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PERCEIVED IMPACTS OF CLIMATE RELATED PARAMETERS ON SMALLHOLDER FARMERS IN ZAMBIA AND ZIMBABWE

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ABSTRACT

There is a scientific consensus that concentrations of greenhouse gases in the atmosphere are increasing due to human activities, causing global climate change. Although substantial research has been undertaken to improve our understanding of complex and interwoven spheres of climate change, there are significant knowledge gaps regarding the understanding of impacts likely to result from significant changes to present patterns of climate. Using case studies of Zambia and Zimbabwe, this study uses both quantitative and qualitative methodologies such as a questionnaire survey, in-depth case studies, and participatory impact diagrams to collect data. Rainfall has been regarded as the most significant climate parameter affecting human activities. In this regard, this study investigates perceived impacts of droughts and floods on smallholder farmers. The study finds that farmers identify impacts of drought and floods on water, crop yields, human and livestock health, and other socio-economic factors. The study concludes that although impacts of climate change on farmers are overwhelmingly negative, there are positive impacts in the form of localized benefits on farmers in certain circumstances. Moreover, impacts on farmers are manifested in different ways, influenced by various factors, such as location and the socio-economic context, among others. The study, therefore, recommends that studies on impacts of climate change on smallholder farmers emphasizes on dissecting climate change impacts and on policy making that builds on the localized benefits from climate change.

Key words: climate change, impacts, smallholder farmers

INTRODUCTION

There is a scientific consensus that concentrations of greenhouse gases in the atmosphere are increasing due to human activities, causing global climate change and that the inevitable global warming will have major impacts on the climate, worldwide (Intergovernmental Panel for Climate Change [IPCC], 2007b; Mendelsohn & Dinah, 2005; Rosenzweig & Solecki, 2009). The IPCC Fourth Report (2007b) dispels any uncertainty about climate change and gives detailed projections for the 21st century, which show that global warming will continue and accelerate. Consequently, impacts of global warming, such as disruptions in food and water systems, will adversely affect development and livelihoods and will most likely add to the challenges climate change already poses for poverty eradication. This is likely to have an impact on the social, as well as cultural and economic development, of rural poor communities and agricultural productivity, particularly in sub-Saharan Africa (Howden, Soussana, Tubiello, Chhetri, Dunlop and Meinke, 2007; Mendelsohn, Dinar and Delfelt, 2000a, b; Mortimer & Manvel, 2006; Twomlow, Mugabe, Mwale, Delve, Nanja, Carberry and Howden, 2008). While cereal production, especially maize, is central to food security in Southern Africa, where the study areas are located, it is highly sensitive to drought and climatic variation and a striking relationship between production volatility and climate events have been established (Clay, Bohn, der Armas, Kabambe and Tchale, 2003).

In southern Africa, among the countries worst affected by droughts are Zambia and Zimbabwe. Both countries, signatories to the United Nations Convention on Climate and Desertification, are facing the adverse effects of climate, which compromises growth in the agricultural sector, and perpetuates subsequent degradation of the environment as rural households try and meet their livelihood needs (Twomlow, et al., 2008; Waiswa, 2003). Drought relief is a common feature, almost every year, in the drier areas of both countries, as there appears to be an increasing trend towards a late start to the rainy season, prolonged mid-season droughts, and shorter growing seasons (Cooper, Singh, Traore, Dimes, Rao, Gerard, Alumira, Shiferaw, Twomlow 2007; Love, Twomlow, Mupangwa, van der Zaag, Gumbo, and Nyabeze, 2006).

Although substantial research has been undertaken to improve our understanding of ‘complex’ and ‘interwoven’ spheres of climate change, there are significant knowledge gaps regarding our ‘understanding of impacts likely to result from significant changes to present patterns of climate' (Wheaton, 1994). Knowledge gaps continue to exist at the level of impact analysis despite a growing number of country-level case studies (Tol, Downing, Kuik and Smith, 2004). In addition, knowledge on local impacts is considered to be uneven and incomplete. This is the case because the bulk of research funding and human resources has been channeled towards developing and improving models of atmospheric climate change and this has deflected attention away from research on socio-economic impacts (Taylor & Buttel, 1992). This provides an impetus for this study to analyze climate change impacts on households and communities in Zambia and Zimbabwe and make a contribution to the already existing literature on climate change impacts. In this regard, this paper focuses on perceived impacts of climate parameters on smallholder farmers in Zimbabwe and Zambia.

Climate Change Impacts

Climate change is cited as a complex and interdependent environmental challenge facing the world today (Clark, Mitchell, Cash and Alcock, 2002). Expected repercussions of climate change are twofold: bio-physical and socio-economic, in which case the latter are central to this paper. On the one hand, bio-physical impacts include rising sea waters, more frequent and intense storms, the extinction of species, worsening droughts, and crop failure. In addition, changes in cloud cover and precipitation, melting of polar ice caps and glaciers, and reduced snow cover are among other bio-physical impacts that have been observed (Mendelsohn & Dinah, 2005; UNDP, 2004; UNFCCC, 2007). On the other hand, socio-economic impacts are characterized by multiple linkages with bio-physical impacts, such as environmental degradation. For instance, food security and poverty reduction have been considered to be linked to environmental degradation (Clark, *et al.,* 2002; Koch, *et al.,* 2006). Such linkages have emanated from expectations that climate change will affect food and water resources that are critical for livelihoods and survival across developing countries (and Africa in particular) where much of the populations rely on local supply systems that are sensitive to climate variation (Nhemachena & Hassan, 2008). Projected scenarios further estimate a 5-7% potential increase in malaria distribution by 2100 (Tanser, Sharp and le Sueur, 2003). The social and economic costs of malaria are huge and include considerable costs to individuals and households as well as high costs at community and national levels (Holding & Snow, 2001; Malaney, *et al.,* 2004; Utzinger, *et al*., 2001).

In the same respect, there are linkages between agriculture and socio-economic impacts from climate change. The area suitable for agriculture and the length of growing seasons and yield potential, particularly along the margins of semi-arid and arid areas, are expected to decrease. This would further adversely affect food security and exacerbate malnutrition in the affected areas. In some countries, yields from rain-fed agriculture could be reduced by up to 50% by 2020 (IPCC, 2007b). Moreover, climate models show that 600,000 square km, classified as moderately water constrained, will experience severe water limitations across the globe. Although impacts will differ in different parts of the world, it is expected that these repercussions will affect every nation on earth (UNDP, 2004).

Conceptualizing Climate Change Impacts

Both positive and negative climate change impacts may be experienced at different levels (Boko, Niang, Nyong, Vogel, Githeko, Medany, Osman-Elasha, Tabo and Yanda, 2007). This is considered to be the case for two reasons; global circulation models project spatial differences in the magnitude and direction of climate change and even within a region experiencing the same characteristics of climate change. The impacts are likely to vary because some ecosystems, sectors, or social groups are more vulnerable to climate change than others. In middle and higher latitudes, global warming will extend the length of the potential growing season, allowing earlier planting of crops in the spring, earlier maturation and harvesting, and the possibility of completing two or more cropping cycles during the same season (Rosenzweig & Hillel, 1995).

However, at a global scale, positive and negative effects are likely to be distributed unevenly, with the most severe negative impacts occurring 'in regions of high present-day vulnerability that are least able to adjust technologically to such effects' (IPCC, 2001; Parry, 1990). For instance, a study that was done by Seo & Mendelsohn (2006a) shows that higher temperatures are beneficial for small farms that keep goats and sheep because it is easy to substitute animals that are heat-tolerant. By contrast, large farms are more dependent on species, such as cattle, which are not heat-tolerant. In addition, beneficial effects can be identified for some regions and social groups, but they are expected to diminish as the magnitude of climate change increases. Also, many identified adverse effects are expected to increase in both extent and severity with the degree of climate change. When considered by region, adverse effects are projected to predominate for much of the world, particularly in the tropics and subtropics (IPCC, 2001).

Moreover, in climate change discussions, scientists and policymakers are reluctant to recognize, address, and discuss the existence of both positive and negative impacts, especially the positive ones, for such discussions are considered to be divisive and counter to efforts to gain a global consensus on climate change (Glantz, 1995). However, for this paper, it is important to engage in a discussion on positive and negative impacts from climate change, based on the assumption that farmers may be able to capitalize on the positive aspects and advantages from climate change to improve their livelihoods. In addition, climate impact assessments inevitably point to winners and losers, and the perception alone of winning or losing can significantly influence climate negotiations (Rosenzweig & Hillel, 1995; UNEP, 1993).

STUDY METHODOLOGY

Study Location

The study was conducted in Monze and Sinazongwe districts in semi-arid southern Zambia, as well as Lupane and Lower Gweru districts in southwestern Zimbabwe (see Figure 1). The wards selected for the survey in Zimbabwe are all under agro-ecological region IV and thus experience generally the same type of climate (Zimbabwe is categorized into agro-ecological regions I to V based on rainfall, vegetation and other agro-ecological factors, in a continuum with region I having the highest rainfall and IV the least). Crop production is risky except in certain very favorable localities. Lower Gweru can be considered as a favorable locality with the prevalence of wetlands, which enables farmers to grow horticulture crops throughout the year. In Lupane district, the villages selected for the baseline survey have households mostly found along the Bubi River, a tributary of the Shangani River. These farmers, in addition to nutrition gardening along the river, are engaged in livestock rearing and drought resistant fodder crops production. This district is drier and water shortages are experienced due to limited water sources. Drought tolerant crops, such as pearl millet and sorghum, do better in the area. Less than 40% of the households produce vegetables because of water shortages.

In Zambia, Sinazongwe district is in agro-ecological zone 1 and the major ethnic grouping in the district is the Tonga speaking people (Zambia has three agro-ecological zones (I to III) and rainfall is the dominant distinguishing climatic factor). In addition to erratic rainfall and recurrent droughts, Sinazongwe is characterized by poor seed availability, poor marketing facilities, and poor infrastructure. Due to these constraints, risk to food insecurity in Sinazongwe is high. In addition to a high temperature environment, Sinazongwe receives low rainfall, which is below 800 mm. On the other hand, Monze district is in agro-ecological zone I, has an annual rainfall ranging from 800 to 1000 mm, and a moderate temperature environment. Production constraints in Monze include low levels of extension services, livestock diseases, and lack of credit facilities. While deforestation and soil erosion in the district are rated as being high, risk to food insecurity is moderate in the district due to relatively developed infrastructure and moderate access to other infrastructure.

Figure 1: Location of study districts in Zimbabwe and Zambia

Data Collection

A total of 720 households from the 4 districts were selected through a multi-stage sampling technique. Using a structured questionnaire, quantitative and qualitative data were then collected on demographic characteristics, farmers' perceptions of climate variability and change, and changes in crop productions and reasons for these changes. In-depth case studies and Focus Group Discussions (FGDs) were used to capture data on perceptions of climate changes and their impacts. In addition, participatory impact diagrams were used to elicit qualitative information on climate variability impacts.

Data Analysis

Impacts of climate change were categorized into specific themes based on the responses from farmers in the various data collection exercises. These themes include (1) crop yields, (2) the socio-economic context, (3) human and livestock health, and (4) water. Data captured in FGDs, case studies and participatory impact diagrams were therefore categorized into these themes. Furthermore, data collected in the survey were analyzed in descriptive frequencies by country in the Statistical Package for the Social Sciences (SPSS).

RESULTS AND DISCUSSION

Farmer Perceptions of Climate Variability and Change

The specific climate parameters that are focused on in this section relate to farmers' perceptions of rainfall changes. The following sections look at the impacts of these parameters. Rainfall has been regarded as the most significant climate parameter affecting human activities (Vogel, 2000) and it is one of the two major parameters that farmers in the study areas mentioned, together with temperature.

Results show an acute awareness of climate variability and change with above 80% of farmers in both Zambia and Zimbabwe indicating that they have noticed significant weather changes over the years (see Figure 2). The implication is that farmers are aware that there are changes in the climate. Perceptions are considered to be important as farmers' perceptions are regarded as a critical determinant of and necessary precondition for adaptation (Koch, et al., 2006). However, there are significantly more farmers in Zimbabwe (18%) than in Zambia (10%) who indicated that they have not noticed any changes in the climate at all. Similarly, as illustrated in Figure 3, more farmers in Zambia have noted flood (farmers in Zimbabwe mentioned excessive rains where farmers in Zambia mentioned floods. Excessive rains have therefore, in this paper, been used as a proxy for floods) and drought occurrences over the years than the farmers in Zimbabwe. While this could imply that farmers in Zambia are significantly more conscious of climate variability and changes than farmers in Zimbabwe, it also appears that farmers who have a lot of challenges to contend with may have their attention divided so much that they would less likely be able to notice changes in climate. In this respect, these multiple challenges may present a farmer with an option to prioritize concerns and cloud their perceptions of climate variability and change. A series of interlocking problems including hyper-inflation, perennial and acute food shortages, shortages of other basic commodities in the formal market, and a critical shortage of farming inputs resulted in the ballooning of the proportion of the national population trapped in cycles of poverty and vulnerability in Zimbabwe (Gandure & Marongwe, 2006). This finding is buttressed by the fact that perceptions of danger and risk have been considered to be shaped by psychological, social, cultural, and institutional processes.

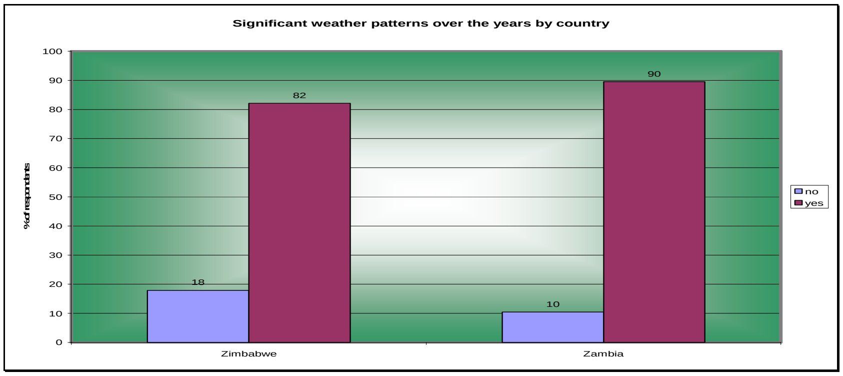

Figure 2: Changes in weather patterns over the years by country

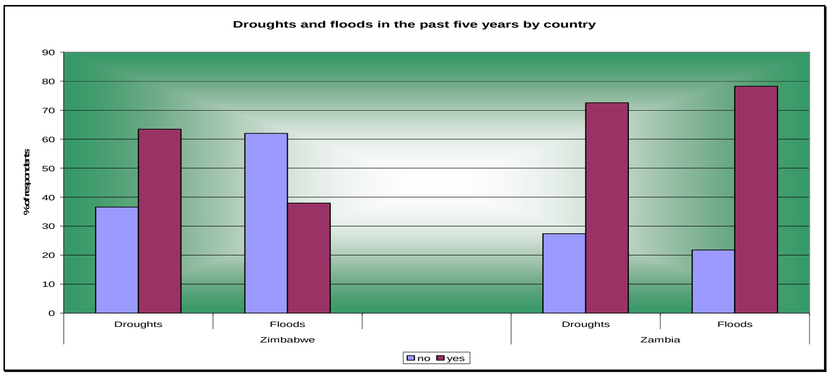

Figure 3: Perceptions on droughts and floods in past 5 years by country

Negative Impacts of Droughts

Impacts of droughts on crop yield

In all the districts in Zambia and Zimbabwe, it was perceived that due to droughts, most crops had dried up, a factor which led to reduced crop yield. In both countries, the major consequence of a reduction in cop yield during this period was food insecurity. A case of desperation was cited in Sinazongwe where a grain storage building was destroyed by a rowdy crowd of villagers who demanded to be given this grain, citing that they could no longer look at the grain and not be able to give it to their families. Yield reductions of a similar nature were recorded during the severe drought of 1991/92, when it was less than half that of 1990/91. In the seasons 1972/73, 1979/80, 1981/82, 1983/84, 1986/87, 1993/94, and 1994/95, significant shortfalls in maize yield were also recorded and these seasons were characterized as having below normal rainfall by the Zambian meteorological department. Essentially, drought has been the biggest shock to food security in the country during the last two decades (MoA, 2000; Muchinda, 2001).

Impacts of drought on the socio-economic status of farmers

There is a general trend on the impacts that farmers had witnessed from droughts. Farmers in the four districts considered themselves to have been impoverished by these droughts as they no longer had an income from crop cultivation as before, having had to either restrict or stop selling produce. This poverty manifested in the form of them no longer having money to send their children to school, culminating in a lot of school drop outs. Consequently, young men in the study areas had resorted to crime to make a living, for instance by stealing crop produce from neighbors' fields and livestock.

Stock theft was especially reported in the drier districts (Lupane and Sinazongwe), where livestock rearing is more prevalent. Farmers added that the reduction in cattle numbers was exacerbated by the disposing of livestock through sales in order to meet household food requirements, particularly in Sinazongwe district. Survey results indicated that livestock sales had gone up to 49% in Zambia districts and 48% in Zimbabwe districts in drought periods. This has negative implications for farmers since livestock is critical for draught power and various other uses.

Also, as a result of this poverty in drought periods, the social fabric was breaking as it was no longer the norm to assist each other as neighbors in times of need. It was revealed in in-depth case studies that farmers are now even embarrassed to ask for assistance from their neighbors when these farmers know that their neighbors have too little, which is not enough for their own families. Previous research has highlighted the important role that social and kinship networks play in sustaining households in times of need (Gandure & Marongwe, 2006). While farmers used to engage in reciprocal work parties, these farmers have stopped as they no longer have adequate food and money to sustain these activities, which would lessen labor requirements and address lack of draught power. This is not unexpected in Zimbabwe where economic realities may call for individualism, that is, limited resources and high prices of basic commodities may mean that households cannot share with outsiders. In both countries, domestic disputes were also said to be on the increase and leading to broken homes. For instance, in Sinazongwe, there were cases of wives who were leaving their impoverished husbands to go back to their own families who were better resource endowed. In such cases, these women never returned to their husbands.

Despite the highlighted convergence, there are impacts that were reported by farmers in Zimbabwe districts, which were not perceived in Zambia districts. In Lupane and Sinazongwe, migration - both internal and external - was considered to be an impact of drought. Migration was reported to be on the increase in drought periods due to food insecurity. In Lower Gweru district, farmers were migrating to engage in gold panning in order to supplement household income. In both Lupane and Lower Gweru (Zimbabwe), farmers were migrating to other countries, such as Botswana, South Africa, and the UK, to search for a living. Most of these migrants are the youths that have left school and are unable to secure employment. Reports indicated that climate variability has been the major constraint to food security, a reasonable standard of living and income generation for these farmers.

Migration was cited as having led to a number of broken homes and a sharp decrease in household labor, a factor that they considered to have also contributed to reduced yields and leading to chronic illness, which farmers used as a proxy for HIV and AIDS. Subsequent deaths were also considered to have caused an increase in orphan incidence. This finding is similar to a study done in Sekhukhune district in South Africa where migration was also considered to have contributed to the high prevalence of HIV and AIDS (Ziervogel & Taylor, 2008). Meadows (2005) indeed confirms that the the virus is opportunistic and is likely to increase in the event of the intensification of other climate-related stressors, such as reduced food security on vulnerable populations. Furthermore, there were reports of governments reneging on relief projects during droughts in the districts in Zimbabwe. In the same districts, a reduction in crop yields led to food shortages and consequently increases in prices of basic food commodities. The implication in the cited impacts is that food insecurity due to droughts has far reaching impacts that may leave households in a cycle of poverty and results suggest that the situation for Lupane and Lower Gweru in Zimbabwe is more desperate than for Monze and Sinazongwe in Zambia.

Impacts of drought on human health

Farmers resorted to using water from dirty swamps for drinking purposes due to the unavailability of water for domestic use, which reportedly caused diarrhoeal diseases. Under normal circumstances, farmers fetch drinking water from deep wells, most of which are located within their homesteads. This was reported to have caused general poor health in a number of households, more so in Sinazongwe and Lupane with cholera identified in the former and malaria in the latter. Previous research findings in Zimbabwe have revealed that climate change associated diseases in Zimbabwe are cholera, dengue fever, yellow fever, and general morbidity. In the same context, access to potable water and sanitation in Zambia is very low during droughts, causing an increase in the frequency of epidemics and enteric diseases (Chigwada, 2004; ZINC, 1998). Both Lupane and Lower Gweru farmers cited malnutrition in children as having risen during drought periods due to high food insecurity levels. Farmers in Monze also attributed the emergence of big rats that they thought were coming from Tanzania, and which, for this reason, they named *Tanzania rats,* to drought.

Impacts of drought on livestock health

In all the four districts, farmers indicated that there was an acute shortage of water for livestock during drought periods. This led to a marked decrease in the quality of pastures. For instance, in Zambia, farmers in Mujika reached a point where they would temporarily migrate to areas where they could get pastures and water for their livestock. This result is consistent with a finding from research done in South Africa's rangelands (Meadows & Hoffman, 2003; Vetter, 2009) that vegetation change, triggered by drought, often results in reduced agricultural productivity, for example, a loss of perennial shrubs or grasses. This is the case as livestock production is clearly dependent on the productivity of the associated vegetation of these rangelands (Meadows, 2005). In turn, poor quality pastures and limited availability of water reduced the amount of draught power that could be provided by livestock. Moreover, this was compounded by the fact that farmers can no longer afford to hire labor to supplement the little draught power available. It has been highlighted that at a given time, a reduction in precipitation would be likely to reduce the income of large livestock farms by about 9% (approximately US $5 billion), due to a reduction both in stock numbers and in net revenue per animal (Seo & Mendelsohn, 2006a, 2006b).

Livestock diseases were on the increase during droughts. In Zimbabwe's districts, diseases that were identified include foot and mouth, anthrax, black leg, and lumpy skin. As a result, a number of livestock deaths were said to have occurred. There is literature to support these assertions by farmers. Outbreaks of anthrax are often associated with alternating heavy rainfall, drought, and high temperatures. Blackleg, an acute infectious clostridial disease, mostly of young cattle, is also spore-forming and disease outbreaks are associated with high temperature, droughts, and heavy rainfall (Parker, Mathis, Looper and Sawyer 2002). In the same context, Sinazongwe farmers' livestock had to share the remaining dirty water with wildlife that also started moving close to homesteads in search of water. This fact was considered to have caused an increase in livestock diseases and deaths.

Impacts of drought on fresh water availability

Most water resources in Monze and Sinazongwe in Zambia and Lupane in Zimbabwe dried up during droughts. However, this was not the case in Lower Gweru. This finding is not surprising, given the location of the district in a well watered region in Zimbabwe. This led to unavailability of water for domestic use and women had to walk long distances to fetch water for the household. Only farmers in Lupane district in Zimbabwe and Sinazongwe district in Zambia reported that they witnessed the drying up of vegetation during droughts. Findings are consistent with predictions, which show that there will likely be an increase in the number of people who could experience water stress by 2055 in Northern and Southern Africa and that the greatest reduction in runoff by the year 2050 will be in the Southern Africa region. For Southern Africa, almost all countries, except South Africa, will probably experience a significant reduction in stream flow (Arnell, 2004, 2006a)

Positive Impacts of Droughts

In Lupane and Lower Gweru, there was a marked decrease in availability of labor to work in the fields when youths leave for neighboring countries during droughts. However, remaining members of the household benefit through remittances that are sent back by their children and relatives. Farmers in Zambia indicated that when there are droughts, they become more hard working and enterprising, leading to diversification into non-farming activities, such as petty trading and handicraft, which supplement the poor harvests that they get during these times. These activities have become a way of adaptation since farmers continue to employ these strategies even in good years. Remittances and livelihood diversification are considered to contribute significantly to the livelihoods of rural households, as found in Sekhukhune district in South Africa (Ziervogel & Taylor, 2008) and in previous research in Zimbabwe (Drimie & Gandure, 2005; Scoones, 2006). Essentially, it is emerged that these impacts also become adaptation strategies that farmers rely on.

Negative Impacts of Floods/excessive rains

<u>Impacts of floods/excessive rains on crop yield</u>

Similar to the impact of drought, it was reported in the four districts in Zambia and Zimbabwe that floods had led to very low yields due to water logging and leaching. For some farmers, there was total failure of crops, particularly in Monze and Sinazongwe. In Zambia, crops were stunted due to floods and those that did reach maturity, rot. Farmers in Monze indicated that water in the fields reached knee height. Some fields were swept away and others were silted, making it difficult for crops to reach maturity. Moreover, farmers in both countries did not get time to weed their fields as most of the time it would be raining. An example was cited in Monze when it rained heavily and continuously for eight days. In Sinazongwe, a lot of farmers resorted to eating wild fruit in order to supplement the little food that they could get. Research done in Ecuador similarly shows that during floods in 1998/99, there was total loss of harvests, which led to increased unemployment and a 10% poverty incidence (Stern, 2007).

<u>Impacts of flood/excessive rain on the socio-economic status of farmers</u>

There are similarities in the way farmers were affected by floods in Monze and Sinazongwe and excessive rains in Lupane and Lower Gweru. During this period, roads were damaged and bridges collapsed in all districts, except Monze. In Sinazongwe and Lower Gweru districts, this led to transport operators withdrawing services as they feared for the safety of their vehicles. This was compounded by the fact that feeder roads in Sinazongwe were impassable and farmers had to walk long distances to get transport to the city. Local retail shops ran out of the basic commodities in both districts and basic commodities became very expensive as it became increasingly difficult to bring them to the shops. There was a drop in school attendance in this district as bridges were destroyed. Moreover, farmers in Lower Gweru district were heavily affected as they subsequently failed to ferry their horticultural produce to the city. In this respect, early warning systems of extreme weather conditions cannot be overemphasised to ensure that farmers are warned in advance and take appropriate measures to deal with these floods. This is a major setback in Southern Africa, among other regions, where early warning systems and education programs raising awareness of climate change are considered to be poor (Stern, 2007).

Furthermore, in all districts, some physical structures that were not strong were reported to have collapsed while others were easily swept away and some roofs carried away. Household property was damaged in the process. In Monze, some toilet buildings were also damaged. In Sinazongwe and Monze districts, some households sought refuge in schools and others had to move in with relatives and this was reported to be a serious disturbance as these relatives were facing problems of their own. In both districts in Zambia and Lower Gweru in Zimbabwe, people who tried to cross rivers were swept away and while young school children were reported to have died, some people were later rescued after being stranded in the river. In Monze, two people even died during this period as they tried to cross the river.

However, there were impacts that were unique to the two Zambian districts. It was reported that trees had also been uprooted during the flood. Schools' infrastructure was destroyed in Sinazongwe and pupils were learning from outside classrooms as roofs were carried away by heavy storms during this time. All these impacts would further affect the already impoverished farmers, who have limited resources and household income from which to draw in these times. Financial costs of extreme weather events represent a greater proportion of GDP loss in developing countries, given the higher monetary value of infrastructure (Stern, 2007).

Impacts of flood/excessive rain on human health

Flood waters contaminated sources of water for domestic use in Monze and Lower Gweru and this led to diahorreal diseases, such as cholera and dysentery. People (especially children) developed sores on their feet and between their toes as they walked in water barefoot for a protracted period. There are similar findings from previous research which show that following the 1997–1998 El Niño event, malaria, Rift Valley Fever (RVF), and cholera outbreaks were recorded in many countries in east Africa (WHO, 1998a). In the same context, although cholera has been around for a long while and periodically, there have been widespread outbreaks, the Zimbabwe Initial National Communication on Climate Change (ZINC) (1998) reinforces that cholera is one of the climate change associated diseases in Zimbabwe. In Zambia, floods have been found to increase the frequency of epidemics (Chigwada, 2004).

Malaria was reported to have affected households in Lupane, Lower Gweru, and Monze during floods and excessive rains. This result is not unexpected as there were earlier predictions of increasing malarial trends, which were likely to become more pronounced as the climate changes. At that time, 80% of malarial incidences in Zimbabwe were linked to changes in rainfall and temperature (Freeman & Bradley, 1996; WHO, 1998a). Similarly, in a study done in Zambia, a simple linear regression revealed that between 1998 and 2005 malaria increased as rainfall increased in Chadiza and Mazabuka Districts in the Eastern and Southern Provinces, respectively. Studies from elsewhere in Zambia also found that malaria incidences in wet years were considerably higher than in dry years. Particularly notable are the reductions in malaria during the 2002 drought.

Impacts of flood/excessive rain on livestock health

Livestock diseases were reported in all the four districts with foot rot and blisters cited in cattle for Monze and Lower Gweru. Some of the affected livestock died as most of the concerned farmers could not afford costs of veterinary medicines to treat their livestock. Animal experts confirm that animals, such as cattle, sheep, and goats standing in mud or water for prolonged periods of time, may develop foot rot (Navarre, 2006). Goats and cattle in Zambia also became blind as a result of floods/excessive rains. Although farmers were able to name some of the diseases affecting livestock after floods, they were not able to tell the name of the disease that causes blindness. The increasing disease incidence in livestock is an expected result as predictions for variability in rainfall in Africa show that increased precipitation of 14% would be likely to reduce the income of small livestock farms by 10%, mostly due to a reduction in the number of animals kept (Seo & Mendelsohn, 2006a). Moreover, it has been documented that increased precipitation as a consequence of climate change could increase the risk of infections in livestock and people (Baylis & Githeko, 2006). Livestock were also lost in Zambia as heavy floods swept them away in the pastures.

Impacts of flood/excessive rain on fresh water

In Monze, wells were damaged and households had to dig new ones during excessive rains and floods. The overflowing of wells also meant that the water in these wells was no longer safe for drinking. Rivers were reported to have been silted in all districts after the floods due to widespread soil erosion. This finding on the siltation of rivers is corroborated by Rosenzweig & Hillel (1995), who asserted that "extreme precipitation events" can cause increased soil erosion. The implication on smallholder farmers is that this would further affect the quality of soil for crop cultivation

Positive Impacts of Floods/excessive rains

In floods, farmers in both countries reported that there is adequate food for livestock in both countries. During this time, pastures and vegetation tend to be green and of good quality and there is adequate water for livestock, which is good for general animal health. This is consistent with results from a study done in South Africa by Turpie, Winkler, Spalding-Flecher and Midgley (2002), which highlights marginal to quite strong positive impacts of climate change in the larger livestock-rearing areas of the better watered east. In Mdubiwa, Lower Gweru, farmers mentioned that they normally have wells drying up fast in times of drought, but when there are excessive rains then these farmers have adequate water for domestic use and also for gardening in the wetlands, which remain charged until the next rain season. The same applies to farmers in Monze and Sinazongwe who, after floods, carry out gardening activities throughout the year. However, it is important not to overemphasize this point as this positive effect tends to be offset by longer dry spells and, in short, a significantly more variable hydrological response (Meadows, 2005).

In addition, some farmers in Monze indicated in in-depth case studies that since they live on high ground, they get good yields for cowpeas and sweet potatoes at these times. This, then, contributes to the income in the households while in areas where it is not very dry, like Nyama ward, excessive rains would destroy garden crops. Previous research has also shown where areas in the path of rain-bearing winds may benefit from increased rainfall (Rosenzweig & Hillel, 1995). Furthermore, reports indicated that during seasons when there are excessive rains, there is good fruiting and households benefit from wild fruits. In excessive rains in Zimbabwe districts, crops that are planted late were considered to do well as they were able to reach maturity with the late rains. This ushers in the notion that access to weather information is critical for farmers so that they are able to take advantage of and offset the effects of excessive rains and floods. In Zambia districts, for those who lived within the vicinity of rivers, live fish were found near homesteads as they had been swept away from the rivers.

Trends in Crop Production

As illustrated in Figure 4, results of the conducted survey indicate that farmers in both countries concurred that there have been changes in crop yields, with a downward trend. This reduction in yields over the past five years in Zambia and Zimbabwe is apparent in staple food and drought tolerant crops, including cash crops for Zambia.

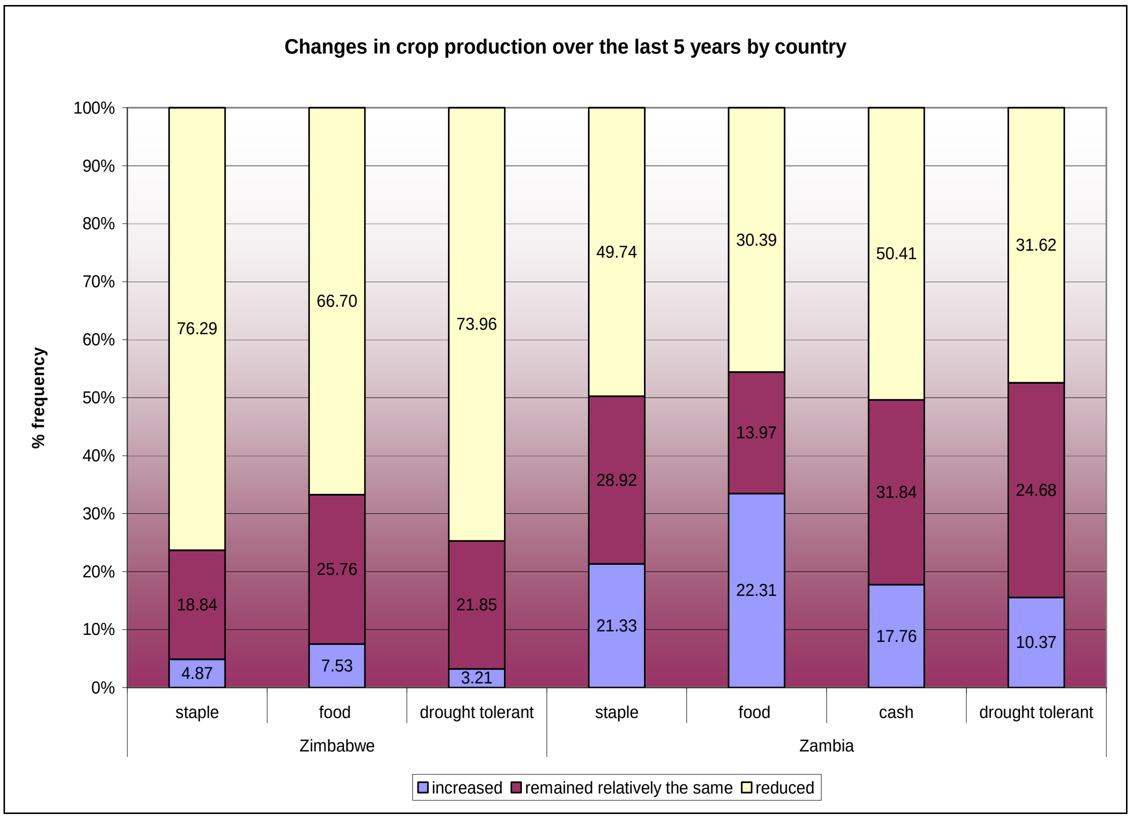

Figure 4: Changes in crop production over the last five years by country

This has negative implications for food security, considering the staple crop has the largest percentage reduction in crop production more so in Zimbabwe (76%) than in Zambia (50%). In addition, this is compounded by the fact that a cash crop (cotton) has not been grown in Zimbabwe, yet it is one of the crops that contribute to income generation for these smallholder farmers and a reduction in drought tolerant crops, yet they are supposed to cushion farmers against climate-related causes of crop reduction. Across countries, survey results show that the major reason for the above noted reduction in crop production is climate related constraints for Zimbabwe (54%) and for Zambia (52%) (Figures 5 and 6). These constraints include erratic rains, excessive rains, and drought, among others.

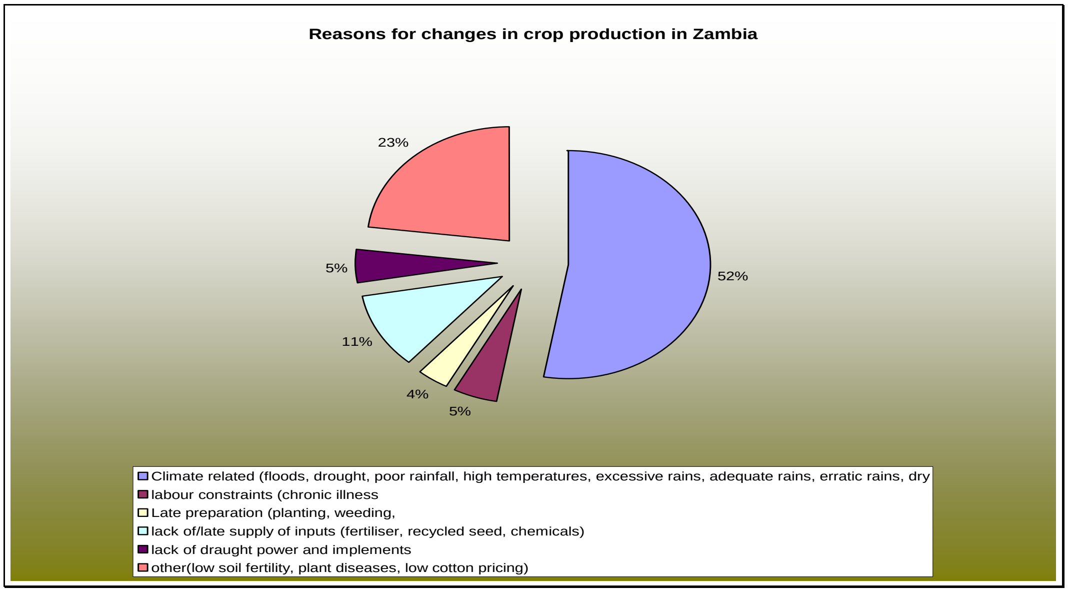

Figure 5: Reasons for crop changes in Zambia

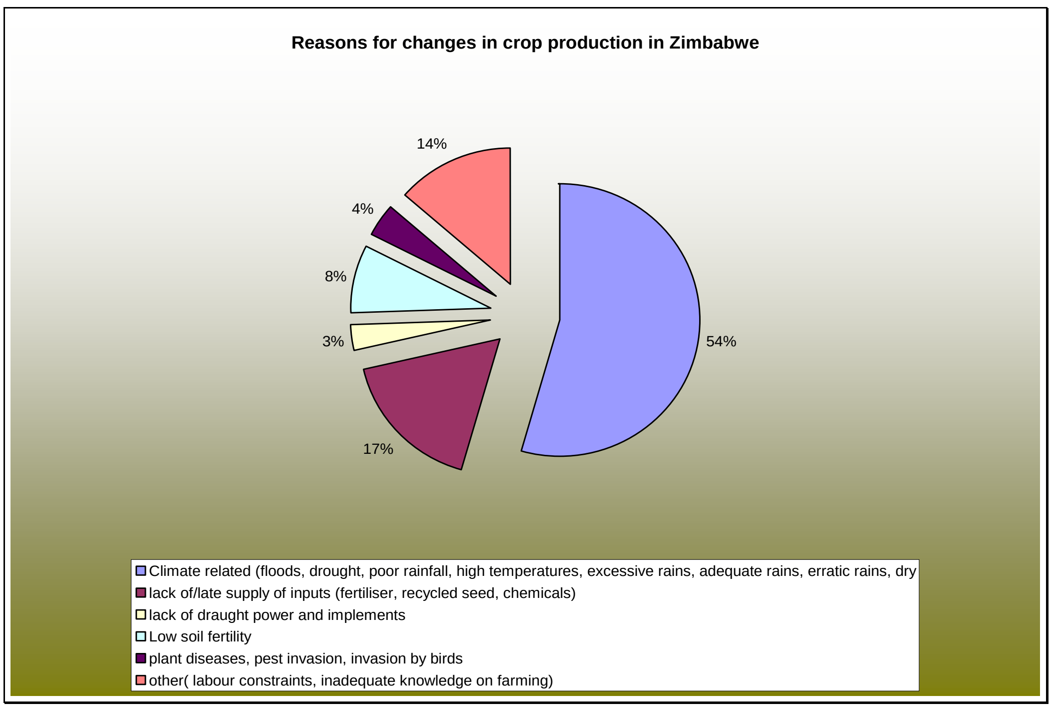

Figure 6: Reasons for crop changes in Zimbabwe

Furthermore, climate variability was cited as a major hindering factor to food security in both countries during FGDs. For Zimbabwe, this finding is consistent with the assertion by the IMF (2003) that the more recent difficulties with governance, mismanagement, and inflation, for example, were not anywhere near as problematic at the time of the drought in 1992/3. This corresponds with the assertion that climate factors have been a significant trigger for changes that alter the nature of the risks associated with living in a variable and changing climate regime (Campbell & Olson, 1991; Thomas & Twyman, 2005).

CONCLUSIONS

This paper has shown that climate change impacts on smallholder farming systems in the sampled districts in Zambia and Zimbabwe fall into four categories, namely on crop yields, the socio-economic context, human and livestock health, and water. In essence, food insecurity during climate extremes has far reaching impacts that may leave households in a cycle of poverty. A reduction in crop yields implies a reduction in income, which in turn leads to a reduction in farmers' capacity to send children to school and to meet daily livelihood needs. The study concludes that there are variations in manifestations of direct and structural–social organization and economic activities-impacts from climate variability and change as a result of differences in types of farming systems and general economic and political contexts. Essentially, while farming systems are important for farmers, the political, social, and economic context of a country may realign farmers' priorities. Therefore, it becomes important to design appropriate policies that buttress farming systems against climate variability and change through taking into account variations in these farming systems and other relevant factors.

Apart from its overwhelmingly negative effects, climate variability might also have a positive impact and localized benefits in the context of structural changes in communities under certain circumstances. These localized benefits can be capitalized on to improve the livelihoods of farmers in Lupane and Lower Gweru (Zimbabwe) and Monze and Sinazongwe (Zambia). In this regard, there is need to make a transition *from* conceptualization of climate change impacts in the policy framework as being inherently negative, to research and policy making with an open-minded lens that dissects climate change and variability impacts in order to enhance alternative livelihoods for farmers.

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