International Journal of Development and Sustainability
ISSN: 2186-8662 – www.isdsnet.com/ijds
Volume 5 Number 4 (2016): Pages 187-198
ISDS Article ID: IJDS15021103

Impacts of climate change on rain-fed agriculture in Matope Ward, Mt Darwin District, Zimbabwe

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Abstract

The study aimed at identifying impacts of climate variability and or climate change on rain-fed agriculture in Matope Ward in Mt Darwin district of Zimbabwe. The researcher used a mixed methods approach with the aim of gathering a deep understanding of the perceptions of smallholder farmers on impacts of climate change and or climate variability on their framing practices. Residents of Matope Ward perceive changes in rainfall and temperatures based on daily experiences, as noted in the study. The phenomenon of climate change is generally associated with rising temperatures and late onset of rains accompanied by shorter rain season lengths. Empirical analysis of rainfall for the period between the years 1920 to 1980, suggested an overall decline in rains. The researcher recommends education for farmers on climate change with a major focus on the issues pertaining to the design of context specific adaptation strategies, which take into cognizance existing local level knowledge to ensure smallholder farmers make informed on-farm investments.

Keywords: Climate Change, Small Holder Farmers, Livelihoods, Perception

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Cite this article as: Kanyepi, T. and Tanyanyiwa, V.I. (2016), "Impacts of climate change on rain-fed agriculture in Matope Ward, Mt Darwin District, Zimbabwe", *International Journal of Development and Sustainability*, Vol. 5 No. 4, pp. 187-198.

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1. Background to Study

Climate change is a reality. It has arisen as a critical development issue with predicted impacts on biodiversity, rural livelihoods, national and global economies (Carlson and Shumba, 2011). Mitchell and Tanner (2006) argue that Climate change threatens the progress in poverty and achievement of the Millennium Development Goals (MDGs). The climate change impacts are likely to accentuate the existing shocks and stresses faced by many communities in developing countries.

There is consensus in literature that Africa is one of the most vulnerable regions in the world due to widespread poverty, limited coping capacity and its highly variable climate (Carlson and Shumba, 2011; Madzwamise, 2010). Agriculture is the backbone of national economies of the Southern African Region, with at least 65% of their citizens living in rural areas and relying on rain fed agriculture and natural resources such as grazing land and fuel wood for survival (Gwimbi, 2009).

IPCC (2007) projects increased water stress accompanied by decreases in yields from rain-fed agriculture and likely increased food insecurity and malnutrition in arid and semi-arid lands. The country, Zimbabwe is highly dependent on the production and export of agricultural goods such as tobacco and cotton which contributes approximately 14% to the Gross Domestic Product and 60% of its raw materials to manufacturing sector (Chagutah, 2010). Agriculture's sensitivity to climate-induced water stress is likely to intensify problems of declining agricultural productivity, economic productivity, poverty and food security (Carlson and Shumba, 2011). Smallholder farmers account for almost 62% of the rural communities in the country, inhabiting some of the most vulnerable and marginal landscapes (Carlson and Shumba, 2011). Mudimu (2008) argues that extreme weather events such as tropical cyclones and droughts have increased in frequency and intensity) in the country.

In the rural communities where 62% of the population resides, smallholder families thrive on rain fed agriculture and livestock rearing as main source of income for their livelihood. Subsistence livelihoods have evolved a number of coping strategies to manage weather variability including drought years and low crop yields. However experience has shown that identified adaptation measures do not necessarily translate into changes. There is need for dire comprehension of local dimensions of climate change which are essential in mitigating adverse climate change impacts. This study seeks to identify impacts of climate variability and or climate change on rain-fed agriculture in Matope Ward in Mt Darwin district of Zimbabwe

1.1. Process of climate change and effect on agriculture

Human activities such as burning of fossil fuels such as oil, coal and petroleum, agriculture and deforestation have led to the warming of the earth's atmosphere driven by greenhouse gas (GHG) emissions from these activities (Carlson and Shumba, 2011). Climate change is driven by greenhouse gas emissions from energy use, agriculture and deforestation (Nordhaus, 2006). Chipindu et al. (2012) postulates that increased greenhouse gas emissions from human activities over the past 60 years, have caused increases in global average temperatures. The agricultural and industrial chemicals include nitrous oxide particularly from use of fertilizers, methane from paddy rice production, also lead to build up of greenhouse gases such as carbon

dioxide as well as water vapour, which all trap heat in the atmosphere causing global warming (Nordhaus, 2006).

Agriculture plays a dual role in climate change, on the one hand, climate change affects agriculture and on the other hand, agriculture also affects climate change. Agriculture is a significant contributor to global GHG emissions. The agricultural sector directly contributes 14 % of total GHG emissions. The main sources are nitrous oxide, particularly from use of fertilizers, methane from paddy rice production, and methane and ammonia from livestock keeping and manure management. However, the agricultural sector is already threatened by existing stresses such as the limited availability of water resources, land degradation, biodiversity loss and air pollution, so climate change will thus make already sensitive systems even more vulnerable (Mitchell and Tanner, 2008). Agricultural yields and livelihoods will also be affected by climate-related impacts on the quantity and quality of water resources.

Seasonal changes in rainfall and temperature are already having an impact on agro-climatic conditions, growing seasons, planting and harvesting calendars as well as on pest, weed and disease populations. In particularly affected areas, this will lead to crop failure and loss of livestock, which in turn increases livelihood insecurity and the likelihood of out-migration and possibly dependency on food aid (IPCC, 2007). Climate change affects agricultural production through influencing temperature, precipitation, and solar-radiation, soil characteristics among other things which are all direct or indirect inputs for production. Climate change is likely to produce various socio-economic consequences by affecting price of agricultural products, consumer welfare, and number of persons at risk of hunger or food security, water and land market, production pattern of countries and comparative advantage and trade structure (Gbetibouo, 2006).

2. Study area: Matope Ward

The study area Matope Ward 24 of Mt Dawin District is located in one of the seven districts located in Mashonaland Central province of Zimbabwe. The study area's locational co-ordinates is Latitude 16 47' Longitude 31 35'. It is located approximately 155km from the capital city of Harare. Matope Ward consists of three villages namely Chiunye, Mutondwe and Chatumbama, which all lie on the north- eastern side of Mt Darwin District town business centre. The study focuses on Chiunye and Mutondwe villages.

Matope Ward is located within an agro-ecological zone, which receives an annual total rainfall that ranges between 550 and 700mm, with an annual temperature range from 25 degrees Celsius to 36 degrees Celsius C. It is classified under region 3 of the agro-ecological classification system. Most of the agricultural production is rain-fed with a few selected smallholder farmers incorporated into an irrigation scheme. The total population of the Mt Darwin district is 211, 919 people.

The Ward has an irrigation scheme named Mutondwe irrigation scheme, an eleven-hectare scheme which engages an average of twenty farmers and is the sole irrigation scheme in Matope Ward. The study area has an electrified business centre and lacks a police station, clinic, post office and a GMB depot. Mutondwe village is the sole village with a high school in the Ward, and it offers A level secondary school. There are 12 NGO's

operating in the whole district of Mt Darwin District specializing in water and sanitation, OV support schemes, education and behavioural change.

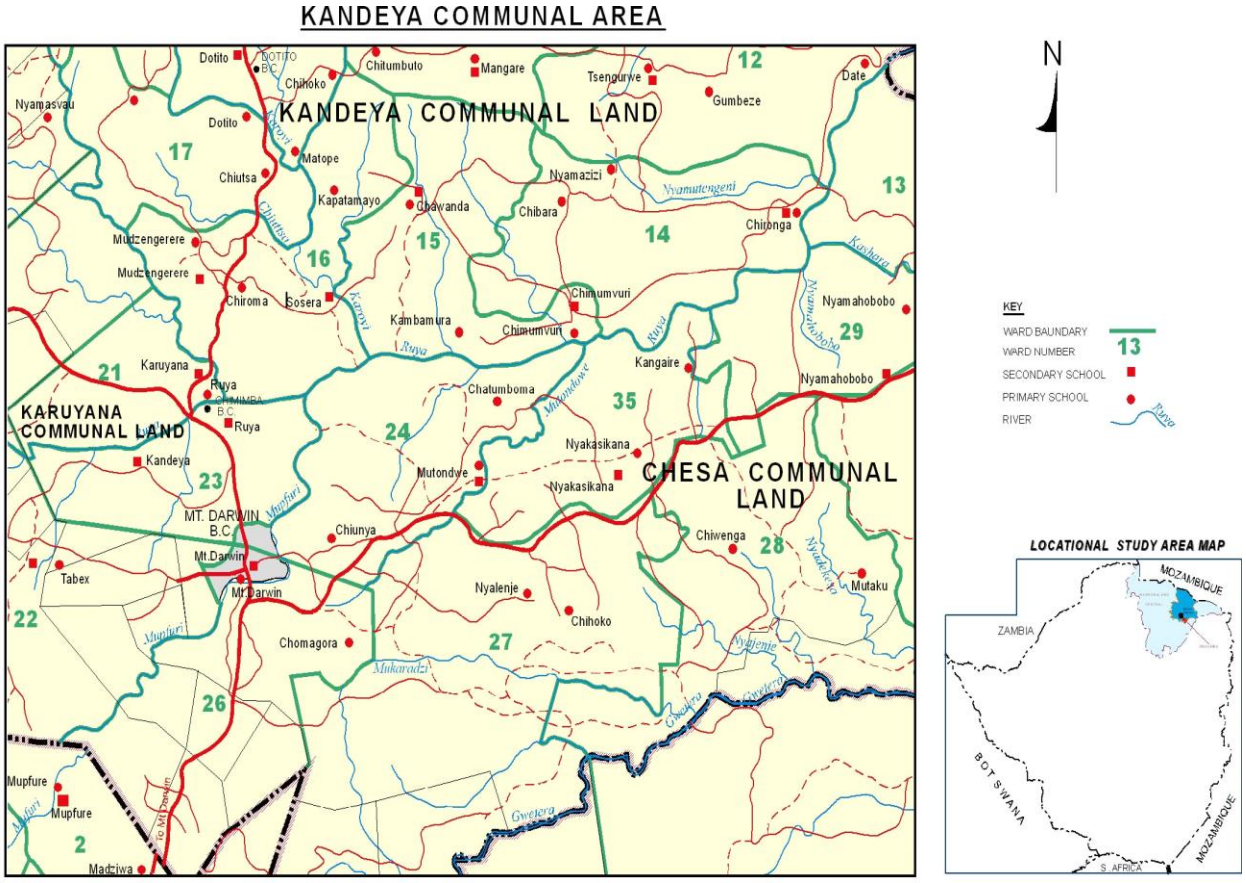

Figure 1. Study Area: Matope Ward

3. Research methodology

The researcher used a mixed method design, which enabled the researcher to obtain complementary quantitative and qualitative data for the same topic, thereby bringing together the strengths of the two distinct methods. The researcher used the strengths of the quantitative method to trace rainfall trends and deduce the relationships. In addition, comparisons between different years in terms of the rainfall amounts received over the past eighty years were able to be evaluated. The qualitative method aspect of the mixed method design aided by elucidating strength of sensitivity to meaning and context for the examination of impacts of climate change to rain-fed agriculture. The merging of quantitative and qualitative allowed for the complementary strengths and also the compensation of the designs' weaknesses. Therefore the combination yielded more validity and reliability than using either method on its own.

3.1. Target Population

The researcher used a sample population which comprised of villagers of Mutondwe and Chiunye villages of Mt Darwin. A random sample of twenty-one households were selected in each of the three villages and questionnaires administered. The researcher made use of key informants such as the village Headmen, meteorological officer, agricultural extension officer and non-governmental representatives. Purposive sampling was also used to select interviewees depending on their role in society to ensure they would elicit their views on climate change and effects of water stress to the community. The research instruments used in this study include a survey questionnaire, depth interview guide, focus group discussion and observation guide were chosen instruments for an in depth understanding and analysis of perceptions of smallholder farmers on climate change adaptation.

3.2. Data collection

The researcher distributed questionnaires to forty-two respondents in Mutondwe and Chiunye village. The administering of the questionnaires was done in person by the researcher whilst at other households the researcher had to drop off and collect on a later date. Maximum supervision of questionnaires' completion by the researcher team enabled 85% questionnaire return. Interviews were carried out during weekdays for the employed interviewees with the Headmen available mostly at the weekends. The focus group discussion was held in Chiunye village with twenty five members in attendance.

4. Results and discussion

4.1. Climate change awareness

The researcher had forty respondents, out of the total number questioned, 55% of the respondents admitted to being aware of alterations in weather patterns in their locality whilst 30% revealed that they were not aware of any weather pattern alterations. The remaining 15% of the respondents professed ignorance on climate change. This information is illustrated in Figure 2.

4.2. Farming systems in Matope Ward

Matope Ward residents are mainly smallholder farmers who depend on livestock rearing and rain-dependent farming. They also cultivate crops on individually owned plots and cattle grazed on communal land. Most household heads have at least basic education or primary schooling, with the larger proportion of the household heads being males. However, there is a contrast between the two villages Mutondwe and Chiunye with the former having a larger proportion of household heads that have secondary education in comparison to the latter. A probable reason for this difference could be accounted to the presence of a secondary school in Mutondwe village unlike in Chiunye that lacks one. There is a wide scale tree felling as farmers seek to create farmland and fuel wood for daily use.

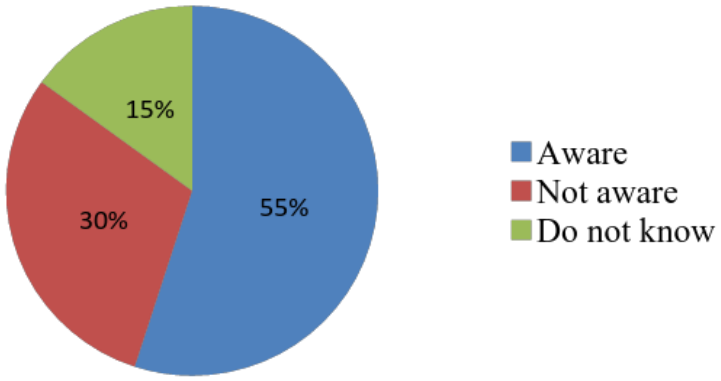

Figure 2. Climate change awareness in the study area

Many households in Chiunye village own very few cattle which delays the process of land preparation as the cattle are an important source of draught power in their farming. Maize stalks are used as a pertinent source of cattle feed during dry season. Most farmers have resorted to selling livestock and barter trade during successive drought years, which has led to a decline in cattle numbers as lamented by most farmers at the dip tank. As a measure to safewguard this reduction in livestock numbers, many farmers are rearing chickens and goats to try and supplement diet and these livestock species can be readily sold for cash.

The smallholder farmers in the study area grow a wide variety of crops with the main crops grown being maize, groundnuts, tobacco, tomatoes and sorghum as illustrated in Figure 3. Generally, there is a bias towards food sufficiency in the crop choices grown although there is also significant cash cropping of tobacco in the two villages.

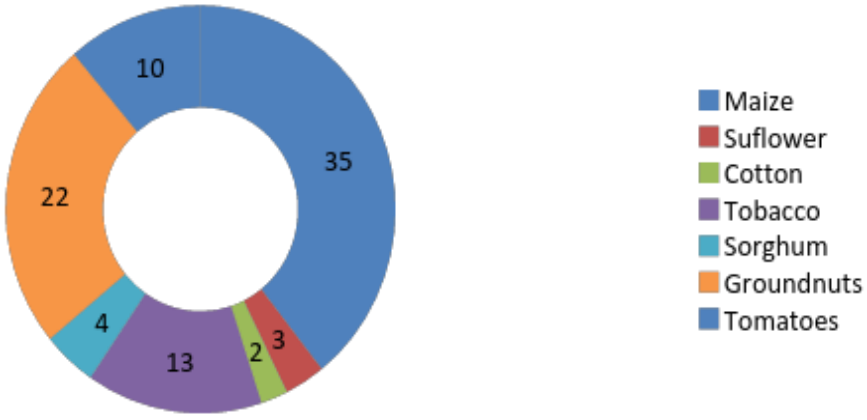

Figure 3. Major types of crop growth in Matope Ward

4.3. Rainfall trends in Mt Darwin District

The researcher made use of rainfall time series so as to clearly analyse the rainfall patterns in Mt Darwin District for the past 100 years. The time series elucidated that the frequency of low rainfall total years had increased as shown in Figure 4. The researcher further drew up an empirical analysis using climate rolling graphs for the study area which further evidence the increase in the frequency of years with low rainfall total. Tracing the yearly rainfall total for the month of January for the past one hundred years , reflected a gradual decrease in monthly rainfall total since year 1901 to year 2008.This decrease is illustrated in the form of a trend line in Figure 5 .

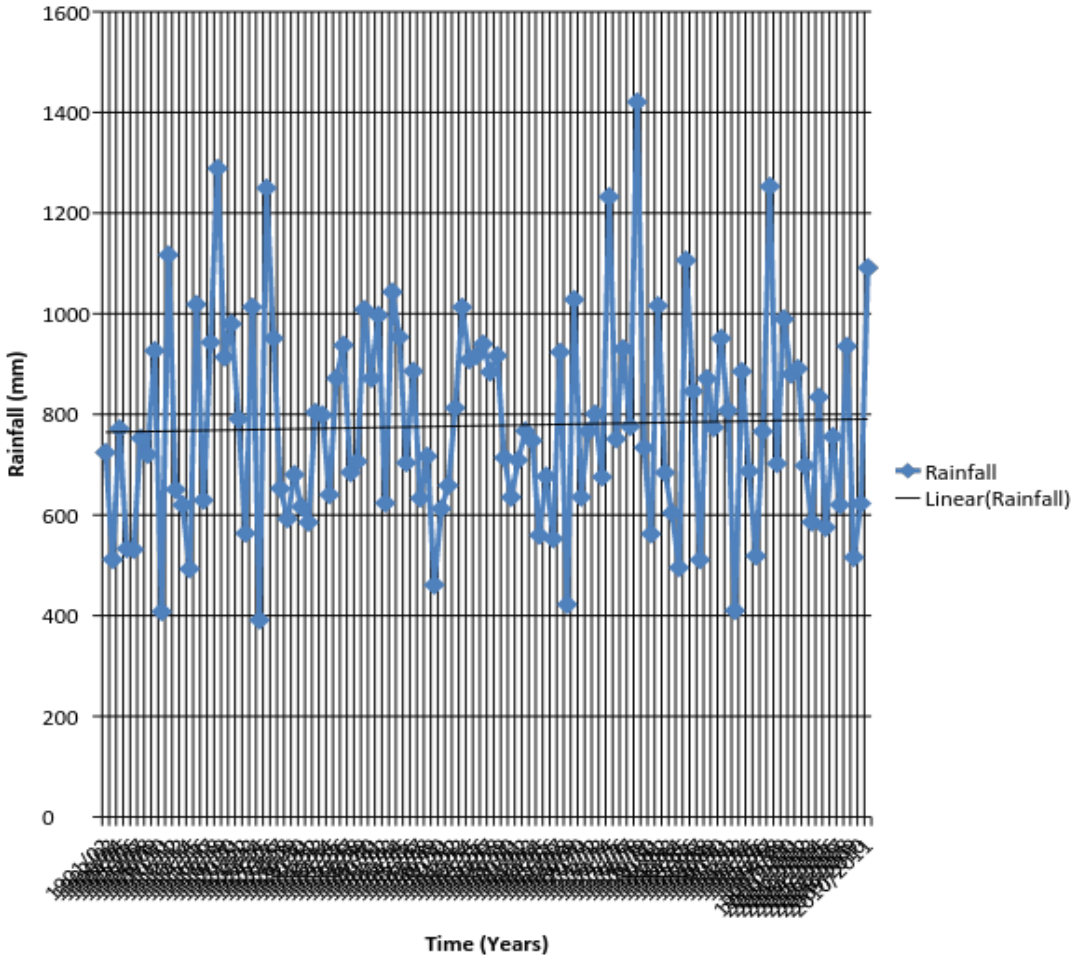

Figure 4. Rainfall trends for Mt Darwin District

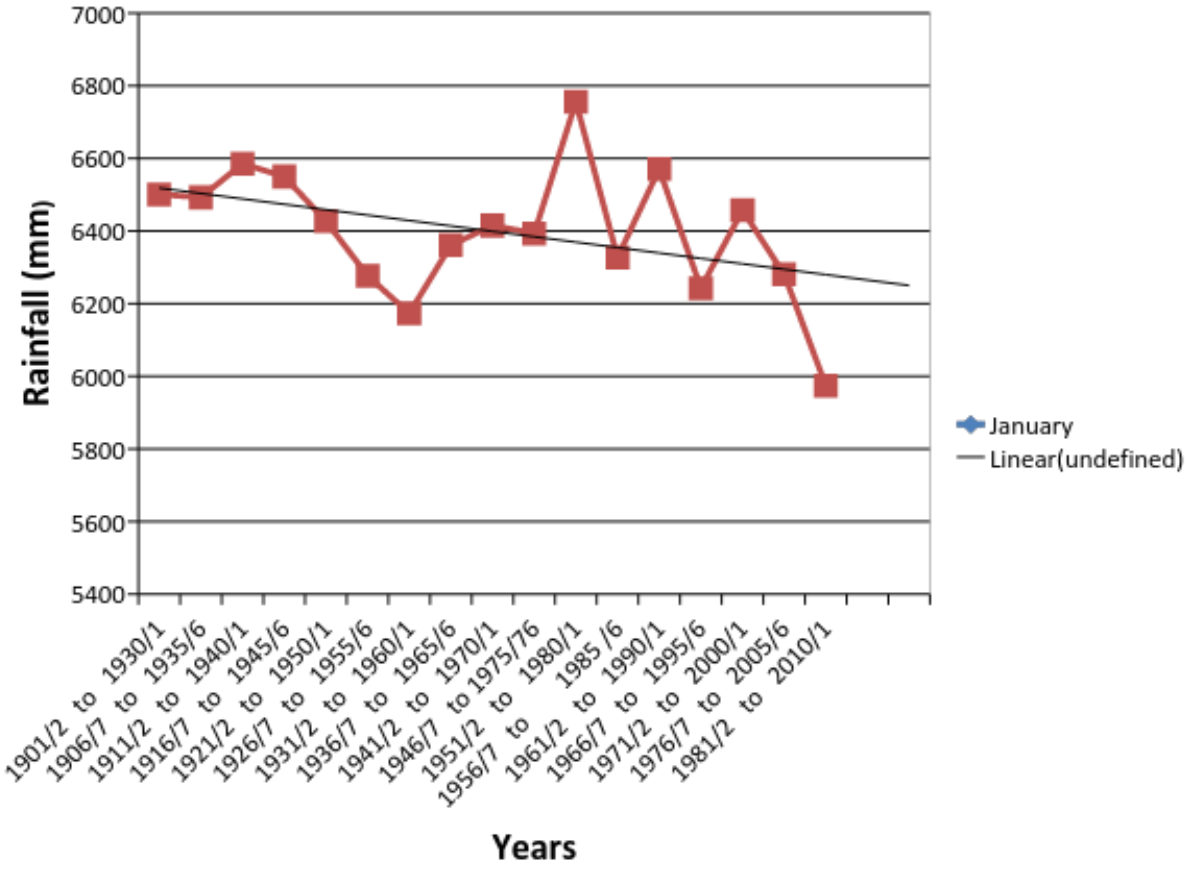

Figure 5. Climate rolling average for Mt Darwin District

4.4. Farmers' perceptions on climate change

The smallholder farmers in Mutondwe and Chiunye villages revealed a fair comprehension of climate change. Thirty percent of the respondents professed that there was no alteration to the climate, whilst ninety percent deemed that there was an alteration to the climate, with the issue of late onset of rains as their most valuable indicator. They also reflected that the general uneven distribution of the rains was another indicator of a difference in the climate pattern. The sentiments of the farmers on climate change were recorded as displayed in Table 1.

4.5. Impacts of climate change in Matope Ward

4.5.1. Food availability

To ascertain the effects of climate change on the farmers' livelihoods, respondents were asked how the indicated weather pattern changes have affected their lives in their locality. Ninety percent of the farmers during the focus discussion were in agreement that climate change causes reduction in yields and hence

culminates in food insecurity in their locality. Fifteen farmers revealed that that climate change leads to the death of livestock due to successive drought years in the study area. Eighty-three percent of the respondents indicated that pests and diseases have hard hit their crops and livestock. All these effects have a direct bearing on food production, availability and accessibility which culminates in poverty.

The 2010/11 rain season brought about both negative and positive significant impacts. The positives included better pastures for livestock and increased ground water recharge for the aquifers guaranteeing better water levels. Many farmers lamented on issue of reduced maize yields since 2008 and with an average household of 4.9 people and a maize area of 0.4ha/household it is difficult to achieve food self-sufficiency in the study area unless crop yields are substantially increased. There has been a general decrease in average rainfall and maize yields in Matope ward over the years as related by meteorological records and the farmers views respectively. However other factors such as issues of the hybrid seed and compatibility of the soil type and rainfall characteristics of Matope Ward may be contributory factors to crop yield decline.

Table 1. Farmers' perceptions on climate change

% farmers	In what way is climate changing?
30	Not changing at all
38	Less overall rainfall
55	Frequent droughts
62	Higher temperatures
90	Late start of rainfall season
65	Uneven rainfall distribution

4.5.2. Food availability

A widower farmer and member of Mwando women's club noted that there was a change in the rain patterns which has affected farmers negatively. She exclaimed that there was hunger in the area as a result of a poor rain season coupled with pests that attacked maize and groundnuts. The 2010/11 rain season brought about

both negative and positive significant impacts. The positives included better pastures for livestock and increased ground water recharge for the aquifers guaranteeing better water levels. Also communities in the area who rely on fish as a source of food and income had increased incomes that season. Echoing the words of others, Basikiti another member of Mutondwe irrigation scheme agreed that fish production has decreased over the past years as a result of water level variations.

4.5.3. Increased pests and diseases

Climate change has brought with it increase of pests and diseases. Food is not only determined by crop production, it involves livestock rearing in the provision of a healthy nutritious food both directly and indirectly. Climate change also affects the quantity and quality of livestock feed such as pasture, forage, grain and distribution and severity of livestock diseases and quantity of parasites (McCarthy et al, 2001). Eighty percent of the respondents indicated that most livestock has perished during the 2008-2012 period mainly due to erratic rainfall patterns which has led to loss of pasture lands for the livestock. Furthermore an increased insurgence of pests and diseases has not spared our livestock.

In addition, seventy percent of the farmers highlighted that they experienced food shortages between October and March after grain from the previous harvest runs out and the current crop is harvested. Eighty percent of the farmers admitted that they sold their livestock in exchange for buckets of maize which has reduced draught power in the area.

4.5.4. Loss of income

Ninety percent of the farmers in Mutondwe irrigation scheme depend on the income they gain from crop harvests sold to send their children to school and buy inputs for next farming seasons. The tobacco farmers engaged in dryland farming in Chiunye village lamented that the erratic rains have left them without a plan, in 2008 even though they had clear signs of a drought and prepared for the worst, the temperatures were very high and seemed to cause the rain water to quickly evaporate no matter how heavy the rains.

Sixty-five percent of the respondents during the focus group discussion, indicated that the temperatures are higher and make it difficult for one to work in the field in the afternoon and they have spent two months, December and January planting and replanting the seed. This was further emphasized by a meteorological officer, that the rainfall and temperature recordings for the study area have altered and it now assumes the trends for region four signifying that some regions have shifted as argued by recent studies that the acclaimed demarcated boundaries may be shifting.

4.6. Biophysical impacts of climate change

4.6.1. Water and wild fruits scarcity

Eighty percent of the respondents noted decreases in production of wild fruits in the area indicating wild fruits such as tsambatsi and tsenza, madzonga and sika as almost scarce in the area. These fruits are used as traditional forecasting indicators of rainfall seasons by village elders in the villages. Women during the focus

group discussion lamented that the boreholes in their area are very few as one of villagers indicated that they had to walk six kilometers to Goho village to fetch firewood and four kilometers to fetch water in Kapfudza village after the rain season ends, while other women sitting next to her kept nodding their heads in agreement.

5. Conclusion

The smallholder farmers in Matope Ward revealed a fair l comprehension of climate change. Most of the smallholder farmers engage in livestock rearing and mainly rain-fed cropping. This dependence of this form of livelihood entails that any adverse alteration of the rainfall patterns is of detrimental consequences on their livelihoods. Through the use of empirical rainfall time series and climate rolling graphs to analyse the rainfall pattern for the past 100 years, the study revealed a increase in frequency of years recording low rainfall totals. This further supports the notion lamented by the smallholder farmers through observations and their perceptions and places their perceptions and scientific evidence in consensus.

Impacts of climate change include food insecurity, water scarcity, loss of income and increase in pests and diseases in the study area. Many farmers lamented on issue of reduced maize yields since 2008 and with an average household of 4.9 people and a maize area of 0.4ha/household it is difficult to achieve food self-sufficiency in the study area unless crop yields are substantially increased. There has been a general decrease in average rainfall and maize yields in Matope Ward over the years as related by meteorological records and the farmers views respectively.

Most farmers of the households in the study area engage in off-farm employment as a measure to bridge the food shortages they experience mainly between the months of October and March. However other factors such as issues of the hybrid seed and compatibility of the soil type and rainfall characteristics of Matope Ward may be contributory factors to crop yield decline.Increased food insecurity may also be due to increased population pressure on resources as supported by the observed increased scarcity of wild fruits as compared to the past.

This may have been further aggravated by mismanagement of available water resources in the area since the use of common pool of resources. The complication of rural life cannot be properly understood through a single theoretical viewpoint as perception varies with the socioeconomic, cultural, gender, environmental and historical context and to some extent personal experiences of the risks. For example, although climate change has determined the change in agricultural practices in Matope Ward, however this change has also been due to issue of underdeveloped value chains for certain crops or due to poor commodity pricing structure by GMB. Furthermore although climate change has resulted in water sources scarcity challenges, at household level this may also be due to poor water management practices.

5.1. Recommendations

In light of the above conclusions, the study recommends that there should be set up incentives to educate farmers and other relevant stakeholders on climate change and its potential impacts on farmers' livelihoods.

In addition there is need for heavy utilization of irrigation as an alternative to reduce the heavy reliance on rain-fed production. This initiative must also be backed by irrigation equipment and also comprehensive farmer education programmes on climate adaptation mechanism at local scale.

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