Climate change impacts on the livelihoods of smallholder farmers in Buhera District, Zimbabwe

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OIDA International Journal of Sustainable Development, Ontario International Development Agency, Canada.
ISSN 1923-6654 (print) ISSN 1923-6662 (online) www.oidaijsd.com
Also available at https://www.ssrn.com/index.cfm/en/oida-intl-journal-sustainable-dev/

Abstract: Scientific evidence of a changing climate is unequivocal with enormous predicted negative impacts, not only on the environment, but also on communities, particularly the poor and vulnerable. The impacts will be more severe among communities with weather dependent and climate sensitive livelihoods. An understanding of how farmers experience and perceive the effects of climate change on their livelihoods can help in developing acceptable strategies for responding to climate and ecosystem changes. Developing innovative solutions to the changing climate is of paramount importance among vulnerable communities particularly because they are the ones who will be worst affected. This study investigates the experienced and perceived impacts of climate change on the livelihoods of smallholder farmers in Buhera communal lands. Using a multi-method approach, data was obtained from a household survey of 114 randomly selected households, eight key informant interviews and two focus group discussions. A general decrease in rainfall and an increase in temperatures were regarded as the most significant climate parameters that have changed and have been affecting the farmers' livelihoods. Climate change impacts on smallholder farmers are manifested in different ways creating a complex web of the perpetual vicious cycle of poverty. Findings show that the changing weather patterns have challenged the livelihoods of the communities through crop failure, livestock death, water scarcity and associated socio-economic problems. The study concludes that although impacts of climate change on farmers' livelihoods are overwhelmingly negative, there are positive impacts in form of localised benefits in certain circumstances especially the drive towards livelihood diversification.

Key words: climate change, perceptions, smallholder farmers, livelihoods, Buhera

Introduction

Evidence has mounted showing that the global climate is changing and that Africa is vulnerable to climate change because of widespread poverty (IPCC 2014, Bhatasara 2017). Large populations living in marginal areas and with limited technology to facilitate coping and adaptation have contributed to high level of vulnerability to climate change on the continent. The phenomenon poses a significant threat to rural agrarian economies due to their high dependence on climate sensitive livelihood options and also interaction of multiple stressors occurring at various levels (IPCC 2007; Maunder and Tembo 2006). Even though climate change is a global phenomenon, the effects are felt locally and adaptation is an inherently local process. These effects are contextual; they intensify existing problems, and create new problems, but always within an existing local reality. Climate change threatens various sectors of economic development including natural resources, agriculture and food security, forestry, tourism, manufacturing and health (IPCC 2014). The phenomenon continues to affect the wellbeing of most rural smallholder farmers through its adverse impacts. Farmers in rural areas have been experiencing low agricultural productivity, crop failure, pests and diseases, human disease outbreaks, lack of water, shortages of agricultural based commodities at household levels and food insecurities (Unganai and Murwira 2010; Jiri et.al 2015). These impacts have posed huge threats to livelihoods among most rural smallholder farmers since they depend on climate sensitive livelihood options such as agriculture. Studies have revealed that Africa is most likely to be affected by climate change in form of increased incidences of prolonged droughts, reduced rainfall and increased temperature (Unganai and Murwira 2010). The IPCC (2014) highlighted that the impacts will not, however, be the same across the continent, with the western, central and southern Africa areas most likely to experience hotter and drier conditions. Climate change could therefore bring negative and positive effects as it affect agricultural systems differently. According to Biazen (2014), Connolly-

Boutin and Smit (2016), Hossan et.al (2012) and Kusakari et.al (2014) the negative effects of climate change have great potential to result in extensive livelihood losses especially for smallholder farmers in all countries who mainly depend on agriculture as their main source of livelihood. Frequent droughts that have been observed over the past decades to reduce soil moisture and water resources and agricultural productivity. Smallholder farmers, particularly rural or communal farmers, are vulnerable to the effects of climate change due to their marginal location, low levels of technology, limited access to climate information and lack of other essential farming resources (Mapanje et.al 2021, Muzamindo et.al 2015).

In Zimbabwe, studies in the semi-arid south-eastern districts (Mafongoya P. 2015); (Unganai 2009), concluded that smallholder farmers have noticed changes in climate which corroborate with measured weather parameters. More than 87% of the studied farmers have noticed the changes and have perceived that these changes have contributed to adverse impacts on their livelihood sources which are mainly agricultural based. Declining rainfall and increase in temperatures have been experienced implying that the region is becoming more and more prone to droughts. The farmers' perceptions have influenced adaptation of agronomic and livestock practises or socio-cultural practises to cope and adapt the climate change and variability. Nhemachena, et.al (2014) also studied climate change adaptation in natural resource dependent semi-arid zones of south-western districts of Zimbabwe, and identified multiple stressors to the adaptation options. More than 64% of the smallholder farmers had reportedly noticed changes in climate, with adverse impacts mainly on crop production and tourism activities. In rain-fed and marginal regions of the country, decisions to invest in farms are greatly influenced by farmers' and rural communities' perceptions of climate-induced risks (Moyo et.al 2012). Small holder farmers need to be able to identify the changes already taking place in their areas and institute appropriate coping and adaptation strategies. A farmer's ability to perceive climate change influences their choice to cope and adapt. Their perceptions influence the propensity to respond to the strength of the climate signal and subsequent adaptation. The impacts of climate change and variability cannot be understood without considering farmer perceptions that influence how climate signals are felt and how they impact on farm level decisions. These studies also concluded that perceiving that the climate is changing increases the probability of uptake of certain adaptation strategies by indigenous small holder farmers.

While climate change is an environmental problem, the scope of its impacts is strongly determined by underlying socio-economic variables and the farmers' perceptions of the phenomena. These have not been fully interrogated and the importance of understanding the adaptation environment is imperative as it determines what is feasible within the capacity of the farmers. Multi-country studies on southern Africa (e.g. Vincent et.al 2013) showed that there is a wide range of strategies that have been adopted by farmers as a response to climate change. These strategies include crisis responses, modifying farming practises, modifying crop types and varieties, resource management and diversification. However it remains imperative to examine the contexts that facilitate one type of response over the other so that different communities can be helped to adapt to climate change. While there is a multiplicity of stressors that confront the farmer's livelihood, climate change and variability remains the most critical and it exacerbates livelihood insecurity to farmers with limited capacity to alternative livelihoods, (Mubaya et.al 2012). It is important for smallholder farmers to be aware of the effects of climate change and variable weather patterns so that they can employ coping and adaptation measures (Jiri et.al 2017). Sound adaptation can be achieved if the farmers themselves take adaptive initiatives from realising their plight. This study investigated the effects of climate change on the well-being of smallholder farmers in the communal areas of Buhera district. The main aim of the study was to establish the perceptions of farmers on climate change and to describe the nature of the climate change effects on the livelihoods of smallholder farmers in the district. The researcher sought to understand if there were any noticeable climate changes that had taken place in Buhera district in the living memory as far as farmers could narrate. The impacts of the observed climate changes on the rural livelihoods of the farmers were also established and discussed.

Research Methodology

The study area

The study was carried out in Buhera district in Manicaland Province, South-eastern Zimbabwe (see Figure 1). Ward 25 was purposively selected for the area is a hot spot for climate related disasters according to Zimbabwe vulnerability assessments (ZimVac 2015, 2013). The area is prone droughts, flash floods, heat waves and occasional hailstorms. The ward lies in agro-ecological zone V receiving less than 500mm of rainfall per year. The area also experiences high day time temperatures of 30-40^{0}C and the winters are mild. The temperature ranges are 6-25^{0}C resulting in high

evapotranspiration rates rendering the area less conducive for crop production save for small grains which are being promoted in the area.

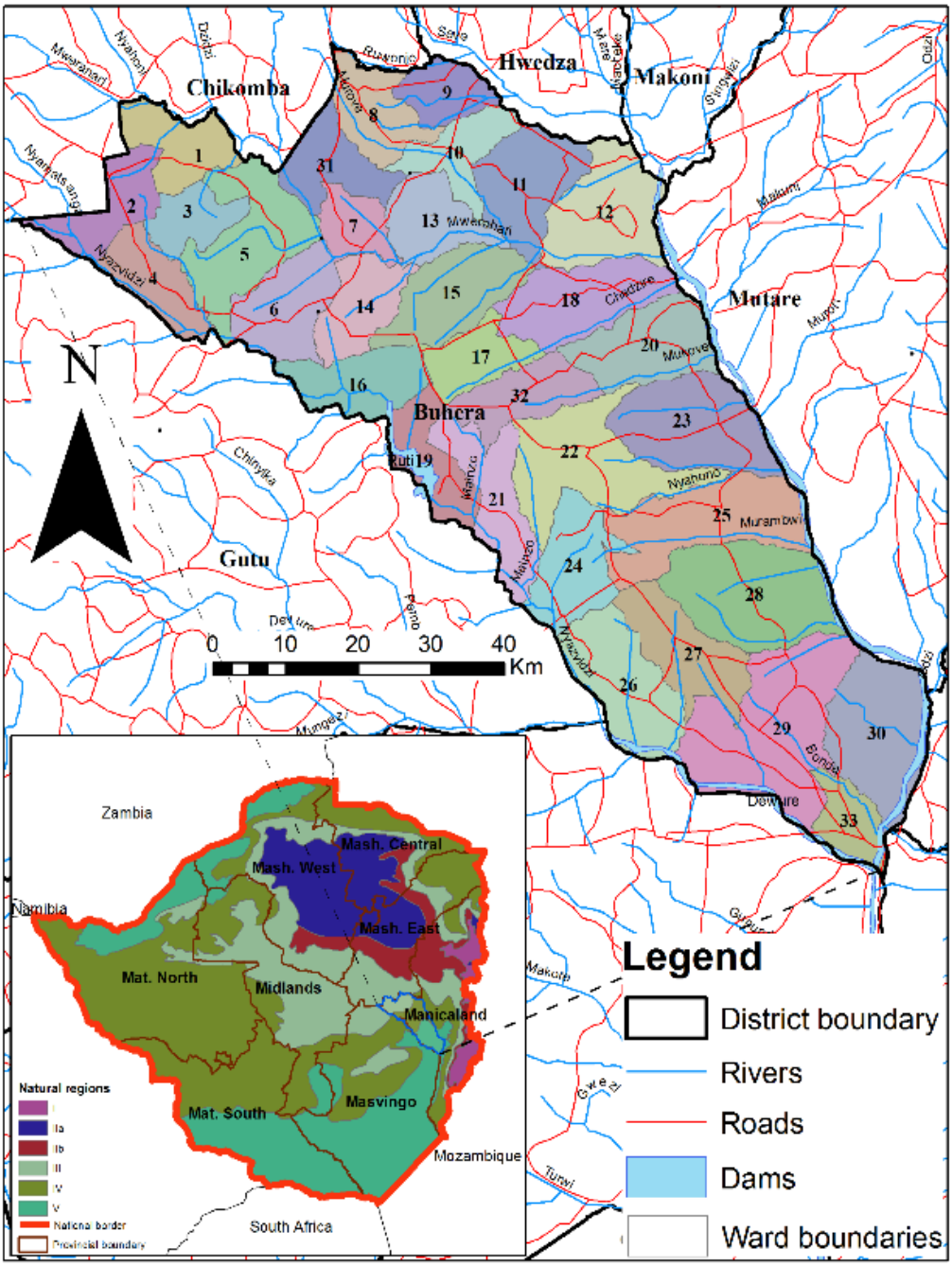

Figure 1: Study area map

Data collection procedures

The study employed three data collection techniques for triangulation purposes. These include a questionnaire survey, in-depth key informant interviews and focus group discussions.

(i) Questionnaire survey

Sample size

Buhera district has 32 wards and out of these, ward 25 was purposively selected because of recurrent food insecurity (ZimVac 2016; 2014). The eastern part of the ward has a total of 1329 households (ZIMSTAT, 2012). Raosoft sample size calculator was used to determine the sample size. It is a software that helps in the calculation of sample size under various scenarios. With the margin of error of 5% (maximum acceptable for empirical studies) and at 95% confidence level, with the population of 1329 households, the sample size was calculated to be 126 households. Households included in the study were identified using systematic random sampling for the questionnaire survey. The formula used is as follows;

$$n = {}^{N\,x}/_{((N\text{-}1)\,E2\,+\,x)}$$

where $x = Z({}^{c}/_{100})^2\, r\,(100\text{-}r)$; $E = \text{Sqrt}\,[{}^{(N\,-\,n)x}/_{n(N\text{-}1)}]$

N is the population size, r is the fraction of responses the researcher is interested in and $z(\frac{c}{100})$ is the critical value for the confidence level c, n is the sample size while E is the margin of error.

Sampling procedure

The k^{th} element in the sampling frame was selected, where k, is the sampling interval calculated as $k=\frac{N}{n}$; where n, is the sample size and N, is the total number of households within the study ward.

$$\frac{1329}{126} = 10.5476$$

K was calculated to be 10, so every 10th household in the village in a transect walk was engaged in questionnaire administration. Thus a systematic random sampling was used to identify 114 (well completed questionnaires) households for a questionnaire survey. These were drawn from 11 randomly selected villages in the ward 25 of Buhera. Household questionnaires were administered to understand how the farmers experience climatic changes and the extent to which their livelihoods have been affected. The questionnaires were ideally targeted at the household head who are also central to household decision-making processes on livelihood issues. However, in cases where they were not present other responsible people (>18 years of age) responded to the questionnaire.

(ii) In-depth key informant interviews

These were done with eight purposively identified respondents. These were chosen because of the role they occupy in the community for climate change adaption. Interviews were held with relevant stakeholders to answer the question of climate change and livelihoods. Traditional community leaders, leaders of community-based organisations, officers from Agricultural Extension Services and humanitarian organisations were interviewed to understand their perception about the climate change phenomena in Buhera and perceived impacts of the general and specific well-being of the people.

(iii) Focus group discussions (FDGs)

Two FGDs were done with farmers who were conveniently identified due to their availability. There was a deliberate effort to involve farmers in three age cohorts, i.e. the young adults (18-25 years), medium aged (26-45 years) and the elderly (>46 years). The FGDs collected data on community perceptions about climate change and how the phenomena had affected their livelihoods. Specific questions were asked on notable signs of climate change in the locality, focusing on rainfall, temperature and extreme weather events, crop performance and the general ecosystem. Questions exploring how livelihoods had been impacted and how communities adapt to climate change as they experienced it were also asked.

Data analysis

Descriptive statistical analyses were done on survey data with the use of a Statistical Package for Social Scientists (SPSS) version 24. Focus group discussions and interview data were analysed through content analysis by identifying themes, concepts, patterns and trends.

Findings

Climate change perceptions in the district

Farmers' knowledge and perceptions on climate change

The research determined the rural communities' perceptions and knowledge of changes in climate variables (mainly temperature, rainfall and extreme events) over a period of more than 20 years, in as much as they could remember, as well as the impacts of such changes. The findings were that communities in Buhera District are generally aware of climate change, with 80.7% having noticed changes and having heard about the concept of climate change. The remaining 19.3% have not heard about climate change and their experiences of the changing parameters are believed to be normal for weather has to be different on different days. When asked how they came to know about climate change, the farmers identified sources of information as shown in figure 1. Although farmers are exposed to various sources of information, their fellow farmers are the most important source of information on climate change, with 71% of those that are aware of climate change having gotten information from each other. Radios are the other source of information, reaching out to around 22% of the population with extension workers, another source, disseminating information to only 7% of the respondents.

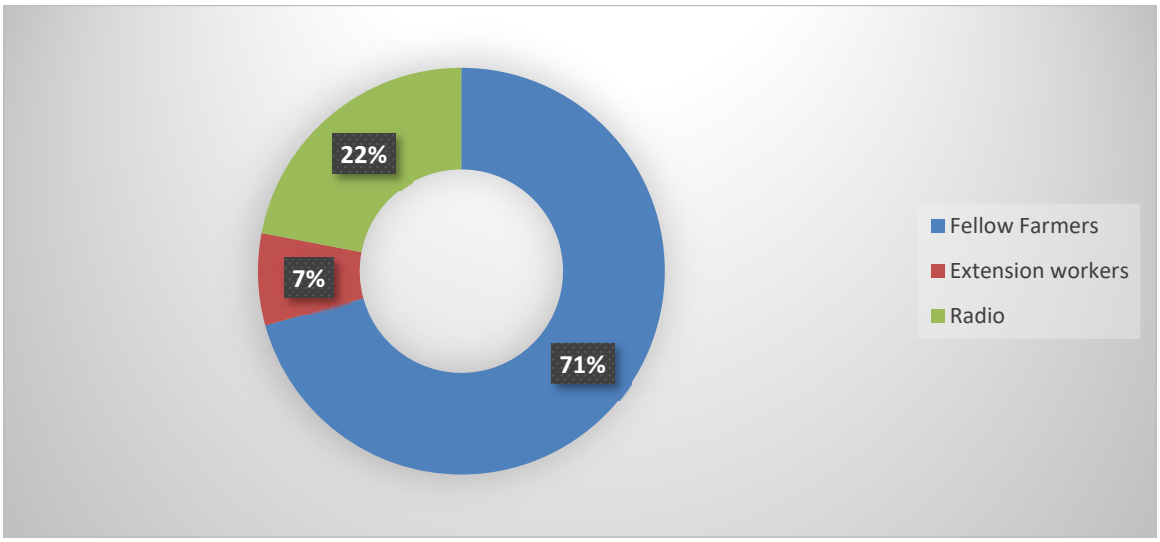

Figure 1: sources of climate information

There exists the understanding that deforestation and veld fires provoke climate change. For some farmers, the extent of awareness of the causes of climate change go so far as to include the actions of industrialised countries. In addition, there was some consciousness as to the role of air pollution in the destruction of the ozone layer and consequently climate changes, as well knowledge of the capacity of vegetation to store carbon.

Nature of climate change in the district

The farmers were aware that there have been changes in climate over the years. Figure 2 depict that the majority of the participants have observed a decline in rainfall (83.3%) and a general increase in temperatures (85.1%).

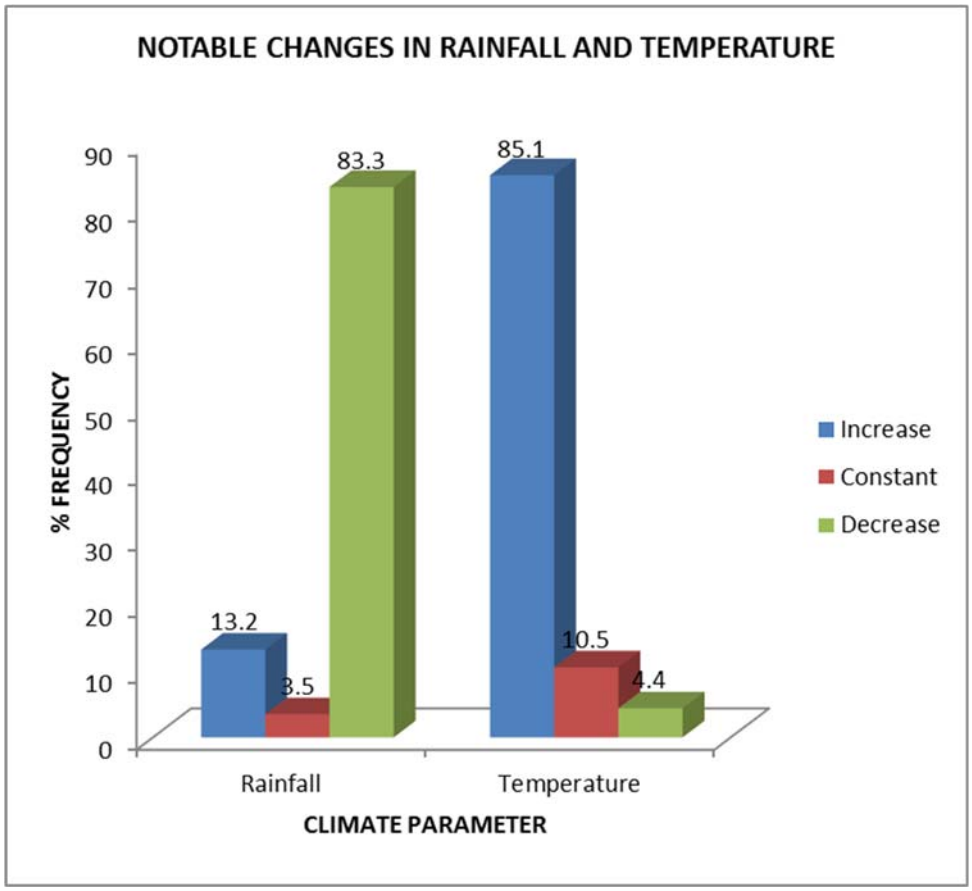

Figure 2: Farmers' perception of climate change

Such temperature-rainfall pattern is becoming more pronounced creating perpetual moisture deficit. Drough incidences were also reported to be on an increase in the area. Over the past 30 years there have been more drought years than wet years. The highest frequency of droughts was in the last decade during which most of the years were drought years. Figure 3 shows the frequency of farmers' experiences of extreme weather events over the past three decades. Generally, the past decade (2009-2019) has witnessed an increase in the extreme weather events. The occurrence of drought was confirmed by the highest number of farmers. Most of these droughts are said to be characterised by late onset of rainfall, mid-season dry spells and early cessation of rainfall. Farmers indicated that in the past the rains started in mid-September/ mid-October, up to end of April and were well distributed throughout the season. Currently the season starts from end of November/ early December and end towards end of March/ mid-April. The farming season has now become short.

Incidences of extreme events

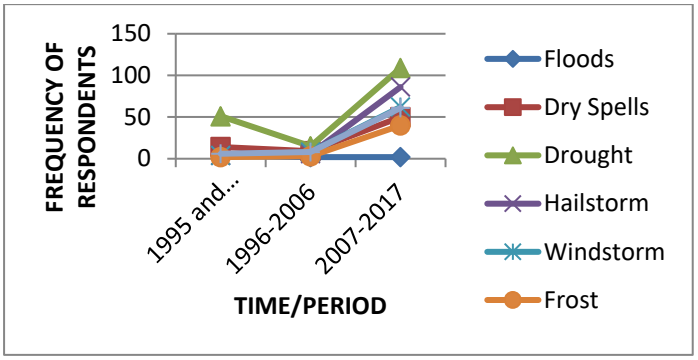

Figure 3: Incidences of extreme weather events

The occurrence of harsh weather has also been observed to be on an increase. The frequency of farmers who indicated having experience the events is high for the past decade. Figure 3 shows that windstorms, hailstorms are experienced in the recent more than before.

Livelihoods of the communities in the district

The main livelihood strategies in the target ward in the district are crop production (rain fed field cropping and gardening), livestock rearing (cattle rearing, small ruminants and poultry) and casual labour (see Figure 4). There are other numerous livelihood options that communities engage in for diversification and when farming fails. These include businesses of selling wild fruits such as baobab (*Adansonia digitata*), nyii (*Berchemia discolour*) and makwakwa (*Strynos madascariensis*). Communities also engage in cooperative activities generating some cash like village savings and lending and through any seasonally viable projects such as basket weaving, selling cooking sticks, crafts and sale of firewood and looking for casual employment. Crop production is the main source of livelihood in the area with about 99% of the people identifying it as their major source of food and income. A variety of crops are grown including pearl millet, finger millet, white and red sorghum, cow peas, round/ bambara nuts and ground nuts. Farmers sell surplus for cash or in barter trade. Red sorghum is mainly grown under contract farming for Delta Beverage Company. There is organised acquisition of inputs and sale of the produce. Maize is grown in the area but on a small scale and usually in gardens because the area receives low rainfall. Most of these gardens are situated on wetlands. Small grain crops have a potential of doing well and farmers concentrate more on their production. Crops that are perceived to be most helpful in extreme dry periods are millet, sorghum and round nuts. Although millet and sorghum and round nuts are good for cropping in perpetual aridity, processing and grinding them for a meal is expensive and laborious. Crop farming is mainly done through the rain-fed system.

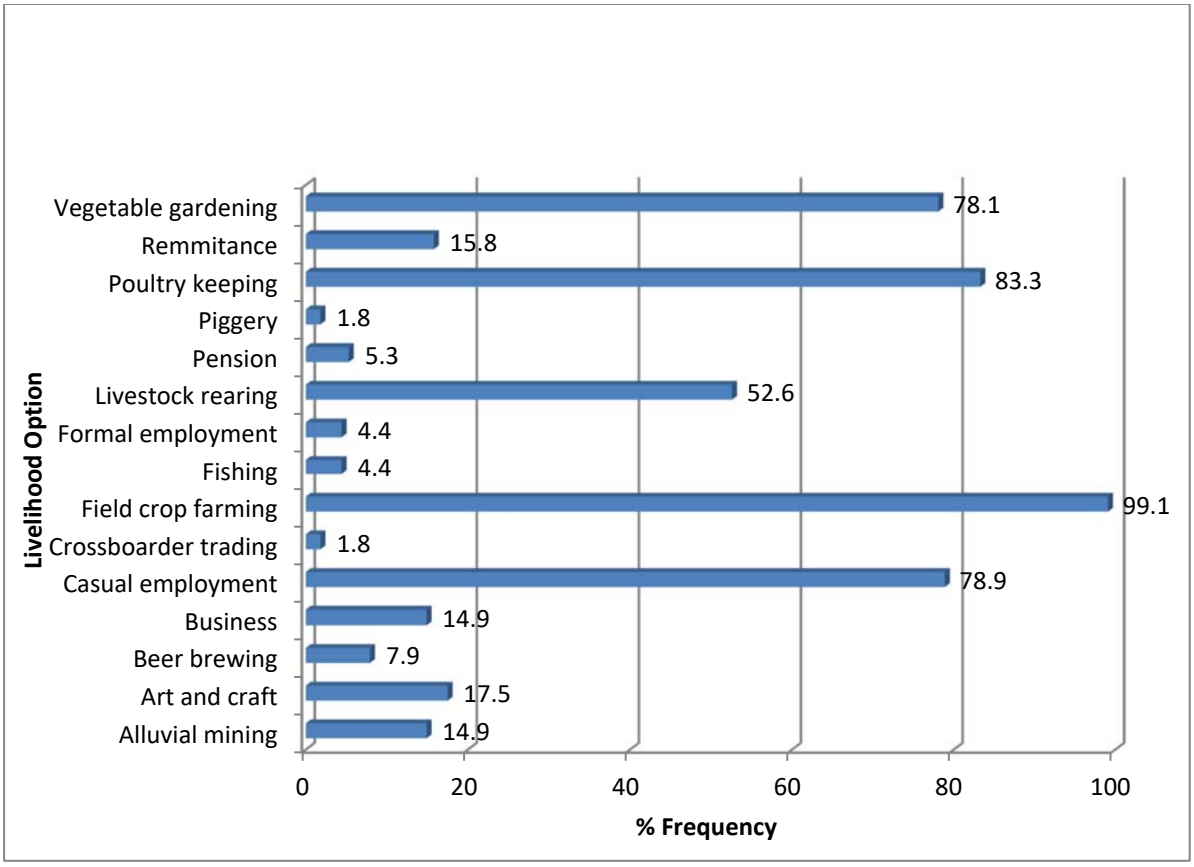

Figure 4. Livelihood activities of the communities in the district

Consolidated community gardens and individual gardens are found concentrated near water bodies such as rivers, dams, boreholes and dambos. Some gardens have crops throughout the year depending on availability of water. The crops that are grown in gardens are maize, green leaf vegetables, onions and tomatoes. Consolidated gardens tend to

create a glut of a particular produce as a number of people will produce one type of crop at the same time and this poses a challenge of markets. Besides challenges, gardening remains an important source of food with more than 78% of the people ranking it the most important source of food and income.

Livestock rearing was ranked the most important source of income and food by about 52.6% of the farmers whilst poultry production has a frequency of 83.3%. This is basically because most households lost their cattle during drought episodes. The main livestock reared are cattle, goats, sheep and very few households have pigs. Cattle breeds are mainly the indigenous Mashona type and in some cases they are crossed with exotic breeds, usually Brahman. There are organised markets for cattle in the area. These are organised by the Livestock production division of the Ministry of Agriculture. Farmers also keep a variety of poultry and this venture has been perceived to be of paramount important as a source of food and income. There is a drive towards promotion of indigenous chickens breeding and husbandry. Households also keep turkeys, broiler chickens and guinea fowls. The market of fowls is varied with some buyers coming from nearby urban areas of Masvingo, Mutare and Murambinda growth point.

Casual employment was also identified as an important source of income and ultimately food, with about 78.9% ranking it the most important livelihood option. The type of jobs which were identified were varied, farming related, livestock rearing related, construction, repairs and maintenance and housekeepers. The able bodied people who could look for jobs highlighted that they would do any job that is available and give them money for upkeep. In some cases, payment of these casual jobs was in form of food, clothes, farming inputs and other implements.

Effects of the observed changes in climate on major livelihood options

The livelihoods of communities in the district are agricultural based. With rainfall and temperature patterns undergoing variations and modifications, food production is heavily affected. Without provision of support to the extent necessary, farmers acknowledged that they would be forced to migrate in search of new work. This would greatly increase pressure on urban environments as most migration flows to urban centres. Droughts are a perennial problem and their effects are felt always. Crop failure, low yields and eventually shortage of food are almost permanent challenges the communities are facing. Livestock also die because of shortage of food and water and the results in shortage of draught power. Even in cases when the livestock do not die, they will be too weak to provide draught power. Absence of draught power would translate to reduced area under cultivation in the following farming season and thus decreased yields. Focus group discussions revealed that even in cases when the farmers are encouraged to reduce their stock, the prices they get at the organised Mutiusinazita and Gwama cattle markets are very low. The buyers dictate the prices to the disadvantage of the farmers. They will suffer a double loss also because they pay a levy to the local administrative Council for bringing their cattle for auctioning.

Participants of the .focus group discussion also indicated that goats and sheep numbers are declining due predators. Hyenas in the areas have killed a significant number of sheep and goats in the past three years. This was also confirmed by community leaders who suspect, that wild animals no longer have enough food in the bush and are now descending on domesticated animals more frequently than before. Participants also emphasised the shortage of grazing and fodder for cattle and indicated that they would face severe food shortages of animal feed from mid-winter till the onset of rain season, when the remaining grass will be totally dry and depleted. An official from the livestock production division also highlighted the decrease in quality of the livestock with continued shortage of food. However, there was a drive to introduce programmes to improve livestock rearing, such as cross breeding and supplementary feed for those who could afford.

The mid-season dry spells that are now a common characteristic feature of the climate of Buhera, coincide with the critical period when crops are in their most vulnerable physiological state. Crops suffer moisture stress, wilt and in all the cases, the expected yield is drastically reduced. Participants in the focus group discussion described crop failure, low harvests and famine as a permanent feature in the area. This has prompted the venturing into other activities that can alleviate food scarcity by increasing household incomes. Droughts have resulted in the shortage of water for various uses, as rivers dry up shortly after the rain season, boreholes and wells dry up before recharge from rainfall in the next season.. As a result people walk long distances to fetch water for domestic use and to water animals during the times when their usual sources dry up. With the exception of Save river, which boarders the district to the east, most streams in the area are seasonal. Gardening is also affected, with farmers having to move to the river valleys for gardening. Most households use privately owned wells, which also often dry up after continuous abstraction. This unreliable water availability situation tends to trigger conflicts among water consumers at community water sources. Increases in temperature have also changed areas in which various crops have been grown. High temperature have affected soil moisture content so much that some areas which were under cultivation have now been left fallow for a long time. The areas are said to have a '*bise*', a hot spot that cannot sustain meaningful plant life.

Windstorms and hailstorms are being experienced in the area are causing destruction of crops, property and livestock. Strong winds are said to be a recent phenomenon especially during the period between end of winter and beginning of the rain season. The blowing winds were so strong that some households reported removal of rooftops, trees uprooted and falling on some properties bringing damage. Farmers have lamented the scarcity of casual employment because of challenges of low disposable income. Most of the part time jobs were done on farms, in the fields, gardens and in animal husbandry. With decrease in productivity, because of adverse climate, the jobs become scarce. Those farmers who rely on hired labour reduced their operations because of unavailability of money to pay for the labour. There was an observation of increased need to seek employment outside farming area. While erratic weather patterns have had some reported effects on grasses and wood used for handcrafts, overall, it seems that this livelihood is not very climate sensitive, providing good option for supplementary income.

Impacts of climate change on the socio-economic status of farmers

The effects of climate change on natural resource-based communities in semi-arid Zimbabwe are complex but the participants of focus group discussions attempted to illustrate in a simplified structure in figure 5. Recurrent droughts and prolonged dry spells have emerged as the major climatic risk in the district. With agriculture being the mainstay of the livelihoods of the community, the major consequence of aridity has been destruction of food crops as well as seed stores and draught power, eventually culminating to a decline in food production and general agricultural produce. A decline in food production has led to famine and starvation which has lasted for some time after every episode of drought. The reduction of food production because of drought meant loss in income. Death of livestock also translated to less draught power and reduced size of land under cultivation, thus low investment; low income from livestock and low food production. Low incomes for many of these communities further reduce their ability to purchase food and there will be increased hunger and poverty within the households. Increased malnutrition and related diseases are already being observed and have detrimental effects on worker productivity. Cyclones, flooding and droughts destroy crops, decrease plants for handcraft production, ravage fruit trees and increase livestock and human mortality. In order to prepare and take necessary precautions for these events, better access to communication is required to enable disaster warning systems to function.

When the means of livelihood in a community is disturbed, it triggers conflicts within households, communities and exodus of people to urban centres. Rural poverty is a push factor for movement to urban areas in search of new and better income opportunities; eventually this situation reduced agricultural labour force. Migration was cited as having led to a number of broken homes. Extreme high temperatures and inadequate nutrition lead to poor health which potentially lowered labour available for non-agricultural activities and also reduce non-agricultural income the community members could earn. Consequently, household incomes remain low.

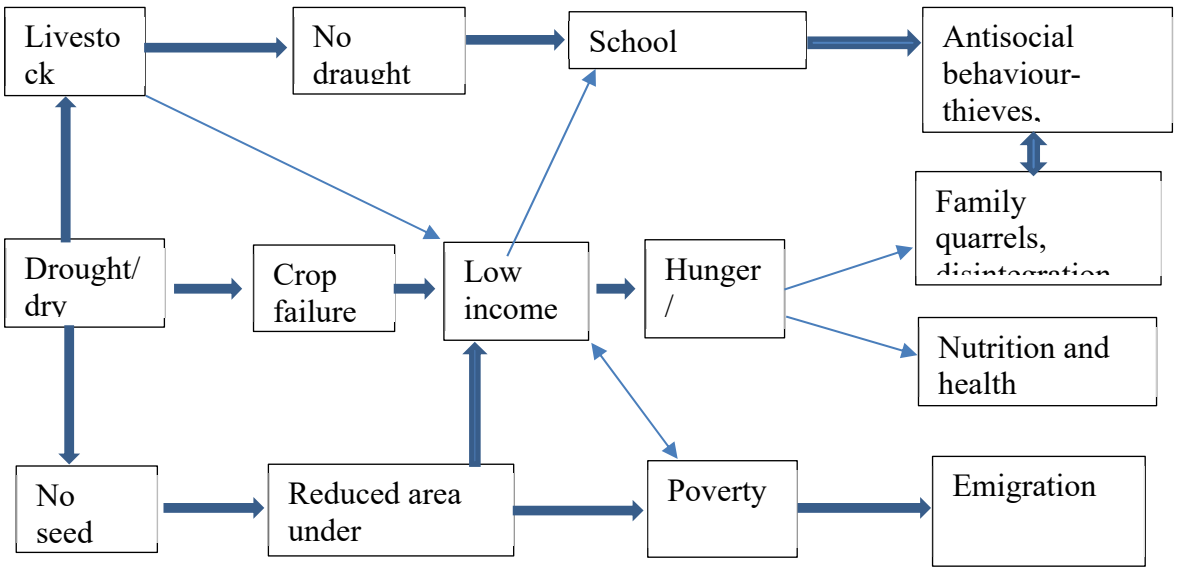

Figure 5: Negative effects of climate change

This poverty manifested in reduced financial resources for sending children to school, culminating in many school dropouts. Consequently some young men in the study area resorted to crime to make a living for instance by stealing crop produce from neighbours' fields and livestock. Because of this poverty, the social fabric is breaking, as it is no longer a norm to assist each other as neighbours in time of need. It was revealed in the focus group discussions that farmers are now even embarrassed to ask for assistance from neighbours when these farmers know that their neighbours have too little that is not enough for two families. Mubaya et al (2010) highlighted the important role that social and kinship networks play in sustaining households in times of need. While farmers used to engage in reciprocal work gatherings, this activity is disappearing, as they no longer have adequate food and money to sustain these activities. Farmers reported that, it is only when they have a good harvest of millet that they call for the work parties because its processing is labour intensive.

Positive impacts of climate change

In the study area, livelihood options are becoming more scarcer leading to out migration of the young persons. This marked a decrease in availability of labour to work in the fields when the youth leave for the nearby Marange diamond fields and also to urban areas. However the remaining members of the household benefit through remittances that are sent back to the village. Indeed the farmers indicated that when the weather has not been good for farming, they become more hardworking and enterprising, leading to diversification into non-farming activities to supplement the poor harvests. These activities have become a way of adapting since farmers would continue to employ the strategies even in agriculturally good years. Remittances and livelihood diversification are considered to contribute significantly to the livelihoods of rural households (Mubaya et.al 2010).

Discussion

Smallholder farmers in this study were exposed to a number of climatic extremes that affected their livelihoods. Climate change is arguably the most pressing challenges confronting the area. The farmers highlighted that they have been experiencing recurrent droughts, prolonged dry spells, windstorms, hailstorms, occasional sheet flooding and heat waves. This has led to livestock deaths and general shortage of water, crop failure, reduced yields and food insecurities over time. The farmers are aware that climate is changing and this puts them in a privileged position to determine their fate. Having noticed the changes over time, they can explain the effects and their responses to the effects of climate change have a base. These results are supported by Jiri et.al (2015) and Zamasiya et.al (2017) who observed that smallholder farmers perceived droughts and increased temperatures to be the major problems brought about by climate change in south eastern Zimbabwe. As such any adaptation measures would be in line with their perceptions. Farmers' attitudes to climate change are a major driver to adaptation.

The majority of the farmers are getting climate information from discussions with fellow farmers (figure 1) highlighting the importance of socialisation among the farmers. Access to information positively influence behavioural intention towards adaptation (Zamasiya et.al 2017). There is need to strengthen support services to disseminate climate information so that whatever information would cascade through farmer social networks is credible and can help the farmers. This is against the background that the agricultural extension workers were sited to contribute the least in climate information dissemination. Farmers need support systems that will spread information about climate change and keep them updated in order for them to respond to the climate threats (Ubisi et.al 2017). Farmer perceptions can reveal the farmers' access to information on climate, the knowledge of the farmer and, access to extension services and farmer-to-farmer extension as well as farmer's social networks (Maddison 2006). Nhemachema and Hassan (2014) also revealed that farmers who notice changes in climate have higher chances of taking up and implementing measures to respond to the changing climate. Farmer perception on climate change is a critical component of farmers' decision to adopt any adaptation response. Mudombi et.al (2014) interrogated the importance of determining the level of climate change information awareness amongst communal farmers and posits that promotion of dissemination of correct information is imperative for informed adaptation decisions. Tall et.al (2018) also recommended that climate information dissemination as part of climate services should be sensitive to heterogeneity of user groups and should go beyond the focus on agriculture production to include other dimensions of agricultural systems. Farmers mentioned that the climate over the past years has been characterised by droughts, reduced rainfall and high temperatures which has resulted in low agricultural outputs. The negative climatic effects compromise the wellbeing of the farmers as they experience food shortages, general low-income levels, and perpetual poverty. The greatest fear is that the agricultural sector is the driver of their wellbeing, so unfavourable weather threatens their food security status and limits their livelihood options.

Climate change has increased crop failure due to unpredictable rainfall droughts, and cyclones. Communities on the whole are currently adapting by diversifying the varieties of crops planted and planting more than one crop at the same time. An increase in counter-season cropping and vegetable gardening was observed but should be scaled up. Vegetable gardening could be productive if efficient market linkages were made. Cropping seasons are no longer routine due to erratic rainfall and changes in temperature. Farmers must now decide when to plant crops and which varieties to use. Increased research into adaptive seed varieties and consequent access to these varieties is necessary. As water supply for agriculture on the whole is expected to decrease, there are increasing concerns for the level of water management necessary to intensify agricultural production. The construction of small dams is particularly important for coping with water control. Overall, increased infrastructure and capacity-building for the use and maintenance of water management systems will be required. Other water-harvesting techniques may alleviate stress in the near term.

An increase in livelihoods option has been observed as agriculture is becoming less able to sustain human needs. These generally are husbandry, off-farm enterprises and handcrafts. Most of these options require strong market linkages, micro-financing and technical capacity-building in order to be viable. For example, improved and expanded husbandry will require increased access to veterinary services. Nyamadzawo et al. (2015) and Nhemachena et al. (2015) acknowledged the importance of mobilising resources for upscaling known, tried and tested technologies for climate change adaptation. This also calls for collective support from government, business and civil society to enhance the adaptive capacity of rural communities. Evidence from Maddison (2006) on 11 African countries indicates that even if farmers accurately perceive climate change, some may still fail to adapt optimally because of markets and budgetary resources, among other factors. This shows the importance of ensuring that rural communities have the means and resources to implement the various potential optimal adaptation strategies at their disposal to address current and expected climate change in their livelihoods. Appropriate institutional frameworks for management of natural resources in areas that are vulnerable to extreme climate events are therefore required to enhance meaningful adaptation (Joshua et al. 2016). The need for such institutional analysis to understand the contexts for climate change adaptation was highlighted by Taruvinga, Visser and Zhou, (2016). Their study contacted in Eastern Cape province of South Africa revealed several socio-economic and institutional factors as drivers of adaptation and an adaptation portfolio diversity worth targeting to promote the capacity of smallholder to cope with climate change. There is need for policy practise that help farmers from traditional conventional production systems and reap the benefits of climate smart agriculture (Mapanje, O. et.al 2021).

Conclusion and recommendations

The specific impacts of climate change on the rural populations of Buhera, Zimbabwe are many, however it appears that the ultimate result will be a reduction in food security, negative effects on human and livestock health, water availability, the socio-economic context, and incomes. It is also evident that food insecurity during climate extremes has far reaching impacts that may leave household in a cycle of poverty. A reduction in crop yields implies a reduction in income, which in turn leads to a reduction in farmer's capacity to send children to school and to meet daily livelihood needs. The study concludes that there are variations in manifestations of direct and indirect impacts of climate change owing to differences in the households' and communities' dominant farming systems and potential to diversify. The impacts of climate change will increase the challenge of ongoing poverty alleviation efforts in the country. It will hit hardest those whose livelihoods are more tied to local resource bases and therefore more climate sensitive. Survey findings point to high vulnerability within agriculture-based livelihood systems. This demonstrates the immediate need for an acknowledgement and improved understanding of vulnerabilities so that appropriate adaptation measures can be implemented swiftly. In addition, within these subsistence systems, those groups already marginalised will be at higher risks; special attention should be given to reducing vulnerability amongst women, young children, elderly and the ill or disabled.

It is imperative that support for adaptation is provided immediately and that efforts to develop a strong cross-cutting national adaptation strategy are prioritised. Sectors that address water, food security, health and disaster management must be involved and have a coordinated action plan. Many of the solutions proposed by communities to adapt to climate change are existing intervention activities, therefore in some cases, building up project support for adaptation may simply be a matter of scaling up or reprioritising certain activities. Nyikahadzoi K. (2017) stressed the importance of the need to improve farmer's knowledge on climate change adaptation technologies and access to early warning information in order to improve adaptive capacity.

Impacts of climate change on cultural knowledge are creating both a threat and an opportunity. Smallholder farmers can no longer rely on the wisdom of their ancestors since the structure of seasons has been devalued by climatic

changes. The indigenous knowledge systems have become unpredictable. The effects have posed massive threat to livelihood and food security. While this threatens cultural identity, it also may help convince rural populations of the need to adapt, thereby increasing openness to new agricultural techniques. With perceived delayed and inaccessible agricultural extension services to help farmers, there is need for an integrated approach of the two knowledge systems to obtain acceptable sustainable livelihood practises.

Apart from overwhelmingly negative effects, climate change might also have positive and localised benefits in the context of structural changes in communities. These localised benefits can be capitalised on to improve the livelihoods of farmers in the district. In this regard, there is need to make a transition from conceptualisation of climate change impacts as in the policy framework as inherently negative, to research and policy making with an open-mind that views climate change impacts as an indicator for pursuing and enhancing alternative livelihoods for smallholder farmers.

Acknowledgements

This research was supported by funding from the United Kingdom's Department for International Development (DfID) under the Climate Impacts Research Capacity and Leadership Enhancement (CIRCLE) programme implemented by the African Academy of Sciences and the Association of Commonwealth Universities.

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