Journal of Sustainable Development in Africa (Volume 11, No.2, 2009)

ISSN: 1520-5509

Clarion University of Pennsylvania, Clarion, Pennsylvania

# CLIMATE CHANGE IMPACTS AND ADAPTATION IN THE AGRICULTURAL SECTOR: THE CASE OF SMALLHOLDER FARMERS IN ZIMBABWE

By

V.T. Mutekwa

Department of Geography & Environmental Science

Midlands State University, Zimbabwe

## ABSTRACT

*This paper discusses the findings of the research study that was carried out in Zimbabwe among predominantly smallholder farmers on their knowledge of climate change impacts and adaptation strategies. The main aim of the research was to assess climate change and weather issues of relevance to smallholder farmers' activities, views and knowledge about climate change, its impacts and adaptation strategies. These farmers are vulnerable to the effects of climate change due to their marginal location, low levels of technology, and lack of other essential farming resources. The paper utilizes information from interviews of agricultural extension officers, desk-based research, literature review, and questionnaire surveys administered to smallholder farmers in Murowa Ward, Zvishavane district. The majority of farmers indicated that prolonged wet, hot, and dry weather conditions affect the efficient use of their resources and investment decisions. Some specific impacts of these conditions include, among others, crop damage, death of livestock, soil erosion, bush fires, poor plant germination, pests, lower incomes, and deterioration of infrastructure. Some farmers professed ignorance about climate change and how it will affect their future farming activities. Other farmers pointed out high frequency and severity of drought, excessive precipitation, drying up of rivers, dams and wells, and changes in timing and pattern of seasons as evidence of climate change. Suggested adaptation strategies include strengthening and improving indigenous land and water management practices, use of decision support tools, such as seasonal weather forecast data, growing drought resistant crops, improving indigenous animal breeds, and development of irrigation infrastructure. It is, therefore, concluded that there is need to conscientise farmers about climate change and design adaptation strategies that take into cognizance existing local level knowledge and practices on land and water management. There is also need to avail agricultural research results relevant to the small holder farmers and train them on how to use the results to make informed on-farm investment decisions.*

## INTRODUCTION

There is a general consensus among scientists, economists, and policy makers that the entire globe is facing a real and serious long-term threat from climate change (Buckland, 1997; Kinuthia, 1997; Hansen *et al*, 2007; Matarira *et al*, 1995). Projections suggest that, by the end of the 21st century, climate change will have had substantial impact on agricultural production and, hence, on the scope for reducing poverty (Slater *et al*, 2007). Although there is relatively little work published on climate change scenarios for Africa, Hulme *et al* (2000) reviewed and observed past changes (1900-2000), as well as possible future (2000-2100) continent-wide changes in temperature and rainfall for Africa and concluded that the climate of Africa was warmer in the year 2000 than it was in 1900. This has occurred at the rate of about $0.5^0$C/century and the six warmest years have occurred since 1987, with 1998 being the warmest year. The twenty-first century picture remains almost the same with predicted annual warming across Africa of slightly below $0.2^0$C to over $0.5^0$C per decade (Hulme *et al*, 2000). In relation to rainfall, the different African regions,

> "Exhibit contrasting rainfall variability characteristics: the Sahel displays large multi-decadal variability with recent drying, East Africa a relatively stable regime with some evidence of long-term wetting, and southeast Africa also a basically stable regime, but with marked inter-decadal Variability" (Hulme et al, 2000:9).

New *et al* (2006)'s analysis of the daily temperature (maximum and minimum) and precipitation data from 14 south and west African countries over the period 1961 – 2000 confirms that there is evidence of daily climate extremes over western and southern Africa. In these two regions, New *et al* (2006) discovered that extreme cold days and nights have decreased and hot days and nights have increased. With respect to rainfall, average dry spell length, average rainfall intensity, and annual 1-day maximum rainfall all show statistically significant increasing trends. Additionally, there is an indication of decreasing total precipitation in the two regions showing a gradual slide towards drier conditions. This indicates an increased trend in the likelihood of the occurrence of weather hazards, such as heavy storms leading to floods, high temperatures, and both seasonal and mid-rainy season droughts that agriculture and other sectors have to contend with.

Although there is still a significant uncertainty regarding the climate change scenarios for sub-Saharan Africa with conflicting scenarios about which areas will get wetter and which will get drier (Kinuthia, 1997), there is no doubt that the climate change/variability phenomenon is slowly setting in and the general consensus appears to be that southern Africa will experience hotter and drier climatic conditions in the medium to long term. This will seriously compromise African agricultural production and access to food, since agricultural land will be lost and there will be shorter growing seasons and lower yields. In some countries, yields from rain-fed crops could be halved by 2020 (Oxfam, 2007). Sub-Saharan African region will be hit hardest because current information is the poorest, technological change has been slowest and the domestic economies depend most heavily on agriculture (Mendelson *et al*, 2000; Morton, 2007). Climate change impact studies, although they are still uncertain on the frequency and severity of adverse weather events, have shown that the effects are significant for low input farming systems, such as subsistence farming that are located in marginal areas and due to socio-economic, demographic, and policy trends have the least capacity to adapt to changing climatic conditions.

Although there are numerous recent regional and national studies of economic and agricultural productivity impact of climate change and variability, or the risk of it, and adaptation strategies in Zimbabwe and other southern African countries (e.g., Matarira *et al*, 1995; Nhemachena and Mano, 2007; Kinuthia, 1997; Buckland, 1997; Downing, 1992; Mendelsohn, 2000; Jones and Thornton (2003) in Morton (2007), there has been little focus on the views and perceptions of the smallholder farmers about climate change and variability and their effect on specific agricultural activities. The visible tendencies in the literature include: firstly, quantitative economic and productivity projections of future impacts from modeling studies at a variety of geographical scales, focusing mainly on staple smallholder crops, or reviewing of data from such studies at regional level. Secondly, there has been much focus on adaptation, based on qualitative data and taking the characterization of impacts as largely straight forward tasks (Morton, 2007). Important examples are the works of, firstly, Matarira *et al* (1995) who used global climatic models and dynamic crop growth models and established that maize yields, the most widely grown crop in Zimbabwe, decrease dramatically under dry land conditions in some regions (sometimes up to 30%), even under full irrigation conditions due to temperature increases that shorten the crop growth period. Secondly, the work by Nhemachena and Mano (2007) who applied the Ricardian cross-sectional model and found out that higher summer temperatures have mostly negative

effects on net farm revenues with an increase in summer temperature of $1^0$C, leading to a net farm revenue loss of about $86 per hectare for all farms and about $98 for rain-fed farms.

Zimbabwe and other southern African countries have been of late experiencing frequent droughts alternating with periods of very high rainfall. In some cases, floods and mid-season prolonged dry spells have been experienced during the same season. This paper examines smallholder farmers' perspectives on climate change and variability and its impacts on their farming activities. Policy responses to climate change/variability have been mainly driven by debates among scientists, whilst the insights of poor people living on the frontline have been largely neglected (ActionAid International, 2006). This study, therefore, tried to put the views of the vulnerable at the center of the climate change impact and adaptation analysis by assessing views and knowledge about climate change, its impacts, and adaptation strategies among smallholder farmers. This helps in the understanding of the complexities of specific real-world smallholder farming systems. Also, a better understanding of farmer perceptions regarding climate change and variability, current adaptation measures and their determinants will be important to inform policy for future successful adaptation of the agricultural sector (Nhemachena and Hassan, 2007). The study also helps to open up debates on the impacts and adaptation to a wider range of stakeholders, including smallholder and subsistence farmers themselves. This will not only improve knowledge of impacts, but aid in building adaptive capacity at all levels, including farmers themselves.

**Agriculture and its importance in Zimbabwe**

Agriculture is a very important sector in southern Africa, in terms of subsistence, contribution to GDP (about 35 percent), employment (70-80 percent of the total labour force), and foreign exchange earnings (about 30 percent) (Abalu and Hassan, 1998). It also remains the main source of livelihoods for most rural communities in the region. To the Zimbabwean economy, the agricultural sector plays an important role through its impact on overall economic growth, households' income generation, and food security.

This sector is, however, dualistic, comprising of large and small-scale sectors. The large-scale sector, until recently, used to be well resourced and predominantly located in high agricultural and economic potential areas of the country (Tekere and Hurungo, 2003). On the other hand, the smallholder farmers are characterized by both marginality and remoteness in that most of them are located in areas that experience low and highly variable rainfall, high temperatures, have poor soils, and are far away from

tarred roads and major urban centers (markets). The farmers themselves are poorly resourced in terms of agricultural capital and technology and have very little, if any, access to credits. These smallholder farmers are predicted to be especially vulnerable to climate change and variability because they have no adaptive capacity due to poverty and reliance on relatively basic technologies. In fact, many farmers in recent years have suffered one bad harvest after another due to late or erratic rainfall.

## MATERIALS AND METHODS

*Study Area*

The study was undertaken in Mazvihwa smallholder farming area (Murowa Ward) in Zvishavane District in the Midlands Province. The ward has a total population of 4,548. Murowa Ward lies in Natural farming region 4 that receives an average annual rainfall ranging from 400 to 600 mm distributed in a unimodal pattern between November and April. Natural farming regions are a classification of the agricultural potential of the country, from natural region 1 (> 1000 mm per annum) which represents high altitude wet areas to natural farming region V which receives low and erratic rainfall averaging 550 mm per annum (Vincent and Thomas, 1960 in Mugabe *et al,* 2007). The changing weather patterns are already creating complex problems because in some years the area is simultaneously affected by drought and excessive rainfall that affect smallholder agricultural productivity.

Land use in Murowa Ward is typical of other smallholder areas in Zimbabwe with dry land crop production in the rainy season and animal rearing. Fields, where crop production is carried out, are individually owned while grazing areas, dams, and boreholes that are constructed by the government or NGOs are considered common property (Mugabe *et al,* 2006). The average arable land per household is about 2.44 hectares (Shirichena, 2004) and this approximates the 2.1 ha/household landholdings established by Zinyama (1987) in Mhondoro and Save north communal areas. Mixed crop-livestock farming is the main activity with drought resistant maize varieties as the widely grown staple crop. Other crops grown in the area include sorghum, finger millet, groundnuts, and various types of garden vegetables. Cattle, donkeys, and goats are the main livestock and are grazed in a communal system. Close interaction between crop and cattle production occurs through crop residues that are used to feed the animals and the reciprocal use of manure to fertilize the crops (Zingore, 2006).

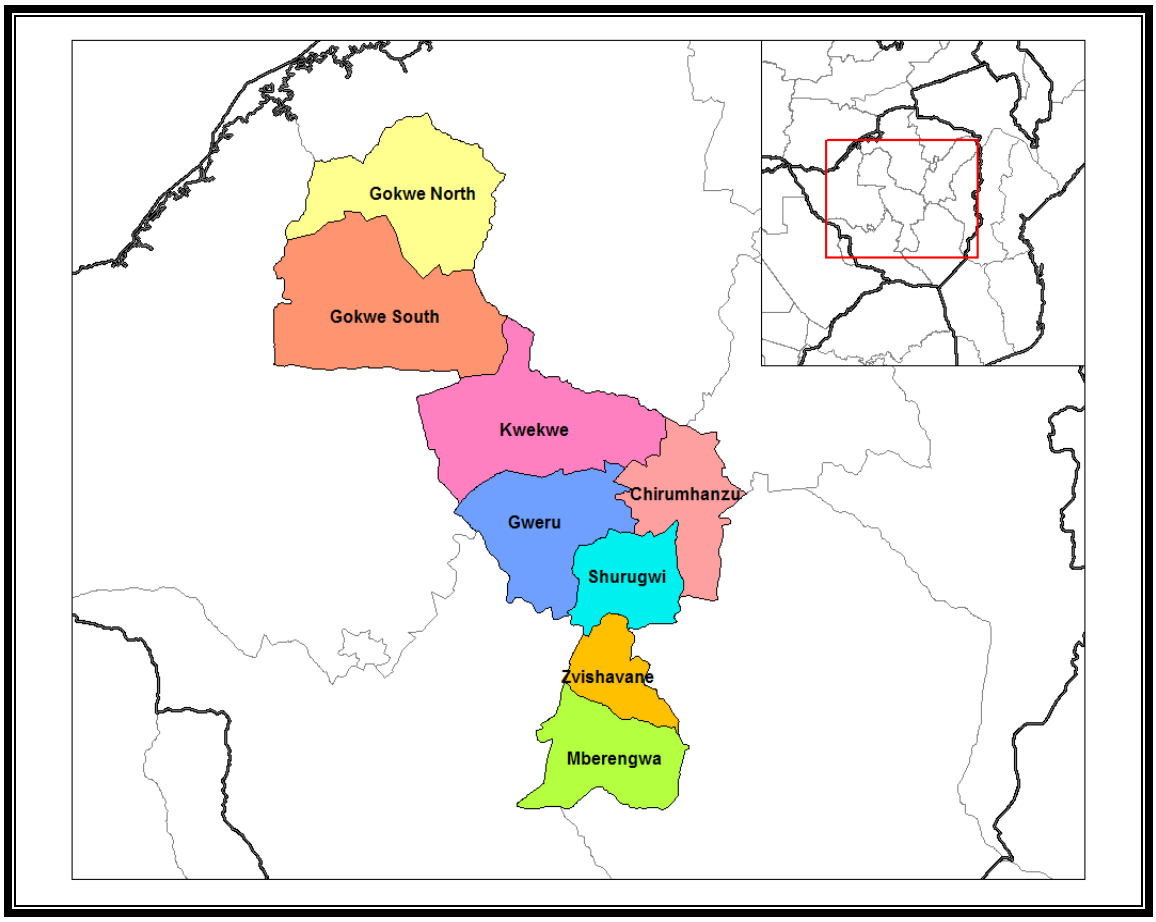


**Figure 1: Districts in the Midlands Province, Zimbabwe**

*Data Collection*

Data was collected mainly through a questionnaire that was administered to 70 randomly selected household heads, composed of 45 women and 25 men. Women dominated the household heads because most men have left for formal employment in towns, particularly in the nearby Zvishavane and Marowa mines. The main themes that determined the structure of the questionnaire were:

- Demographic and other socio-economic characteristics of the farmers that have implications on their perceptions, attitudes, knowledge, and adoption of adaptation strategies, such as gender, age, agricultural resources, main source of household income, education, period of stay in the area, and household size.
- Knowledge, attitudes, and perceptions about climate change its impact on agricultural activities and productivity.

- Present and future adaptation strategies to the vagaries of climate change.

Apart from questionnaires, formal and informal interviews were carried out with the knowledgeable section of the community, such as leaders of farmer field schools, prominent farmers, traditional leaders, Agricultural Extension Officers, and the Zvishavane Water Projects Officer.

## RESULTS AND DISCUSSION

*Demographic and Socio-Economic Characteristics of the Respondents*

Of the 70 household heads interviewed, the mean age of the household heads was 51.4 years. Over half of the interviewees had primary education (53%), whilst 29% had secondary, 11% had primary, and 7% had never been to school. The mean household size was 6.2 and the main source of household income for the majority (45.8%) was farming. Other sources of income that provided sustenance to the ward residence included off-farm formal employment (27.7%), remittances (14.9%), whilst 11.6% depended on other sources such as crafts, trading in clothing, among others. The size of land holdings in Murowa Ward, like in several other smallholder areas in Zimbabwe, is a real cause for concern. The average household owns two plots; the plot surrounding the homestead and the main plot (or farm) usually away from the homestead. The average farm size was estimated at 2.2 hectares per household that approximates 2.1 hectares per household found by Zinyama (1987) in Mhondoro and Save north smallholder farming areas. Land is not easily obtainable since the population density is high (61.8 persons/$km^2$). Land for farming is acquired through the headman, or chief, since it's communally owned.

*Smallholder Farmers' Views and Knowledge about Climate Change*

The findings indicated that local people's perceptions on climate change/variability are based on assessment of mainly temperature and precipitation events as they experience them within the locality. Figure 2 shows that the majority of the farmers (53%) professed ignorance about climate change and its potential consequences, whilst 47% indicated that there was some kind of change that they had observed in recent years. Of those who have noticed some change in climate, 58% of them pointed out that rainfall patterns have become highly unpredictable in the last few years to the effect that they could not predict the time of onset of seasonal rainfall and the prevalence of mid-season dry spells had increased.

Twenty two percent have observed that, in addition to the unpredictable nature of precipitation, below-normal rainfall years are becoming more frequent exacerbating food insecurity throughout the area.

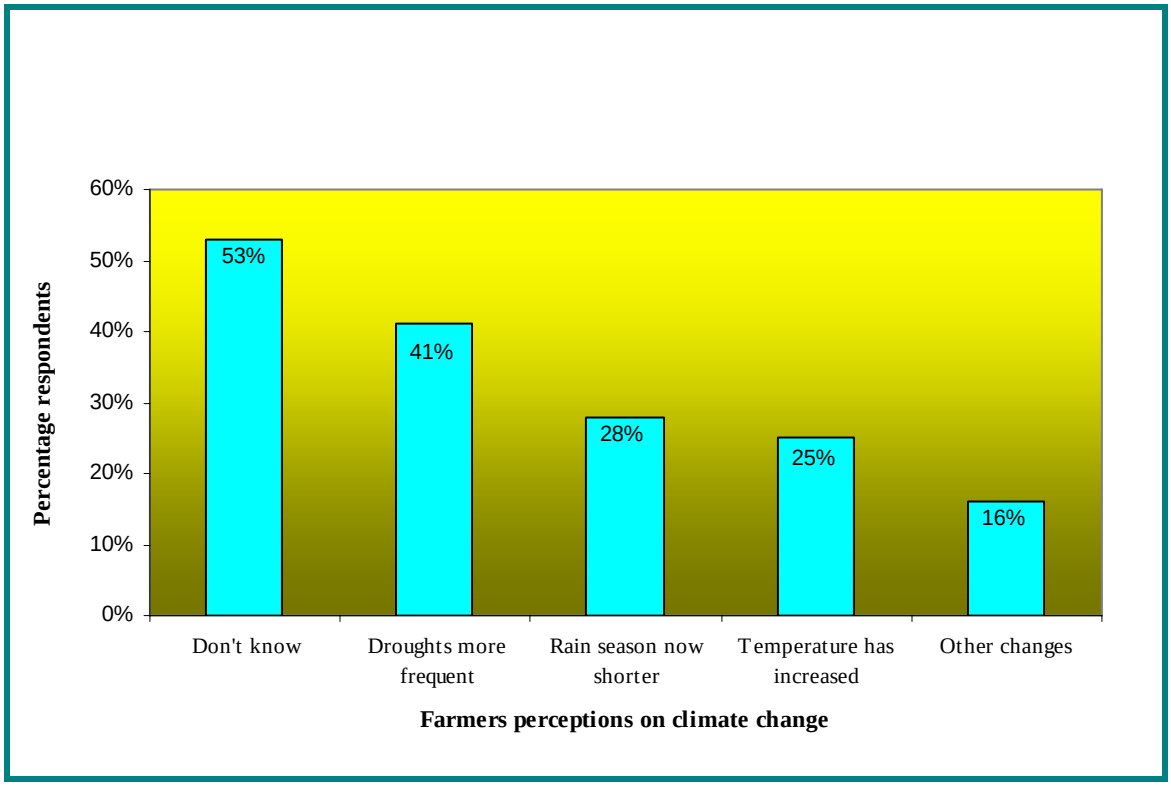


**Figure 2: Smallholder Farmers Views and Knowledge about Current and Long-term Climate Change**

What was more confusing to the farmers was that the area could simultaneously experience drought and excessive precipitation during the same season. The trend in precipitation, as observed by elderly farmers, was that their area was getting drier. A higher frequency of seasonal droughts or mid-season dry spells and late onset and early ending of the rain season evidenced increased desiccation of the Murowa Ward. Most farmers indicated that the rain season used to begin in late October or early November and end as late as mid May, but the late 1990s onwards trend is that the rain season can start as late as mid December and end as early as mid March. With respect to temperature, farmers observed that they are on an increasing trend, as evidenced by the high rate at which surface water sources such as streams dry up and the wilting of crops after the occurrence of a precipitation event. The interviewed Agricultural Extension Officers and NGO staff indicated that they have not been educating farmers about the changing climatic conditions and what the situation is likely to be in the future. They pointed out that they are at a loss as to what exactly should they tell the farmers since current knowledge and

models are not yet conclusive about the nature of change and its impact, especially at very local levels. Whilst climate change knowledge could help the farmers to be more innovative and receptive of the advice that they get from these institutions, the thrust is to assist the farmers to adapt to the drought conditions that have always been affecting the farmers in the ward.

*4.2 Current Climate Change-related Weather Events and their Impact on Smallholder Farming Systems*

Through the interviews carried out during this study, smallholder farmers explained how the current weather patterns were affecting their farming systems and subsequently their livelihoods. They cited mainly precipitation and temperature-related weather events, as the ones that are a real cause for concern in relation to their agricultural activities. The high frequency of excessive rainfall and drought since the early 1980s has been the major challenge eroding the farmers' assets, leaving them more vulnerable to the vagaries of these climatic events. The high frequency of these events give farmers no time to recover from previous impacts through either asset accumulation or acquiring the skills and knowledge necessary for adapting to future climate changes. Consequently, farmers are subjected to continuous hunger and deeper cycles of poverty and vulnerability (ActioAid International, 2006). The unpredictability of precipitation presented more challenges to the farmers than any other climate change elements. One elderly farmer in the area stated that what they are witnessing today is a new and worrying phenomenon.

> We are increasingly experiencing a high frequency of drought and excessive rainfall or both during the same year. Due to these events, food shortages have also become much critical and we are selling household assets to buy food. During drought our livestock die and we remain without draught power.

*Impact of Prolonged Wet Weather*

Prolonged wet conditions during the crop growing season may lead to flooding, waterloging, erosion, and excessive leaching - all of which lead to crop failure, depending on the intensity of the condition. Weeding, fertilizer and pests and diseases chemicals application becomes difficult. Farming costs increase as more fertilizers and other chemicals are required, leading to losses to insect pests and diseases of field crops, as well as those that are stored on the farm. If these conditions are experienced during harvesting and post-harvesting periods, heavy crop damage and loss are incurred as crops rot in the fields, as well as on open spaces since most farmers do not have water or moisture proof storage facilities.

The impact of prolonged wet weather conditions on crop marketing is also quite devastating for the farmers. The water-damaged crops will be of poor quality and, therefore, fetch low prices on the market. Sometimes the prolonged wet weather leads to deterioration of already poor rural roads and bridges making the roads that traverse the area impassable. This affects the timely transportation of both agricultural inputs and outputs to and from the markets further affecting agricultural productivity and household incomes in subsequent years. Some of the road infrastructure remains in state of disrepair for years leading to deepening poverty among particularly the farmers whose household income mainly comes from farming. The farmers were, however, quick to point out that prolonged wet conditions that damage crops were uncommon but when they occur, they will be quite intensive and devastating. In recent years, such conditions were experienced in Murowa Ward during the 2003-2004 and the 2007-2008 seasons and led to serious household food insecurity among about 80% of the smallholder farmers in the ward.

*Prolonged Hot and Dry Weather during the Rain Season*

The damage caused by this weather condition depends on the part of the crop growing season it would have occurred. If such conditions are experienced during the early stages of the rain season, they mainly affect the farmers' ability to meet the planting deadlines and cause poor crop germination. Mid-season, prolonged dry spells, stress crops through wilting and may promote the occurrence of insect pests, such as armyworms. Murowa Ward is already a drought-prone area but the farmers indicated that dry spells have become more frequent and devastating in recent years. Overall, agricultural productivity hinges on whether there has not been a prolonged dry condition in the area during the crop growing season, since farming is mainly rain fed. The fall in crop production leads to household food insecurity that is associated with a sharp rise in food prices until the next good harvests. This happens at a time that most households would have failed to raise household incomes through selling agricultural products and poverty levels increase dramatically. A poor rainfall season results in very poor pastures during the dry season, affecting the condition of their livestock, particularly cattle. The main impact is the existence of very weak draught animals at the onset of the rain season. The overall livelihood impacts of extreme weather conditions on smallholder farmers, therefore, include sale of assets, indebtedness, out-migration, and dependency on food relief.

## FARM LEVEL ADAPTATION STRATEGIES AND THEIR SUSTAINABILITY

Smallholder systems, especially those located in marginal environments, such as Marowa ward, are often characterized by livelihood strategies that have been evolved to reduce overall vulnerability to climate shocks (adaptive strategies) and to manage their impacts *ex-post* (coping strategies). The distinction between these two categories is very blurred since what starts as a coping strategy in exceptional years can become adaptations for households or whole communities (Morton, 2007). Therefore, many features of smallholder livelihoods in Marowa ward can be regarded as adaptive strategies to climate change.

Prior to the 1980s, climate extremes, such as drought and excessive precipitation, occurred at an average frequency of about 8 to 15 years, i.e. a rhythm that enabled the smallholder farmers to deal with these problems either at the individual/household level or through well-established social networks (Kandji *et al*, 2006). The farmers, therefore, have adaptation strategies that they adopted to cope with these conditions. Figure 3 shows the strategies that farmers used to employ to deal with weather and climatic problems they used to experience before they observed that climate was now changing. These traditional coping methods were based on experience accumulated over the years and transmitted from generation to generation.

**Figure 3: Traditional Adaptation Strategies to Semi-arid Conditions**

Climate change is eroding these coping mechanisms by causing climatic extremes with a frequency and intensity that local people had never seen before. This has alerted the farmers to the need to re-examine land use, management practices, and farm infrastructure leading to the adoption of additional coping strategies shown on Figure 4. As can be noticed on the results, every farmer, including those that claimed had no knowledge about climate change, have adopted at least one strategy to cope with the current climatic trends. The most popular adaptation strategies in Murowa Ward included planting short season varieties, crop diversification, and varying planting dates. The main thrust of these strategies is increased diversification and escaping sensitive growth stages through crop management practices that ensure that critical crop growth stages do not coincide with harsh climatic conditions in the season, such as mid-season droughts (Nhemachena and Hassan, 2007). Crop diversification improves household food security since different crops are affected differently by the same climatic conditions. Also, given the high frequency of mid-season dry spells and shortening of the rain season, farmers grow short season and drought-resistant crop varieties, such as sorghum, rapoko, and finger millet. For a staple crop, such as maize, instead of planting local varieties, farmers have opted for hybrid maize that take a shorter

period to mature and yield more than traditional varieties in good years. This appears quite logical and sustainable if seed producers continue to improve on these varieties. However, indigenous land races that were more adapted to the conditions in the area are being lost as farmers prefer high yielding hybrid varieties.

Livelihood diversification has increasingly become an important adaptation strategy in Murowa Ward. It was reported that there are more climate change related migrations to the nearest Shabani mine, Zvishavane town, and to other distant towns in the country. Some young people are going as far as South Africa and Botswana resulting in their families and other close relatives depending on remittances to supplement agricultural incomes, as well as during periods of food shortages. Other activities, such as gold panning, fruit gathering and selling, are on the increase. The sustainability of these sources of income is quite questionable considering that since the early 1990s the job market has been shrinking as the government failed to foster positive economic growth while activities, such as gold panning are illegal and environmentally degrading.

Soil and water conservation strategies, such as water harvesting activities, which currently are practiced by about 38% of the smallholder farmers, are being intensified as Agricultural Extension Officers and NGOs, such as Zvishavane Water Projects, wake flat out to promote the activities. These institutions are enthusiastic about promoting these practices because they are building on farmers' indigenous knowledge, skills, and experience acquired over the years, as farmers were battling to survive the harsh climatic conditions that prevail in the area. If these practices are properly promoted and adopted by the farmers, they promise to address some of the climate change challenges among smallholder farmers considering their poor resources and marginal location which makes conventional irrigation impossible.

Other adaptation strategies include growing legumes (such as beans) towards the end of the rain season when cereals fail, mainly due to excessive rainfall, and application of more fertilizers when nutrients are heavily leached from the soils. Legumes mature fast and provide nutritious relish. They also fetch good prices on the market. Application of more fertilizers as an adaptation strategy has its own challenges. Chemical fertilizers are scarce and exorbitantly priced in Zimbabwe and most smallholder farmers cannot afford them.

All the countries in the SADC region, including Zimbabwe, offer seasonal climate forecast data after the SACOF meeting. The forecast in Zimbabwe is issued through various media channels, such as the radio, newspapers, and television. All of the farmers interviewed professed ignorance of the seasonal climate forecast information and they do not use this information to make efficient use of their limited resources through informed on-farm practices and investment decisions to mitigate against low and variable rainfall in this semi-arid area.

The adaptation strategies that were pointed out by the farmers are based on lessons learnt from previous climatic stresses (indigenous knowledge systems), shared knowledge with other distant farmers through farmer field days and trips, and advice from both Agricultural Extension Officers and NGOs that are involved in various food security activities in the ward. Lessons learnt from previous climatic stresses provide important entry points for social learning and enhanced adaptive capacity to both wetter and drier periods now and in the future.

**Figure 4: Additional Strategies due to Climate Change**

## FACTORS THAT UNDERMINE FARMERS' ADAPTIVE CAPACITY TO CLIMATE CHANGE

The study showed that farmers' adaptive capacity to climate change is undermined by several factors that range from limited understanding of the nature and consequences of climate change, farm members' health status (particularly in relation to HIV/AIDS), unemployment that is supposed to both complement and supplement agricultural incomes, and poor rural infrastructure.

Limited awareness about the nature and magnitude of climate change starts with researchers and academics. For instance, in relation to southern Africa, there are several climate change issues that have not yet been established with certainty that are important for agriculture, such as the time of onset of summer rainfall and the prevalence of dry spells within the rain seasons. This affects the information that has to be relayed to the farmers and the specific strategies to be devised, promoted, and adopted. Development specialists' intervention strategies, therefore, facilitate adaptation mainly to current and not future climate changes (Gandure, 2008). Available models and information also exist at regional, continental, and global levels. Models are not yet able to predict the impacts at very small scales, so extension officers have real challenges in providing the farmers with knowledge that is location and ecologically specific. This has resulted in limited awareness and knowledge on climate change, its impacts, and adaptation strategies amongst the farmers at local level.

Soil and water conservation strategies, despite their potential effectiveness in addressing some of the challenges of climate change, require much labour and appropriate training of extension workers and farmers. Conservation tillage, for instance, is a useful option for improving the storage of rainwater in the soil and can help mitigate agricultural drought. However, it requires adequate draught power, appropriate machines, and good training of farmers to be effective. These conditions rarely exist amongst the majority of smallholder farmers. It is those farmers who are endowed with more livelihood assets that mainly adopt conservation tillage as compared to those with limited assets. External support from governmental institutions and development agencies is, therefore, needed to implement most soil and water conservation projects.

## CONCLUSIONS

Although the nature and impacts of climate change are still debatable, there is consensus that it is inevitable and the smallholder farmers in Murowa Ward have already started, though unknowingly for

the majority, to learn to live with its reality and adapting as they can to its impacts. But these impacts are predicted to get worse with time necessitating more serious measures to be taken by the government, the farmers themselves, NGOs, and other private sector organisations that may assist farmers with knowledge and resources to enhance their adaptive capacity.

The fact that the majority of smallholder farmers are still ignorant about climate change means that climate change awareness campaigns are needed to sensitize them about the challenge and its implications in order to facilitate the promotion and adoption of adaptation strategies. These farmers already operate in the marginal areas and most had already adopted some coping strategies to the harsh climatic conditions that have prevailed over the years. These can serve as useful entry points for intervention. Therefore, the old and new intervention strategies need to be intensified through participatory approaches, such as farmer field days and trips. Agricultural Extension Officers also need to explain and train farmers on the importance of seasonal climate forecast information and how they can use it to make efficient use of their limited resources through informed investment decisions.

Since there is no universal way to adapt to any challenges, let alone climate change, adaptation strategies need to be context-specific. This necessitates quantification of various thresholds, such as labour, household agricultural assets, knowledge, money, and skills that determine the smallholder farmers' adaptive capacity to climate change. Specific programmes and projects can then be implemented to address them so as to enhance the farmers' adaptive capacity to the current and future climate changes. The sustainability of adaptation strategies has to be prioritized. The adaptation strategies should, therefore, be considered in terms of the farmers' location, livelihood systems, and ecological setting so as to make them socially, economically, and ecologically sustainable.

There is need to increase smallholder farmers' productive capacity now so that they can improve their asset base which will place them on a strong footing to take advantage of climate change and variability when it becomes more serious (Slater *et al,* 2007). This will improve national and household food security, incomes, and reduce poverty and environmental degradation.

**REFERENCES**


Abalu, G. and Hassan, R. (1998). Agricultural Productivity and Natural Resource use in Southern Africa. *Food Policy* 23: 477-490.

ActionAid International (2006). Climate Change and Smallholder Farmers in Malawi: Understanding Poor People's Experiences in Climate Change Adaptation, A Report by ActionAid International, October.

Ayalew, M., (1997), "What is Food Security and Famine and Hunger?" *Internet Journal of African Studies, Issue No. 2 – March;* Using Science Against Famine: Food Security, Famine Early Warning, and El Niño.

Buckland, R. W. (1997). "Implications of Climatic Variability for Food Security in The Southern African Development Community.*" Internet Journal of African Studies, Issue No. 2 – March;* Using Science Against Famine: Food Security, Famine Early Warning, and El Niño.

Callear, D. (1997). "Can We Get Policymakers to Take Notice of Information on Drought and Imminent Food Shortages?" *Internet Journal of African Studies, Issue No. 2 – March;* Using Science Against Famine: Food Security, Famine Early Warning, and El Niño.

Chawatama, S.; Mutisi, C.; Mupawaenda, A. C. (2005). The socio-economic status of smallholder livestock production in Zimbabwe: A diagnostic study. *Livestock Research for Rural Development. Volume 17, Article #143.* Retrieved on April 19, 2008, from http://www.cipav.org.co/lrrd/lrrd17/12/chaw17143.htm.

Dilley, M. (1997). "Warning and Intervention: What Kind of Information Does the Response Community Need from the Early Warning Community?" *Internet Journal of African Studies, Issue No. 2 – March;* Using Science Against Famine: Food Security, Famine Early Warning, and El Niño.

Downing, T. E. (1992). *Climate Change and Vulnerable Places: Global Food Security and Country Studies in Zimbabwe, Kenya, Senegal and Chile*. Oxford, UK: Environmental Change Unit, Oxford University.

Gandure, S. (2008). Assessing Effectiveness of Food Security Interventions to Multiple Stresses in Zimbabwe. Paper presented at the Food Security and Environmental Change Conference, Oxford, 2-4 April, UK.

Glantz, M. H. (1997). 'Eradicating Famines in Theory and Practice: Thoughts on Early Warning Systems' *Internet Journal of African Studies, Issue No. 2 – March;* Using Science Against Famine: Food Security, Famine Early Warning, and El Niño.

Hansen, J. W.; Baethgen, W.; Osgood, D.; Ceccato, P.; Ngugi, R. K. (2007). 'Innovations in Climate Risk Management: Protecting and Building Rural Livelihoods in a Variable and Changing Climate' *SAT eJournal,* Vol. 4, Issue 1. ejournal.icrisat.org.

Hulme, M.; Doherty, R.; Ngara, T.; New, M.; Lister, D. (2000). 'African Climate Change: 1900-2100' *Climate Research* 12 April.

Huss-Ashmore, R. (1997). "Local-Level Data for use as Early Warning Indicators" *Internet Journal of African Studies, Issue No. 2 – March;* Using Science Against Famine: Food Security, Famine Early Warning, and El Niño.

Juana, J. S. and Mabugu, R. E. (2005). 'Assessment of Small-holder Agriculture's Contribution to the Economy of Zimbabwe: A Social Accounting Matrix Multiplier Analysis' *Agrekon,* Vol 44, No 3, September.

Kandji, S. T.; Verchot, L.; Mackensen, J. (2006). Climate Change and Variability in Southern Africa: Impacts and Adaptation in the Agricultural Sector, ICRAF and UNEP.

Kinuthia, J. H. (1997*).* "Global Warming and Climate Impacts in Southern Africa: How Might Things Change?" *Internet Journal of African Studies,* Issue No. 2 – March; Using Science Against Famine: Food Security, Famine Early Warning, and El Niño.

Matarira, C. H.; Makadho, J. M.; Mwamuka, F. C. (1995). "Zimbabwe: Climate Change Impacts on Maize Production and Adaptive Measures for the Agricultural Sector" in Ramos-Mane, C. and Benioff, R. (Editors) *Interim Report on Climate Change Country Studies,* US Country Studies Program, Washington, DC.

Mendelsohn, R.; Dinar, A.; Dalfelt, A. (2000). *Climate Change Impacts on African Agriculture.*

Morton, J. F. (2007). 'The Impact of Climate Change on Smallholder and Subsistence Agriculture' *PNAS* Vol. 104, No. 50, December 11.

Mudhara, M.; Hildebrand, P. E.; Gladwin, C. H. (Undated). "Gender-Sensitive LP Models in Soil Fertility Research for Smallholder Farmers: Reaching De Jure Female Headed Households in Zimbabwe." *African Studies Quarterly* 6, no.1: [online] URL: http://web.africa.ufl.edu/asq/v6/v6i1a12.htm.

Mugabe, F. T.; Hodnett, M.; Senzanje, A. (2007). 'Comparative Hydrological Behaviour of two Small Catchments in Semi-arid Zimbabwe'. *Journal of Arid Environments, doi:10.1016/j.jaridenv.2006.11.016.*

Ndebele, J. J.; Muchenje, V.; Mapiye, C.; Chimonyo, M.; Musemwa, L.; Ndlovu, T. (2007). "Cattle breeding management practices in the Gwayi smallholder farming area of South-Western Zimbabwe". *Livestock Research for Rural Development. Volume 19, Article #183.* Retrieved on April 19, 2008, from http://www.cipav.org.co/lrrd/lrrd19/12/ndeb19183.htm Africa and they contribute significantly to food security.

New, M.; Hewitson, B.; Stephenson, D. B.; Tsiga, A.; Kruger, A.; Manhique, A.; Gomez, B.; Coelho, C. A. S.; Masisi, D. N.; Kululanga, J.; Adosi, J.; Mbambalala, E.; Adesina, F.; Saleh, H.; Kanyanga, J.; Bulane, L.; Fortunata, L.; Mdoka, M. L.; Lajoie, R. (2006). 'Evidence of Trends in Daily Climate Extremes over Southern and west Africa' *Journal of Geophysical Research*, Vol. 111, D14102, doi: 10.1029/2005JD006289.

Nhemachena, C. and Hassan, R. (2007). *Micro-Level Analysis of Farmers' Adaptation to Climate Change in Southern Africa.* IFPRI Discussion Paper 00714 August, International Food Policy Research Institute, Washington, DC, USA.

Oxfam (2007). Adapting to climate change:What's needed in poor countries, and who should pay. *Oxfam Briefing Paper 104*, May. Oxfam International.

Sidhu, R. (2008). Global Environmental Changes and Food Security in Indo Gangetic Plains: Issues and Activities. Paper presented at the *Food Security and Environmental Change Conference, Oxford, 2-4 April 2008.*

Slater, R.; Peskett, L.; Ludi, E.; Brown, D. (2007). 'Climate change, agricultural policy and poverty reduction – how much do we know?', *Natural Resource Perspectives,* 109. September.

Tekere, M. & Hurungo, J. (2003). *The status of agriculture trade and liberalization in SADC countries: The case for Zimbabwe*. Southern African Trade and Development Newsletter No 9 (March 2003).

Zindore, S. (2006). Exploring Diversity within Smallholder Farming Systems in Zimbabwe: Nutrient use Efficiencies and Resource Management Strategies for Crop Production. Unpublished PhD Thesis, PhD thesis, Wageningen University, Wageningen, The Netherlands.

Zinyama, L. M. (1987). 'Gender, Age and the Ownership of Agricultural Resources in Mhondoro and Save North Communal Areas of Zimbabwe' *Geographical Journal of Zimbabwe (18),* December, GAZ, UZ, Harare.