proves that most of Masvingo province is vulnerable to climate change as shown by trends in climatic data, dry spell analysis which shows an increasing trend in terms of frequency and magnitude of dry spell events. To adapt to climate change Masvingo Province needs to reduce it’s over reliance on rain fed agriculture. This includes venturing more into irrigation farming which the option is considering the fact that the province has the largest water bodies in the country. Adaptation options might also include growing small grains and better soil nutrient management.

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