DROUGHT TRENDS AND THEIR IMPACTS ON NATURAL RESOURCES
UTILISATION IN THE MIDDLE ZAMBEZI VALLEY FROM 1970 TO 2016– THE
CASE OF MT DARWIN DISTRICT

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A Dissertation submitted to the Department of Geography, Faculty of Science Bindura University of Science Education, in partial fulfillment of the requirements for the Degree of Master of Science in Natural Resources Management and Environmental Sustainability

OCTOBER 2016
Approval Form

I, the undersigned certify that I have read this thesis and have approved its submission to the Department of Geography for marking after confirming that it conforms to the Department’s Academic requirements.

Name of supervisor: Professor Jephias Mapuva

Signature: .........................................................

Date: .................................................................
Declaration

I, Guwah Lynn the undersigned candidate, declare that the content of this thesis is my original work and has not been previously submitted to any other University for an award of a degree either in part or in its entirety.

Signature: ………………………………………………………………

Date: ………………………………………………………………
Dedication

This thesis is dedicated to my soulmate Caleb, and our children Kelly and Regis Jnr.
Acknowledgements

I would like to thank my supervisor, the late Dr. Ignatius Mberengwa for steering and guiding the initial course of my studies. To Professor Jephias Mapuva thank you for the important assistance and guidance that you gave me. My most sincere gratitude goes to my rainbow family. Thank you for everything: your time, your support and your commitment, all of which are invaluable. To my mom, Mrs M. Guwah, thank you for holding the torch of inspiration that my late father Mr C. T. Guwah, began. Thank you.

To my sisters Karen and Tendai, when I was weary, thank you for giving me hope that I will complete the study. To my grandma, Mrs Matsikidze, thank you for your listening ear.

My profound gratitude also goes to the numerous key informants interviewed during the process of this research for taking time to respond to questions and allowing me the opportunity to understand the situation on the ground. This study was partly possible because of the valuable information they provided.
Abstract

The study sought to establish drought trends and their impacts on natural resource utilisation in the Middle Zambezi Valley in Mt Darwin District. The study used a case study research design. Household questionnaires, focus group discussions, key informants interviews and personal observations were used to collect data for the study. A purposive sampling method was used to select 140 households that were interviewed in this study. The study results revealed that Mt Darwin Valley has high variability in annual rainfall. The findings also revealed that since year 2000 droughts in the district have increased having recorded droughts every two to three years, compared to previous decades when droughts occurred after every 5 to 10 years. The study also showed that communities in Mt Darwin Valley depend mainly on rain fed agriculture and on drought-coping mechanisms that involve natural resource utilization. This has resulted in land degradation, deforestation, river siltation and reduced biodiversity. Furthermore, the study revealed that there are institutions with the technical capacity to manage droughts but the existing structures address human vulnerability to drought and do not take cognizance of the environment’s vulnerability to drought. This study therefore recommends that comprehensive policies on drought and climate change be developed with a focus to mitigate the impacts of droughts and other extreme weather events on natural resources in the Middle Zambezi Valley.
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<tr>
<td>Agritex</td>
<td>Agricultural Technical and Extension Services</td>
</tr>
<tr>
<td>AEW</td>
<td>Agritex Extension Worker</td>
</tr>
<tr>
<td>EMA</td>
<td>Environmental Management Agency</td>
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<td>KIIIs</td>
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<td>LPD</td>
<td>Livestock Production Department</td>
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<td>NGOs</td>
<td>Non-Governmental Organisations</td>
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<td>NTFPs</td>
<td>Non-Timber Forest Products</td>
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<td>PRDC</td>
<td>Pfura Rural District Council</td>
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<td>SPSS</td>
<td>Statistical Package for the Social Sciences</td>
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<td>SSA</td>
<td>Sub-Saharan Africa</td>
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<td>Vet</td>
<td>Veterinary Services</td>
</tr>
<tr>
<td>ZimStat</td>
<td>Zimbabwe National Statistics Agency</td>
</tr>
<tr>
<td>ZimVac</td>
<td>Zimbabwe Vulnerability Assessment Committee</td>
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CHAPTER ONE : INTRODUCTION

1.1 Introduction

This chapter highlights the background to the study and statement of the problem pointing out the gap that the study intends to fill. The significance of the study is also brought out. The objectives, delimitations and limitations are identified while the organization of the thesis and the chapter summary are discussed. The research sought to assess drought trends and their impacts on natural resource utilisation by rural communities in the Middle Zambezi Valley. The study was carried out in Wards 2, 6 and 33 in Mt Darwin District. Drought trends from the global level to the local level were explored. Droughts cause social, economic, environmental and political impacts. The impacts have a direct and negative bearing on the environment since communities increase their use of natural resources as coping strategies, at the expense of the environment.

1.2 Background to the Study

Available data has shown that drought is expected to increase in frequency and severity in the future as a result of climate change, mainly as a consequence of decreases in regional precipitation (Sheffield et al., 2012). In the past five decades, drought has become a major problem of Africa and it has caused depletion of assets and environmental degradation (Shiferaw et al., 2014). This is supported by the Intergovernmental Panel on Climate Change’s (IPCC) reports of 2001, 2007, and 2012, as cited in Brown et al (2012) which suggest that Africa will witness intensified water problems, diminished crop production from dryland farming, exacerbated food shortages and increased nutritional diseases and land aridity. This is because Africa has shown that it is more vulnerable to erratic weather patterns, which are a symptom of climate change. To this effect the IPCC (2012) report suggests that droughts in Southern Africa
will intensify.

The impacts of drought are among the most costly events and processes in Africa. The widespread poverty and the fact that a large share of Africa’s economies depend on climate-sensitive sectors mainly rain fed agriculture, poor infrastructure, heavy disease burdens, high dependence on and unsustainable exploitation of natural resources, and conflicts, render the continent especially vulnerable to impacts of drought. Droughts account for 80 percent of loss of life and 70 percent of economic losses linked to natural hazards in Sub-Saharan Africa (Shiferaw et al., 2014).

Drought is a chronic problem in sub-Saharan Africa and is the most important factor affecting livelihoods of the people in the region (Wilhite et al., 2000). Thus, the natural resource base that supports smallholder communities currently faces pressure from poor management practices and increasing population pressure amongst other factors (Mapfumo, 2009), and the impacts of climate variability and change will likely further increase the pressure. Coping mechanisms and intervention strategies have focused primarily on protecting agriculture and livestock production and have underscored the natural resource base. This has seen an indirect and unforeseen increase in pressure on the already fragile natural resources (Feresu, 2010), which is a threat to environmental sustainability.

Communities in Zimbabwe have experienced major climatic events which included the prominent droughts of 1991-1992, 1994-1995, 1997-1998 (Dilley, 2000), and the El-Niño that resulted in the more recent droughts of 2002. Droughts create new burdens for those communities that are already poor and vulnerable. For instance in the 1991-1992 drought, the income of poor rural communities in Zimbabwe dropped by 50 percent (Kanbur et al., 2000). The
rainfall in the Zambezi Valley is highly seasonal (90% occurring between November and March), often with a mid-season dry spell that occurs during critical periods of crop growth. Precipitation typically occurs on a number of isolated days and locations, seldom exceeding 50 rain days per annum (Mavhura et al., 2015).

However, for Mt Darwin there have been changes in the frequency of droughts until previous years when the frequency of occurrence increased to every 2 to 3 years. Since 2002, Mt. Darwin Valley area has experienced recurring droughts which have negatively affected household livelihood patterns. This has forced communities to rely more on the exploitation of natural resources. These activities have a profound impact on the existence, quantity and quality of natural resources. About 70% of Zimbabwe’s population derives its livelihood from subsistence agriculture and other rural activities, but these livelihoods are threatened by droughts. The country is prone to drought which has become more frequent in the past decade (Andear, 2009). Drought is considered by many to be the most complex, but least understood of all natural hazards, affecting more people than any other hazard in socioeconomic terms (Wilhite et al., 2000). It is a creeping phenomenon whose effects accumulate over time before they are felt and lingering on long after the actual event while problems associated with it can have economic, environmental and social impacts (Mushore et al, 2013).

According to the Southern Africa Office for the Coordination of Humanitarian Affairs (OCHA) outlook summary of 2015, El Niño induced droughts have been experienced in 2002/3, 2004/05, 2006/07 2009/10 and 2014/15, showing that the frequency of droughts has increased compared with previous years when droughts were a 10 year cycle phenomenon. Thus this study will assess the impact of droughts on natural resources, their exploitation by communities and future
implications. Drought proofing strategies that take cognisance of natural resources conservation will be identified.

1.3. Statement of the problem

The era of climate change has begun and has been manifested through drought and erratic rainfall patterns among others. Erratic rainfall, increased temperatures and frequency of drought occurrences in Sub-Saharan Africa (SSA) are some of the major factors attributed to effects of climate change and variability. Widespread poverty and the fact that a large share of Africa’s economies depend on climate-sensitive activities mainly agriculture, render the continent especially vulnerable to the impacts of drought. These arguments are supported by several studies (Tiffen, 1995; Vogel, 1995; Fauchereau et al., 2003) that have observed that Southern Africa is one of the regions estimated to be most at risk from droughts. These changes in climate are predicted to reduce crop yields and ecosystem productivity by between 5-25% by the year 2020 in SSA, including Zimbabwe, (IPCC, 2007). Reduction in crop productivity will result in increased pressure on natural resources as communities seek alternative sources of food and income.

Natural resources such as woodlands, rangelands, rivers and springs, have traditionally supported livelihoods of smallholder communities in SSA. With the occurrence of regular droughts, these natural resources have come under threat. Very little focus has been on natural resources and their vulnerability to droughts and the effect of human coping strategies on natural resources. Drought remains one of the most serious threats to the management, sustainable use and equitable sharing of benefits of biodiversity. Damage to the environment has long-term consequences and flow-on effects on economic, political and social structures. Onsite impacts of
drought lead to overall loss of economic and biological productivity. These onsite impacts in turn trigger and contribute to indirect or offsite impacts and as biological and economic productivity deteriorates, communities are forced migrate to other areas or engage in other coping activities that too contribute to biodiversity degradation. Drought affects the richness and diversity of the natural resource base. It is therefore the main aim of this study to establish drought trends and their impacts on natural resource utilisation with specific reference to Mt Darwin District.

1.4 Objectives of the Study

This section considers the general objective of the study and the specific set of objectives. The general objective gives the main focus of the study whilst specific objectives spell out the specific intentions of the research.

1.4.1 General Objective

The general objective of this study is to establish drought trends and their impacts on natural resources utilisation in the Middle Zambezi Valley, in Mt Darwin District of Zimbabwe.

1.4.2 Specific Objectives

The specific objectives of this study are:

1. To establish drought trends in Mt Darwin District
2. To determine the state and extent of natural resource utilisation in the study area
3. To review the current response strategies to the impacts of droughts on natural resources
4. To suggest sustainable strategies to natural resources management

1.5 Research Questions

The persistence of droughts in Mt Darwin District has evoked a number of investigative questions.
1. What are the drought trends in Mt Darwin District over the last 5 decades?
2. What is the state and extent of natural resource utilisation in the study area?
3. What are the current response strategies to the impacts of droughts on natural resources?
4. What are some of the strategies that ensure sustainable natural resources management?

1.6 Significance of the study

The findings of this study are important as they will add on to the existing body of knowledge about drought trends in Zimbabwe in general and Mt Darwin in particular. The findings will fill the gap of knowledge about the impact of recurrent droughts in sensitive and marginal physiogeographic areas such as the Lowveld area under review. Planners and sector ministries will benefit from additional knowledge emanating from this study which may be used as a platform for further research. Furthermore, the study will provide referral material to the academia for further research on climate change and extreme weather events in an attempt to achieve environmental sustainability. Findings from this study will also enable other researchers to replicate the study in the remaining valley wards in Mt Darwin District to assess the impacts of recurrent droughts on natural resource utilisation.

The study is also of significance to communities in Mt Darwin as it will reveal the impact of the cumulative effects of persistent droughts and natural resource exploitation on an already fragile natural resource base on which they depend. Moreover, the study will enable policy makers to make informed decisions about pre-funding drought and appropriate mitigation and adaptation strategies.
1.7 Delimitation of the study

The study is restricted to the Middle Zambezi Valley area in Mt Darwin District in Mashonaland Central Province in the northeast of Zimbabwe, and the period of study is from 1970 to 2016. The period of study was determined by the available climate data from the Meteorological station in Mt Darwin. While the District is prone to other natural disasters, the research focused only on droughts, and though drought impacts are social, economic and environmental, the research concentrated on the environmental impacts.

1.8 Limitations of the Study

The researcher faced some challenges from climate change effects and excessive rains which rendered some wards inaccessible. Furthermore, people are generally more inclined to agricultural drought, crop production and issues of hunger because of the potential benefits that can be derived, thus information to do with natural resources and natural resource protection were often not forthcoming since such issues are often associated with law enforcement and prosecution. Moreover, given that the study area is rural, some of the respondents are illiterate and were unable to read the questionnaires.

1.9 Definition of key terms

Technical terms used in this study have been largely contextual, as such readers need to use them in their context if one is to understand them in a way that suits this study. The following terms are therefore defined as follows:

**Drought:** According to United Nations International Strategy for Disaster Reduction (UNISDR) (2009), a drought is a deficiency of precipitation over an extended period of time, usually a season or more, which results in a water shortage for some activity, group or environmental
sector. Wilhite and Glantz (1985) grouped droughts into four types: meteorological, agricultural, hydrologic, and socio-economic. Meteorological drought is a designated period of time with precipitation less than a specified amount while the availability of moisture at different times in the growing season to meet crops' needs is an agricultural drought. A hydrologic drought refers to a period when stream-flows are unable to supply established users under a given water management system. Socio-economic definitions of drought relate to supply and demand of specific goods. This study mainly uses the meteorological definition of drought which is a situation in which actual rainfall is significantly below the long-term average for the area causing water imbalances that negatively affect land resource systems.

Natural resources: Natural resources refer to renewable and non-renewable resources that can be tangible or non-tangible, such as minerals, climate, soil, water, flora and fauna (Government of Tanzania, 2005). The OECD (2005), defines natural resources as natural assets (raw materials) occurring in nature that can be used for economic production or consumption. This study shall mainly use the OECD definition and will focus on land, forestry, wildlife and water resources.

Environmental degradation: Environmental degradation is the reduction of the capacity of the environment to meet social and ecological objectives, and needs (UNISDR, 2009). According to Tyagi (2014), environmental degradation may be defined as any change or disturbance to the environment perceived to be deleterious or undesirable. The study shall use the UNISDR definition.

Vulnerability: Vulnerability is a term that describes the characteristics of populations, activities, or the environment that make them susceptible to the effects of drought. The degree of vulnerability depends on the environmental and social characteristics of the region and is
measured by the ability to anticipate, cope with, resist, and recover from drought (IPCC, 2007). Wisner et al. (2004: 11) defined vulnerability as the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard (an extreme natural event or process). The study shall apply both definitions as they are relevant to the study.

**Poverty:** Poverty is when income and resources (material, cultural and social) are so inadequate as to preclude them from having a standard of living which is regarded as acceptable (Government of Ireland, 2007). However, frequently poverty is defined in either relative or absolute terms. Absolute poverty measures poverty in relation to the amount of money necessary to meet basic needs such as food, clothing and shelter. Relative poverty defines poverty in relation to the economic status of other members of the society. Extreme poverty is set to the possession of less than $1 a day (Smelser and Baltes, 2001). The study shall apply both the Smelser and Baltes definition since it is broader in scope.

**1.10 Organisation of the Study**

The study is divided into five chapters comprising different content.

**The first Chapter** provides a general introduction and background that describes drought trends from a global perspective to the local level. The impacts of droughts are explored and these include increased land aridity, intensified water problems and widespread poverty. The chapter outlines the objectives of the study and the rationale for conducting the study. Chapter one also presents the study area under investigation as well as the limitations to the study.

In **the second Chapter** the concept of climate change, El Nino and the drought phenomenon are explored. The inherent challenges related to drought occurrences from an international and
regional perspective are discussed. The conceptual frameworks to be used in the study are explained and research works on droughts in the region and in Zimbabwe are also explored.

**The third Chapter** consists of the methodology. It highlights the strategies and procedures used for acquiring and analyzing data. This chapter also highlights the analytical framework, its development and intentions and processes for analysis. The chapter also explains why certain methods like questionnaires, interviews with key informants, focus group discussions and surveys are used by the researcher in this study amongst other things. The chapter describes the location of Mt Darwin Valley area and the bio-physical and socio-economic characteristics of the study area.

In the fourth Chapter collected data is analysed and the research results are presented and discussed. Implications of the results as well their limitations are also highlighted in this chapter.

**The fifth Chapter** provides a summary of the main findings and conclusions drawn from this study. Key recommendations that seek to tackle the challenges of natural resources management are presented for adoption. Finally a general conclusion is made based on the findings and recommendations.

**1.11 Chapter Summary**

This chapter explored drought trends at the global, regional and local levels. The impacts of drought appear to be increasing in both developing and developed countries, a clear sign of unsustainable resource use and growing pressures on natural resources. The chapter also spelt out the problem statement and significance of the study. Research questions and objectives that
guided the research were also discussed with the definition of key terms and the organisation of
the study concluding the chapter. The next chapter focuses on literature review.
CHAPTER TWO : LITERATURE REVIEW

2.1 Introduction

This chapter explores relevant literature around major aspects of climate change, notably droughts. The research therefore seeks to assess drought trends, their impacts and natural resource utilisation with specific reference to Wards 2, 6 and 33 in Mt Darwin District from 1970 to 2016. A literature review surveys books, scholarly articles, and any other sources relevant to a particular issue, area of research, or theory, and by so doing, provides a description, summary, and critical evaluation of these works in relation to the research problem being investigated (Fink, 2014). As such, literature relevant to the research study was reviewed to substantiate the problem perceived.

2.2 Interrogating the concept of Climate Change: A global perspective

Climate change and variability is increasingly emerging as one of the most serious global challenges. It is projected to compromise agricultural production, especially in smallholder systems as prevalent in Africa (Muller et. al., 2011). The climate of Southern Africa is highly variable and unpredictable and the region is prone to extreme weather conditions like droughts (Kinuthia1997 in Nhemachena and Hassan 2007). The region is becoming drier and experience more extreme weather events such as droughts. Researches carried out have proved that there is evidence of climate change and variability in Zimbabwe. However research has shown that human activity is the major contributor to climate change. Although there are several climate change definitions available, one factor that they have in common is, the fact that there is a change in the climate (Bongo et al., 2015).
Projections of future climate patterns are based on computer-based models (General Circulation Models) of the climate system and incorporate important processes of the atmosphere and the oceans as well as the expected growth in greenhouse gases from socio-economic scenarios (UNISDR, 2008) and it is known with certainty that the concentrations of Carbon Dioxide (CO₂), methane (CH₄) and Chlorofluorocarbons (CFCs) have increased as a result of recent human activity (NDMC, 2016). Carbon dioxide is responsible for more than half of the increase. Annual emissions of CO₂ between 1970 and 2004 have increased by about 80% (IPCC, 2007). In 1750, levels of CO₂ were around 270 parts per million (ppm). By 2005, these levels were up to 379 ppm, and the 10-year rate of growth in concentrations, 1.9 ppm per year, was greater than any previous 10-year period in the modern record (IPCC, 2007).

Although there are differences between the General Circulation Models (GCM) projections, the models are in general agreement that, as a result of increasing greenhouse gas concentrations, the current best estimate is that average global temperature will increase 1.8–4.0°C by 2100 (IPCC, 2007). In the past 100 years, the global average surface temperature has increased 0.60°C. This increase by itself is within the normal variability and, although it may be a result of climate change, it cannot be used as definitive proof that recent human activities have caused a global warming. Between 1995 and 2006, however, 11 of the 12 years ranked among the 12 warmest years on record, with records dating back to 1850 (ibid). Over the African continent projected temperature rises ranging from 1.4°C to 5.8°C and for Southern Africa, a warming of 1.7 to 2.5°C is projected by 2050 (Hulme et al., 2001). It is further projected that by 2100, temperature increases for Southern Africa will range between 1.0°C to 3.5°C (IPCC, 2007).
2.2.1 Influence of El Nino - Southern Oscillation (ENSO) factor

ENSO refers to the irregular shifts in the Pacific sea surface temperatures and atmospheric conditions strongly influencing inter-annual rainfall variability in the tropics. It is a natural climate phenomenon in the Pacific with global teleconnections. The ENSO phenomenon has three phases, warm phase (El Niño), cold phase (La Niña) and neutral phase. Mutasa (2010) postulated that droughts in Southern Africa are linked to the El Nino phenomenon. Zyl (2006) had earlier suggested that El Nino and Southern Oscillation (ENSO) events are well documented as the brewers of droughts. The Southern Oscillation (SO) is the atmospheric counterpart of El Nino and El Nino is the oceanic counterpart of Southern Oscillation (Nguyen, 2006). Since El Nino and South Oscillation are related, the two terms are combined into a single phrase, the El Nino – Southern Oscillation (ENSO), (Philander 1990, in Nguyen 2006).

To UNISDR (2009:5) “ENSO is a complex interaction of the tropical Pacific Ocean and the global atmosphere that results in irregularly occurring episodes of changed ocean and weather patterns in many parts of the world, often with significant impacts over many months, such as altered marine habitats, rainfall changes, floods, droughts, and changes in storm patterns”. Therefore El Nino causes drought in such a way that during their occurrence, the oceanic currents becomes warm and persistent causing reversal of normal weather conditions. In the same thought the shift of SO is linked with prevalent reduction of sea surface temperatures which leads to the displacement of the Inter – Tropical Convergence Zone (ITCZ), (Zyl, 2006). This means that areas which depend on ITCZ rainfalls are likely to experience drought if the ITCZ is displaced.
Most Zimbabwean droughts have been linked to El Nino and El Lana is regarded as the opposite of El Nino which restores the adversarial conditions. Equally so, the devastating droughts of 1875-1876 (northern China), 1877-1878 (Brazil, India and Morocco) and 1888-1889 (Russia, Korea and Ethiopia), for example, were linked to El Niño effects (Wisner, et al., 2004), while the phenomenon was blamed for the 1992 drought in southern Africa (Chenje and Johnson, 1994).

2.2.2 Exploring the prevalence and impacts of droughts: A global perspective

Despite the devastating impacts of droughts the world lacks an exact and standardized drought definition (Ndlovu, 2011). Mutasa (2010) concurs, as the author further argues that there is lack of a single, universal and acceptable definition for the word drought. This absence of a universal definition of drought often causes confusion as to whether droughts are real and their harshness (UNISDR, 2005). However, such diversity is important as it helps to bring clarity. There are four perspectives on drought: meteorological, agricultural, hydrological and socioeconomic. Meteorological drought is usually defined by the measure of the departure of precipitation from the normal and the duration of the dry period. Agricultural definitions refer to situations in which the moisture in the soil is no longer sufficient to meet the needs of the crops growing in the area. Hydrological drought deals with surface and subsurface water supplies (such as stream flow, reservoir/lake levels, ground water). Socio-economic drought refers to the situation that occurs when economic goods associated with the elements of meteorological, agricultural and hydrological drought fail to meet the demand (Bang & Sitango, 2003).

A thorough analysis of the given definitions can allow identification of common features. In this respect there can be varying definitions of a drought but a number of features are commonly found. Almost all drought definitions recognise that:
• Droughts occur when there is a deficiency in precipitation;
• Droughts occur over a certain period of time which maybe short or long;
• A condition of dryness is witnessed during droughts;
• Droughts cut across all – wet or dry – climatic regions;
• Droughts have impacts on the animals, people, economy, vegetation and environment
• A drought is a climatic condition (Warwick, 1975)

Droughts affect more people than any other natural hazard owing to their large scale and long-lasting nature. The decade 2001–2010 saw droughts occur in different parts of the world. Some of the highest-impact and long-term droughts struck Australia (in 2002 and other years), East Africa (2004 and 2005, resulting in widespread loss of life), and the Amazon Basin (2010) with negative environmental impacts (Sivakumar 2013 in Wilhite et al. 2014). Texas, for example, experienced two record droughts in 2011 and 2006, resulting in billions of dollars in economic losses (Damberg and AghaKouchak, 2013). South and Southeast Asian countries such as Bangladesh, Nepal, Bhutan, Cambodia and Lao PDR have also suffered from increasing droughts (Miyan, 2015).

Nangombe (2015) noted that drought occurrences in Zimbabwe have become more frequent between the period 1950 and 2013, with the country having succumbed to the four drought types during that time with varying degrees of intensity. The table below (Table 2.1) highlights major droughts that occurred in Zimbabwe between 1950 and 2013.
Table 2.1: Droughts in Zimbabwe between 1950 and 2013

<table>
<thead>
<tr>
<th>Magnitude</th>
<th>Extreme</th>
<th>Severe</th>
<th>Mild</th>
</tr>
</thead>
<tbody>
<tr>
<td>Socio-economic</td>
<td>2007/08</td>
<td></td>
<td></td>
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</tbody>
</table>

Source: Nangombe (2015)

Table 2.1 shows that the four types of droughts occurred in Zimbabwe between the period 1950 and 2013. The most common droughts are the meteorological and agricultural droughts which recorded extreme, severe and mild occurrences. Socio-economic droughts are the least common while hydrological droughts were only recorded in 3 seasons. Extreme agricultural droughts were recorded in 1972, 1981, 1991 and 2007 seasons. Severe agricultural droughts increased in frequency of occurrence in the 1990s having occurred in 1990, 1993 and 1994. A similar trend is noticeable with meteorological droughts. The general trend that can be therefore be deduced from Nangombe’s study (Table 2.1) of droughts between 1950 and 2013 is that, droughts in general, are increasing in frequency of occurrence in Zimbabwe.

### 2.2.3 A review of Drought impacts on natural resource utilization

Periodic syntheses of the ever-expanding knowledge about drought impacts on natural resources and associated ecosystems, land use and values, and human communities are critical to effective policy formulation (Alig, 2011). Research done in the Sahel and eastern Africa demonstrated that when rainfall decreases by at least 23%, closed woodlands can shift to open woodlands (Hély et
Global climate change induced by anthropogenic release of greenhouse gases (GHGs), including carbon dioxide (CO$_2$), may modify the growth and geographic distribution of forests, as well as productivity of competing land uses (Alig, 2011). Impacts on agriculture and forests could arise from increases in atmospheric CO$_2$ concentrations, change in temperature regimes, and variations in patterns of rainfall over the course of a year. Shifts in global climatic conditions could affect agricultural crop and forest growing conditions, and hence land values for those uses.

There are also important implications of drought trends on wildlife beyond survival of the species themselves, such that displacement of land-migrating species as well as other wildlife may affect the greater ecosystem (Harris et al, 2009). For example, large ungulates are critical for driving ecosystem functions such as enriching grassland production and replenishing soil nutrients (ibid). In Africa, browsing by ungulates plays an important role in maintaining cooperative relationships between nectar feeding ants and Acacia spp. trees by limiting the presence of antagonistic ant species (Palmer et al. 2008).

Environmental warming has worldwide implications for the future geographical distribution of organisms (Traill et al., 2010). Many animals previously not found in a particular region due to physiological or foraging constraints gain advantage through physiological adaptations to higher temperatures. Stackowicz et al., (2002) emphasises that although temperature shifts can alter invasive dynamics, the greatest effect of climate change in biotic communities arises from shifts in maximum and minimum temperatures rather than annual means. These changes have been observed to give invasive species an early seasonal start, resulting in increased growth and recruitment relative to natives.
Drought severity is dependent not only on the duration, intensity and geographical extent of a specific episode, but also on the demands made by human activities and vegetation on an area’s water supplies (Alig, 2011). The reality is that human actions are part of the web of influences on ecological change, and are not external impacts disturbing the equilibrium (Bongo and Bourdillion, 2001). It is therefore necessary to understand how adaptation to and policies for addressing climate change may affect landscapes, ecosystems, ecosystem services, and local economies (Alig, 2011). It must also be remembered that natural resources often buffer communities during periods of climatic stressors such as droughts.

Despite the increase in droughts and spiraling impacts, no concerted efforts have been made at the global level to initiate a dialogue on the formulation and adoption of national drought policies that provide a framework for a proactive, risk-based management for dealing with drought events. Without a coordinated national drought policy that includes comprehensive monitoring, early warning and information systems, impact assessment procedures, risk management measures, drought preparedness plans, and emergency response programs, nations will continue to respond to drought in a reactive, crisis management mode (Wilhite et al, 2014). Countries that have not developed such systems, even in part, to develop and inform strategic response options often illustrate a broader lack of institutional flexibility and preparedness and thus higher vulnerability IPCC, 2012).

2.3 A Theoretical approach to drought and conservation planning

The common problems with drought and other natural hazards is maintaining interest in planning beyond the relatively short window of opportunity that follows the event, given the on-again, off-again nature of this phenomenon. Interest in drought planning quickly wanes in the post drought
period when precipitation conditions have returned to normal or above normal level (Wilhite, 2000). Drought mitigation is directed specifically at human relief only and no post-response and recovery evaluation are undertaken, hence opportunities to learn from the past are lost (Wilhite, 2002; NDMC, 2007). On a positive note, however, drought and famine early warning systems commonly exist despite the obsolete equipment and poor meteorological networks used (Ndlovu, 2011). The study explored the ACT framework, an approach to conservation planning.

2.3.1 Exploring the Adaptation for Conservation Targets (ACT) framework

The Adaptation for Conservation Targets (ACT) framework (Figure 2.1) is a simple yet structured approach that builds familiar elements of natural resource planning (e.g., local knowledge, conceptual modeling, and adaptive management) into a process tailored for addressing climate change. Scientists, managers, and decision makers worldwide have advocated for the development of innovative approaches to minimize the effects of climate change on species, ecosystems, and ecological functions (Cross et al., 2012). Below is a presentation of the ACT framework, showing aspects of adaptation to climate change scenarios and prioritization of actions to the effects of droughts (Figure 2.1).

The ACT framework can be used where any degree of formal conservation planning has already occurred, and considers multiple future scenarios to address uncertainty. It can function as a stand-alone planning process, or it can be used to integrate climate change into existing decision making and strategic planning processes. Following the basic approach of adaptive management cycles, ACT steps can be repeated to monitor and project changes in management and social priorities, climate trajectories, and ecological responses (Cross et al., 2012).
Information needs identified throughout the process can yield a priority research agenda, but need not prevent progress towards implementing management actions. The framework is based on the premise that effective adaptation of management to climate change can rely on local knowledge of an ecosystem and does not necessarily require detailed projections of climate change or its effects (ibid).

Figure 2.1: Adaptation for Conservation Targets (ACT) framework
Source: Adapted from Cross et al. (2012)
Cross et al. (2012) outlines the steps to follow in developing the ACT framework as follows:

Step 1: Identify the feature targeted for conservation (e.g., species, ecosystem or ecological function) and specify a management objective for that feature

Step 2: Assess the potential effects of plausible future climate scenarios (drought) on that feature:
  - Build a conceptual model that illustrates the climatic, ecological, social, and economic drivers affecting the feature (Figure 2.2)

![Figure 2.2: Conceptual model](Image)

Source: Author (2016)

- Develop a suite of plausible climate change scenarios (in this study, the drought scenario)
- Examine how the feature and its non-climatic drivers may respond to each scenario

Step 3: Identify management actions to achieve the stated objective under each scenario

Step 4: Prioritize management actions
The ACT framework emphasizes reliance on local ecological knowledge through the use of graphical conceptual models and expert opinion-based assessments of climate change effects and management options, supplemented by scientific literature. This part of the planning process is nonlinear because the processes of identifying key drivers, developing plausible scenarios, and synthesizing information on potential ecological responses inform each other. Scenarios can incorporate average climate trends and changes in the frequency and intensity of extreme climate events (in this case, droughts), allowing one to address both incremental and abrupt shifts in ecosystem structure or function (Cross et al., 2012).

The ACT framework offers an efficient and structured process for translating broad adaptation principles (e.g., minimize non-climate stressors, monitor to detect changes, intensively manage populations, or increase the size and number of reserves) into actionable management strategies. It does, however, require local knowledge of the system of interest, management expertise, and a basic understanding of readily available climate projections and their limitations (ibid). Moreover, used in conjunction with the conceptual framework in Figure 2.2 the ACT framework can bring out the relationship between natural resources utilisation and improvement in well-being of households.

2.4 Global Perspective of Drought Trends

Droughts occur both in developed and developing countries with significant impacts and are exacerbating in frequency, severity and duration (Miyan, 2015). Since 1950, many regions of Asia, Africa, Australia, Europe, and America have experienced longer and intense droughts (IPCC, 2012). Regional climate simulations and high resolution global atmospheric model simulations over Europe indicated that the Mediterranean region is prone to severe droughts.
Since the 1970s, there is a drying trend globally, especially in high northern latitudes (IPCC, 2007). At the same time, a widespread increase in droughts and spatially coherent shifts in drought regimes are expected with changing global circulation patterns (Dai, 2011).

Cook et al. (2015) demonstrated that the mean state of drought in the late 21st century over the Central Plains and Southwest of America will likely exceed even the most severe “mega-drought” periods of the medieval era in both high and moderate future emissions scenarios, representing an unprecedented fundamental climate shift with respect to the last millennium. Their (ibid) results point to a drier future that falls far beyond the contemporary experience of natural and human systems in Western North America, conditions that may present a substantial challenge to adaptation.

In a study by Ragab and Prudhomme (2002), their findings revealed that there has been a decrease in rainfall throughout the Mediterranean region, southern Africa and the Sahel, the Aral Sea basin and Australia over the past century. Furthermore, Ragab and Prudhomme (2002), explained that future climatic predictions indicate that for the dry season (April-September), by the 2050s, North Africa and some parts of Egypt, Saudi Arabia, Iran, Syria, Jordan and Israel, are expected to have reduced rainfall amounts of 20-25% less than the present mean values. Equally so, for the same period, the temperature in the coastal areas of the Mediterranean countries will rise by about 1.5°C while the rainfall will decrease by about 10-15% and in wintertime, the temperature in the coastal areas will also increase by 1.5°C on average, while inside the region it will increase by 1.75-2.5°C.

Ragab and Prudhomme (2002) findings also showed that in the Taklimakan region (Tarim Basin) west of China, the annual average temperature will increase by 1.75-2.5°C while in the Thar
Desert (India, Pakistan, Afghanistan), indications are that the annual average increase in temperature will range from 1.5 to 2.25°C in winter and from 2 to 2.5°C in summer. Moreover, annual average precipitation is shown to decrease by 5-25% in the same region.

The impacts of droughts encompass the global ecosystem as a whole but vary from region to region (Miyan, 2015). The China drought from 1876 to 1878 affected 83 million people; the America drought started in 1579 and spread over the southwestern region and lasted for more than twenty years. From early 2000 onwards severe droughts affected vast areas of South Asia, including Western India, Southern and Central Pakistan (Miyan, 2015). Afghanistan, India, Pakistan and Sri Lanka report droughts at least once in every three year period in the past five decades, while Bangladesh and Nepal also suffer from drought frequently. These global trends show that drought is one of the most looming, natural and climate induced disaster, which affects millions almost every year globally and climate change is the major cause of droughts worldwide.

2.5 Drought trends in the African context

The African continent is expected to be most affected by climate change, land degradation, and desertification. Though Africa has the lowest source of GHG emissions from inhabited continents (due to low levels of industrial development), it is the most vulnerable to the effects of climate change (Beg et al., 2011, Huq et al., 2004 and Bewket, 2012 as cited in Gemeda and Sima, 2015). The African Sahel recorded one of the worst droughts in history which started in 1968 and lasted till 1988, resulting in about 150 million people starving (Miyan, 2015).

Eastern African countries (Burundi, Eritrea, Ethiopia, Kenya, Uganda, Tanzania, Rwanda, and Somalia) are also among the most vulnerable countries to the effects of drought due to their
dependency on rain-fed agriculture (Gemeda and Sima, 2015). A Report by Williams and Funk (2011) described that over the last 3 decades rainfall has decreased over eastern Africa. Kenya was affected by drought seven times between 1991 and 2008, and this affected about 35 million people. Ethiopia also experienced six drought times over 1983-2008. Other African countries were also affected by drought several times (Gemeda and Sima, 2015).

Ngaka (2012) investigated and analysed the preparedness, impact of and response by the farming community to the 2007/2008 drought in the Eastern Cape and Free State provinces of South Africa, findings of the study showed an inadequacy of extension support service, particularly as a vehicle for disseminating early warning information, and the most significant impact of droughts was livestock losses.

In a study carried out by Leichenko and O’Brien (2002) on African farmers and how they cope with climate variability and adapt to long-term change, it was found that farmers who formerly had difficulty adapting to climatic variability may become less vulnerable to drought related food shortages as a result of trade liberalization. Findings of the study however, showed an inadequacy of extension support service, particularly as a vehicle for disseminating early-warning information and the most significant impact of droughts was livestock losses.

Many parts of Africa already experience highly variable precipitation with significant regional variations and very high inter-annual variability. Lake Chad in northern Africa has shrunk from its greatest extent in the 1960s to about one-tenth that area in the 1980s (Gleick, 1998) because of the decrease in rainfall.
Watson et al. (1996) as cited in Leichenko and O’Brien (2002) postulated that approximately two-thirds of the African continent is made up of drylands and considered to be highly vulnerable to climate variability. As a semi-arid tropical region, southern Africa is among the most drought-vulnerable regions in the world (Dilley 2000) and inter- and intra-annual variability of rainfall are considered key climatic elements that determine the success of agriculture (Sivakumar 1998). Thus when two severe droughts occurred during the 1990s, one in 1992 and the other in 1995, in southern Africa, total cereal production in the region was cut nearly in half during the 1992 drought, and by nearly one-third during the 1995 drought (World Bank 2000).

In terms of future climate change, the dominant effect of climate change in southern Africa is most likely to be altered water balances, which will result in a change in hydrological regions and altered cropping patterns (Hulme 1996; Downing et al. 1997). Water availability is critical to plant growth, thus any change in precipitation will influence agricultural productivity for the region. Temperatures are also projected to increase across southern Africa, speeding up plant growth and reducing the length of the growing season (Leichenko and O’Brien, 2002). However, if plant growth is accelerated during the grain filling period, woody content may increase, thus the quality of yields is most likely to decrease, even if the actual crop yields increase (Hulme 1996).

According to the IPCC report (2007) by 2100, due to drought, arid and semi-arid regions of Africa are expected to expand by 5-8%, or 60-90 million hectares, resulting in agricultural losses of between 0.4-7% of gross domestic product (GDP) in Northern, Western, Central and Southern Africa (IPCC, 2007).
2.6 Drought trends: The Zimbabwe context

Zimbabwe lies in a semi-arid region with limited and unreliable rainfall patterns and temperature variations (Brown et. al., 2012). Rainfall exhibits considerable spatial and temporal variability characterised by shifts in the onset of rains, increases in the frequency and intensity of heavy rainfall events, increases in the proportion of low rainfall years, decreases in low intensity rainfall events, and increases in the frequency and intensity of midseason dry-spells (Unganai, 2009). Extreme weather events, namely tropical cyclones and drought have also increased in frequency and intensity (Mutasa, 2008). Moreover, according to the Zimbabwe Meteorological Service, daily minimum temperatures have risen by approximately 2.6°C over the last century while daily maximum temperatures have risen by 2°C during the same period (Brown et. al., 2012). High degree of rainfall variability is the norm in Zimbabwe because it lies within the tropics to subtropics (Manatsa et. al., 2010).

A study carried out in semi-arid Zimbabwe in Masvingo and Hwange Districts on farmers’ perception of climate variability by Moyo et. al., (2012) revealed that farmers perceived climatic and weather patterns to have changed over the past two decades. This change was perceived to be indicated by erratic rainfall patterns, decreased rainfall and temperature increases. The impacts of the climatic changes were identified as crop productivity decline and increased livestock morbidity and mortality.

Gwimbi (2009) also analysed the vulnerability of cotton farmers to climate change in Gokwe District in Zimbabwe. The survey revealed that cotton farmers believed that temperatures were increasing and precipitation was decreasing (Gwimbi, 2009). Matarira et al (1995) used global climatic models and dynamic crop growth models and established that maize yields decrease
dramatically under dry land conditions in some regions sometimes up to 30%, even under irrigation conditions due to temperature increases that shorten the crop growth period.

The findings of a research carried out by Mutekwa (2009) in Zvishavane revealed that the impacts of climate change include crop damage, death of livestock, soil erosion, bush fires, poor plant germination, pests, lower incomes and deterioration of infrastructure. The smallholders pointed out high frequency and severity of drought, excessive precipitation, drying up of rivers and wells and the changing onset and cessation of seasons as evidence of climate change (Mutekwa 2009).

Bosongo (2011) investigated the perceptions of households on the pattern of rainfall, droughts and floods over 23 years, the impacts of floods and droughts on households and how households cope with these events. The research was conducted in Kanyemba in Lower Middle Zambezi Valley’s Manyame catchment in Zambezi river basin. The research revealed that dry-spells and floods, which occur during the crop-growing period reduced crop production by about 65%. The study also found that households adopted a number of strategies to address droughts and flood impacts such as vegetable farming and crop production in the floodplain.

Ncube-Phiri et al. (2014) on the other hand analysed the progression of the Muzarabani community towards vulnerability to hazards such as floods, drought and, and how prevailing conditions and existing structures and activities increased susceptibility of the community to disasters. The results of the study indicated that households, government and non-governmental organisations had come up with different mitigation strategies, such as growing crops along river beds, livestock production, raised granaries and doorsteps, flood evacuation shelters and other
emergency services. Research revealed that although viable, some of the strategies increased the community’s vulnerability.

Mushore et al. (2013) identified the drought mitigation strategies used in Ward 2 of Bikita District, and assessed the impacts of the strategies and the inherent challenges faced during attempts to implement them. Results indicated that people are using drought mitigation strategies which include food aid, food for work, and sale of livestock, remittances and irrigation schemes. It was also revealed that the most effective drought mitigation strategies were provision of food aid and food for work whereas the least effective were remittances and irrigation. The study also revealed that 72% of the community was not satisfied with the effectiveness of all the drought mitigation strategies being used.

An analysis of the relationship between environmental change and farm productivity in the communal lands of Masvingo Province in Zimbabwe done by Farai et al (2012) highlighted the current climate change scenarios for the relationship between environmental change and farm productivity and assessed peoples’ awareness of climate change. The study revealed that the climate change scenario in Masvingo has resulted in declining farm productivity and the people’s perceptions on climate change pointed out that the crop growing season is becoming shorter, temperatures are rising and rainfall amounts are declining, while mid-season droughts were occurring frequently. Farai, et al (2012) also indicated that studies on environmental change and farm productivity are often concentrated on drought and desertification.

Masendeke and Shoko (2014) assessed drought coping strategies and their effectiveness in Mberengwa District in Ward 12. The findings from the study revealed coping strategies that included food storage, livestock management and Government assistance. From the results, it
was recommended that there is need to develop effective coping mechanisms such as utilisation of indigenous food sources and growing of drought tolerant crops.

Gukurume (2014) explored the impact of climate change and variability on agricultural productivity in the communal area of Bikita District. He further examined the adaptation and mitigation strategies devised by farmers to deal with the vagaries of climate change and variability. From his research it was established that communal farmers have not been passive victims of climate change and variability. Gukurume (2014) argued that while climate change has compounded the vulnerability of peasant farmers in the drought – prone district of Bikita through declining agricultural productivity, he established that the farmers have rationally responded to climate change through various adaptation and mitigation strategies.

2.7 Knowledge Gap

While there is recognition of the importance of natural resources as “safety nets” in periods of climatic stress (Frost et al., 2007; Neufeldt et al., 2013), knowledge gaps still exist with regard to understanding the dynamics in natural resource utilisation patterns within communities as well as the influences of resource endowments at household level. Emerging trends suggest changes in use patterns of natural resources due to increased incidences of drought (Woittiez et al., 2013), with implications on how values in rural development are changing. It is also clear that scholarly researches agree that southern Africa is particularly vulnerable to climate change due to its heavy dependence on rain-fed agriculture and climate sensitive resources (Chikodzi et al., 2013) and it is justifiable that researches on human vulnerability to climate change be done justice. However it is also prudent that further research be conducted to assess drought impacts on natural resource utilization, the focus of this study.
2.8 Chapter Summary

Drought is a natural hazard that is a common climatic feature of most countries. It is the result of interplay of a natural event and the demand placed on water and other natural resources by man. This demand on natural resources can worsen the impacts of drought through the unsustainable use of natural resources. The impacts of drought vary and may linger for years after the termination of the period of deficient precipitation. It is therefore necessary that strategies be adopted that help to improve the resilience of ecosystems and communities against droughts. The next chapter focuses on the description of the study area and the research methodology that was used in the study.
CHAPTER THREE : RESEARCH METHODOLOGY

3.1 Introduction
This chapter examines the methods and instruments that were used to collect data. Kothari (2004) defines a research methodology as an analytical technique of resolving a study problem. A research methodology is therefore a study or a systematic analysis of the methods that a researcher uses to gather data. The research methodology section describes the various methods used to collect and analyse primary and secondary data as well as explaining and justifying why these methods were used. The chapter also describes the location of the study area, as well as its biophysical and socio-economic characteristics.

3.2 Location of the study area
Mt Darwin District is located in Mashonaland Central Province in the northeast of Zimbabwe. The study was carried out in Wards 2, 6 and 33 of Mt Darwin District. The study area is a rural area with mostly smallholder farmers. Mt Darwin is 157km north of Harare. Below is a map (Figure 3.1) that shows the location of Mt Darwin in relation to Harare and other cities and towns in Zimbabwe. The map also shows the study area in the valley comprising Wards 2, 6 and 33.
Figure 3.1: Map of Wards 2, 6 and 33 in Mt Darwin District  
Source: Geography Lab, Bindura University of Science Education (2016)

3.3 Target Population

Sidhu (1984) refers to a target / research population as the aggregate or totality of individuals from which the sample is chosen. The target area of the research was Wards 2, 6 and 33 of Mt Darwin District, and the target population comprised smallholder farmers and other community members in the Wards. Ward 2 has a total population of 12180 with 2959 households, and an average household size of 4.1 people. Ward 6 has a population of 4823 people with 1084 households and an average household size of 4.4 people. Ward 33 has a population of 6783 people with 1656 households and an average household size of 4.1 people (ZimStat, 2012). This comprised the target population. However, only 140 household heads were chosen as the sample population. The table below (Table 3.1) shows the sample population that was used for the
research. Ward 2 has the highest number of households, hence 55 household heads were randomly chosen, while 45 household heads were selected in Ward 33, and 40 household heads were randomly chosen in Ward 6.

Table 3.1: Distribution of households in study villages and percentage sample size

<table>
<thead>
<tr>
<th>Ward</th>
<th>Agro-ecological zone</th>
<th>Village</th>
<th>Total households</th>
<th>Sample size</th>
<th>% sample size</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>IV &amp; V</td>
<td>Chingawo</td>
<td>97</td>
<td>15</td>
<td>15.5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bomba</td>
<td>77</td>
<td>15</td>
<td>19.5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chitima</td>
<td>63</td>
<td>10</td>
<td>15.9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chiutsi</td>
<td>75</td>
<td>15</td>
<td>20%</td>
</tr>
<tr>
<td>6</td>
<td>IV</td>
<td>Mutasa</td>
<td>122</td>
<td>20</td>
<td>16.4%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manyika</td>
<td>103</td>
<td>20</td>
<td>19.4%</td>
</tr>
<tr>
<td>33</td>
<td>IV</td>
<td>Chiriseri</td>
<td>84</td>
<td>15</td>
<td>17.9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kahondo</td>
<td>81</td>
<td>15</td>
<td>18.5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chigango</td>
<td>79</td>
<td>15</td>
<td>19%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>781</td>
<td>140</td>
<td></td>
</tr>
</tbody>
</table>

Source: Village and Council records (2016)

It must be noted that the target population did not only include people from the three wards but it also included key district informants – the council chairman, heads of departments from the District Administrator's office (DA), Agricultural Technical and Extension services (Agritex), Livestock Production Department (LPD), Forestry Commission, Environmental Management Agency (EMA), Veterinary Services Department (VSD), the Chief Executive Officer and Executive Officer Environment and Agriculture of Pfura Rural District Council (PRDC), representatives from NGOs, local and traditional leadership.

3.4 Research Design

Makore-Rukuni et al (2001) defines a research design as a plan or structure for an investigation. It is a set of plans and procedures that reduce error and simultaneously helps the researcher obtain empirical evidence about isolated variables of interest. Bhattacherjee (2012) further pinpoints that a research design is a ‘blueprint’ for a practical research which is meant to provide
answers to research questions or to test specific assumptions of the study. While Smith (2008) concurs that a research design brings out the pathway of the research, the author emphasizes the need for a realistic time frame and milestones that the research process needs to achieve.

3.4.1 Case study approach

The research used a case study approach to study drought trends, their impacts and natural resources utilisation in Wards 2, 6 and 33 of Mt Darwin District. According to Thomas (2011), a case study is an analysis of persons, events, decisions, periods, projects, policies, institutions, or other systems that are studied holistically by one or more method. Saunders, Lewis and Thornhill (2007) further explain that a case study gives detailed, intensive knowledge about a single case, which can be generalized to other cases. The case study also enables the use of different data collection techniques.

A case study approach was adopted in order to produce a detailed analysis of the impacts of droughts on natural resource utilisation. According to Yin (1994), the case study approach is an appropriate way of capturing context specific and quality detail. Feagin et al., (1991) defines a case study as “an in-depth, multifaceted investigation using qualitative research methods of social phenomena”. The case study approach helped to draw out data using a semi-structured interview from the selected households. This method develops personal relationships with individual members of selected households. Through this approach, the respondents were able to develop a sense of trust.

Conversely, a major challenge in case study dissertations is connecting the primary research or re-analysis with the broader theoretical themes and empirical concerns of the existing literature. Other disadvantages of the case study approach are that the data gathered is situational, the data
may be biased due to the researcher’s closeness to a situation and it is usually a time-consuming process.

However, the case study is justified for this research as it enables the researcher to discuss the case in its social context by documenting real events, recording what people say and studying written documents. Furthermore, the choice of the case study research design was because the research questions that frame the study are closely connected to their phenomena which are the natural resources in the study area. The case study design also allowed for the questions regarding the state and extent of natural resource utilisation to be addressed while exploring opportunities and strategies for sustainable natural resources management in the study area.

To increase the effectiveness of the case study research design, a mixed methods or triangulation approach was adopted. The mixed methods approach helped in the generalization of the findings to the population under study. It also helped to develop a detailed view of drought trends and their impacts on natural resource utilisation in the study area.

3.4.2 Qualitative research method

Qualitative research on the other hand is "subjective" in nature and mainly concentrates on opinions and perceptions rather than hard measurable data. Types of qualitative research methods include, but are not limited to, observations, survey of documents and questionnaires.

Qualitative research uses a naturalistic approach that seeks to understand phenomena in context-specific settings such as “real world setting, when the researcher does not attempt to manipulate the phenomena of interest” (Patton, 2001). Qualitative data are often textural observations that portray attitudes, perceptions or intentions (Family Health International, 2005). Qualitative
research methods and analysis also provide added value in identifying and exploring intangible factors such as cultural expectations, gender roles, ethnic and religious implications.

A qualitative approach to research, in collecting the appropriate data, is not interested only in numerical data that can be used for statistical analysis. In support of this statement, Neuman (2000) states that qualitative researchers are more concerned about issues of richness, texture and feeling of raw data because their inductive approach emphasizes developing insight and generalization out of the data collected. Qualitative data was collected through household questionnaires, field trips and participant observations of environmental impacts of drought, natural resource utilisation activities and the current state of the natural resources in the 3 wards.

3.4.3 Quantitative research method

Quantitative research is generally "objective" in nature although some may argue that it can be "subjective" as well. Creswell, (1994) defines quantitative research as an enquiry into social or human problem based on testing a hypothesis or a theory composed of variables, measured with numbers, and analysed with statistical procedures in order to determine whether the hypothesis or the theory holds true.

A quantitative approach to research mainly focuses on quantifiable data in terms of numbers and measures that can be analyzed statistically. “Quantitative researchers are more concerned about issues of design, measurement and sample because their deductive approach emphasizes detailed planning prior to data collection and analysis” (Neuman, 2000).

In quantitative research validity is concerned with whether or not the study indeed measures that which it is intended to measure and reliability with whether the study can be replicated by
another researcher in the same context (Bartlett, 2001). Quantitative data therefore involves measurements of tangible, countable, sensate features of the world. (Bouman & Atkinson, 1995). A limitation of this research approach is that it depends on available or readily statistical data that can be analysed; therefore it is not suitable for testing new subjects/concepts with limited available data. In this study, quantitative data was however, gathered from climate parameters that included rainfall and temperature data.

3.4.4 The Mixed Methods Approach or Triangulation

A research’s credibility is pegged on the methods employed in data collection and analysis. In this research, both qualitative and quantitative methods were used. This created a triangulation of methods termed —mixed methods research (Bryman, 2008) or —mixed methods approach (Creswell, 2003) to ensure that the collected data was representative of both the geographical area and the subject under study. The researcher combined quantitative and qualitative research techniques so that the combination resulted in complementary strengths and non-overlapping weaknesses.

Triangulation is used to combine the advantages of both the qualitative and the quantitative approach. It refers to the combination of two or more theories, data sources, methods or investigators in one study of a single phenomenon to converge on a single construct, and can be employed in both quantitative (validation) and qualitative (inquiry) studies (Yeasmin and Rahman, 2012). Each research method offers specific advantages as well as disadvantages.

The triangulation method was therefore used to analyse data coming from different data collection methods, informants and places. Internal and external validity was used to confirm the correctness of the study design. It was assured through pre-testing of the questionnaires and
through triangulation of the results. Triangulation was done on respondents’ responses, results from FGDs, information from key informants and from observations. This was so as to ensure the authenticity and relationships on data collected by qualitative and quantitative methods. It must be noted that triangulation is not without some drawbacks. If the research is not clearly focused theoretically or conceptually, it will not produce a satisfactory outcome.

Furthermore, if the researcher does not manage data carefully, triangulation can result in a dominant, personally preferred method being legitimimized. However, the researcher was careful in data collection so as to prevent bias and contradictions. The opinions of respondents and key informants contributed to qualitative data hence it was grouped into broad thematic narratives. Analysed qualitative data that was collected through primary and secondary sources was clustered into themes and commented by writing summaries of discussions and observations. The study also used secondary sources to collect data and these included rainfall, temperature and evaporation data from the Mt Darwin Meteorology station.

3.5 Data Collection Methods

For a research to be carried out effectively, there are instruments or tools used to collect data. The methodological approach that one is going to use is determined by among other things, the type of data to be investigated and the tools to be used. The data that is to be collected determines the tools ad methods that are going to be used. Since this study used both qualitative and quantitative methods of inquiry, two methods of data collection were also used; primary and secondary data collection methods.
3.5.1 Primary Data Collection Methods

Primary data are the data that are extracted from the field of study in their raw state (Gwimbi and Dirwai, 2003). The primary data are obtained in the field by the researcher as first-hand information for the specific research purpose. The tools / research instruments used to gather this data depend on the type of data to be collected and the resources available for that research.

Wilkinson and Birmingham (2003) define research instruments as devices for obtaining data relevant to the research. According to Wilkinson and Birmingham (2003) there are many research instrument and no single one is par excellence. As such, since Annum (2014) argues that the validity and reliability of any study always relies on the accuracy of the research, this research extensively used four of them – questionnaires, interviews, focus groups and observations – so that they could complement each other to make sure accurate data was attained from the sample population.

3.5.1.1 Questionnaires

In this research, the major primary data collection tool was the household questionnaire. According to Gwimbi and Dirwai (2003), a questionnaire is a document used as a data collection instrument. A structured questionnaire contains a lists of questions to which an individual has to respond by choosing his/her best appropriate answer from the ones given by the researcher. The technique ensured the clarification of drought related issues such as drought impacts and coping strategies and allowed an interpretation of the participants’ responses by eliciting better rates of responses (Goddard and Melville, 2001).

The questionnaire plays a pivotal role in most pieces of research where primary data collection is carried out. Its purpose is to collect accurate and appropriate information from respondents. With
a questionnaire, the same questions are repeated to different respondents, thereby enabling the researcher to ask all respondents exactly the same question, unlike interviews where the question may vary with interviewees (Gwimbi and Dirwai, 2003).

The households sampled were formed by household members of age greater than 15 years, and that was to conform to the criteria fixed in the study approach (Bryman, 2008). The questionnaire was structured to collect information on demographic characteristics, socioeconomic situation of the respondents, local peoples’ perception on drought trends, drought impacts on natural resources and natural resource utilisation by communities. Self-administered questionnaires (Appendix 1) were used to collect information on drought impacts, the state of natural resources, and the demand for natural resources during drought periods. The researcher used mainly structured questionnaires which contained definite and concrete questions. At times the researcher used non-structured questionnaires during some interviews, where the respondents were illiterate and the researcher had to interview them to get information.

The Statistical Package for the Social Sciences (SPSS) version 16 software package was used to process and analyse the data collected from the questionnaires. Responses on the questionnaire were numerically coded and input into the SPSS data editor and analysed. Several data analysis functions were used to generate descriptive statistics.

### 3.5.1.2 Interviews

Semi-structured interviews can be defined as a conversation with a purpose of gathering information (Behr, 1983). According to Annum (2014) an interview is an interaction between an interviewer and interviewee in which the interviewer orally asks an interviewee a set of questions to obtain data. The advantages of interviews are that respondents can voice their opinions freely,
the researcher can ask follow up questions and the researcher is indirectly involved. However, interviews can get out of hand if the interviewer does not control the process, and most of the interviews were done in the vernacular requiring translation during data entry. This may result in inaccurate data.

Structured interviews are formal interviews which contain a set of questions often referred to as interview questionnaires which are posed to each interviewee and the responses are recorded on a standardised schedule (Annum, 2014). With structured interviews the researcher follows a set pattern and adheres to the prescribed order as the researcher go by the process of interviewing postulates Annum (2014). On the other hand unstructured interviews are less formal interviews, in which – although sets of questions may be followed – the interviewer may not follow the chronological order of questions and may be flexible enough to make adjustments to the phrasing of question so that they are understood by all respondents (ibid). This researcher used both types of interviews so as to elicit data from respondents.

The main disadvantage with interviews is that the interviewer controls the data collection process. This can lead to bias and subjectivity on the part of the researcher. To avoid this, a researcher can make recordings of interviewees (Best and Khan, 1993). However, this researcher discovered that most interviewees are skeptical of recorded interviews, so the interviewer restricted the interviews to written down sessions of responses.

Interviews were held with the District Administrator, Pfura RDC, ZINWA, traditional leaders, councilors, Agritex, EMA, Forestry Commission, Vet and LPD extension officers (operating in the study area), World Vision, ZimStat and Mt Darwin Met office. The interviews entailed the use of semi-structured interviews. Checklists (Appendix 2) were prepared and these covered
issues that include drought and population trends in the study area, natural resource utilisation in the study area, and the status of natural resources in the study area. The in-depth discussions facilitated the triangulation of information obtained from the questionnaire survey and focus group discussions. The information was further augmented by the use of policy documents and secondary literature dealing with climate change, drought and natural resources management in Zimbabwe. This provided a contemporary context to the study and also provided an understanding of drought and climate change issues.

3.5.1.3 Focus Group Discussions (FGDs)

Kumar (2011) explains that a “focus group is a form of strategy in qualitative research in which attitudes, opinions and perceptions towards an issue, product, services or programmes are explored through a free and open discussion between members of a group and the researcher”. Focus groups are not expensive as they do not require printing and they need less time to complete (ibid). However, focus groups have the disadvantage that there will be some passive and dominant speakers in the discussions. To curtail this, the researcher requested the dominant respondents to draw a resource map of their ward so that the passive respondents could participate freely.

Somekh and Lewin (2005) also noted that focus groups have the added weakness that it is very difficult to ensure confidentiality within focus groups and people may fear to disclose information which is confidential but vital for the research. The researcher reserved such questions for the one on one interviews. Two focus groups per ward discussed the drought occurrences and trends in the study area, so as to represent every type of participant (men, women, farmers, youth etc). The information was used to support the key informant interviews.
The focus groups discussed the extent of natural resources exploitation in the area and the intensity of exploitation during drought conditions. The researcher administered resource mapping and semi structured interviews as tools for the focus group discussion (FGD). The focus groups comprised different participants; groups for men, groups for women, mixed groups so as to capture gender-based differences in perceptions. Each group comprised a maximum of 10 participants. A checklist (Appendix 3) was administered indicating the issues to be resolved by the FGD.

### 3.5.1.4 Personal Observations

An observation is a research instrument “characterised by a prolonged period of intense social interaction between the researcher and the subjects, during which data, in the form of field notes, are unobtrusively and systematically collected” Bogdan (1972:116) as cited in Wilkinson and Birmingham (2003). This research instrument involves the researcher watching or listening to an interaction or event from the study elements at the same time taking down notes. This can be done by the researcher being a participant or a non-participant observer. Observations had the advantage that the researcher triangulated the observations with other research approaches, such as interviews and questionnaires (Gray, 2009). In addition, the researcher obtained firsthand experience with informants (Annum, 2014).

Conversely observations can result in limited data as the respondents would think the researcher has a hidden agenda other than researching and too much time can be spent preparing for the observation / field trip. The researcher however, prevented these problems by explaining to the participants that it was an academic researcher with confidentiality ethics. Permission was also sought from the District Administrator to undertake the research. Furthermore, the researcher
combined observations with questionnaire surveys, interviews and FGDs. Personal observations were used to verify the state of the natural resources in the study area and to observe natural resource utilisation. Photographs were taken of the study area, the natural resources within the area and pertinent scenes that validated the research. The observation method allows for taking note of respondents’ behavior in their natural setting.

3.5.2 Secondary Data Collection Methods

Secondary data are collected from existing records that help the researcher to come up with historical background of the work done. Secondary data provides a good background, as it is an existing literature around the topic. It can be used in conjunction with the primary data collected. It is fast to use, as there are no data collection and processing. Notwithstanding, secondary data are unlikely to address the research questions, and depended on solely, defeats the purpose of research itself (Gwimbi and Dirwai, 2003). The research made use of relevant and regularly updated websites. The researcher expected that this kind of data would help in understanding the primary data that was gathered. As the researcher assumed, the data was located quickly and inexpensively.

The researcher collected secondary data from sources such as research papers, journals, web-based documents, published and unpublished researches, published reports and books. Climate data was obtained as secondary data from ZINWA and the Meteorological district offices. Most of the recommendations brought out by the researcher at the end of the study were guided by secondary data collected.
3.6 Sample and Sampling Methods

A sample is a set of respondents selected from a larger population for the purposes of a research survey (Mugo, 2002). In this research, the researcher obtained data and information from a sample, “rather than a complete enumeration (a census)…” of the whole population due to a number of reasons (Mugo, 2002:1). Firstly sampling was cost effective and time effective for this research as opposed to the census method which would have been costly and time consuming because every respondent must be reached. Sampling was not exhaustive as compared to the census method which would be tiresome as it demands the researcher’s energy through a door to door approach.

Multi-stage sampling

A multi-stage sampling procedure was used for this research. The study was conducted in Mt Darwin District and Mt Darwin North constituency was purposively selected for the study. The motivation for the choice of Mt Darwin North was based on its location in the middle Zambezi valley and its agro-ecological characteristics. Three wards out of ten were therefore selected in Mt Darwin North constituency.

Probability and Non – probability sampling

The sampling techniques used in research spring from two sampling methodologies, probability and non-probability sampling methods. All probability sampling techniques use the random system of selecting respondents which increases the chances of any member of the study population to participate in a study. On the other hand non-probability sampling has techniques which uses a non-random system to choose the respondents and this means every element does not have the chance to be chosen. In this research both probability and non-probability methods
were used. Stratified sampling and simple random sampling follows the probability method whereas purposive sampling follows the non-probability method.

3.6.1 Simple Random Sampling

Lists of household heads’ names were provided for each village by the village head / Sabhuku and simple random sampling techniques was employed in selecting the respondents. According to Kothari (2004) simple random sampling is a technique in “which each and every item in the population has an equal chance of inclusion in the sample and each one of the possible samples, in case of finite universe, has the same probability of being selected”. In other words O’Leary (2010) specifies that Simple Random Sampling (SRS) involves identifying all elements of a population, listing those elements and randomly selecting from the list.

The advantage of SRS according to O’Leary (2010) includes the fact that it would be fair and allows for generalisation. It is also very easy to use than other techniques. However, according to O’Leary (2010) the weakness of SRS is the process of identifying, listing, and randomly selecting respondents which is unfeasible, and the resulting sample may not capture all the respondents under study.

For this research, simple random sampling was however used to get respondents from householders. The researcher obtained the lists of the respondents from ward councillors. This sampling technique ensured that every household head had an equal chance of being selected. Depending on the number of households in each village, 10 – 20 households were selected from each village sample to ensure that the sample sizes constituted more than 15% of the total households in each village. A total of 140 household heads were thus sampled having been
selected from 9 villages in the 3 wards. The sampled households are outlined in Figure 3.2 below.

3.6.2 Stratified sampling
Stratified sampling is a technique in which a researcher divides the population into subgroups (strata) based on mutually exclusive criteria, and then samples are randomly or systematically taken from each group (Westfall, 2008). Thus the researcher divides a heterogeneous population into homogeneous small units and selects a sample from each group using a random procedure. In this research a stratified sampling technique was therefore used for selecting traditional leaders who were further put into chiefs and village head strata.

3.6.3 Purposive sampling
O’Leary (2010) views purposive sampling as handpicking sampling – selection of a sample with a particular purpose in mind. The technique is also referred to as judgemental sampling by Marshall (1996) and to him it is a process by which the sample population is acquired through the discretion given to a particular group or individuals of the population by the researcher because they hold information of the target population that is required by the researcher. The researcher opted to use this technique because accurate data would be timely obtained. The researcher however used this technique cautiously to avoid a high risk of sampling error which is highly probable with this technique because if wrong groups were targeted and selected wrong information would be obtained. The 3 Wards were purposively selected for the study so that only those wards with relatively uniform climatic conditions were sampled in order to have a true reflection of the variables in the research objectives. Key informants were also purposively selected during interviews (such as Forestry Commission, EMA and the D.A).
3.6.4 Snow balling sampling

This technique entails the researcher identifying critical or key informants in which the researcher is interested in. The identified respondent is used as an informant who in turn identifies other respondents in their “network” who qualify for inclusion in the sample. The process was repeated until the desired sample was achieved (Smith, 2008). This was done during the process of administering household questionnaires and during FGDs.

3.7 Data Presentation and Analysis

Statistics Canada (2009) defines data analysis as a strategy of coming up with answers to research questions through thorough assessment and investigation of data using an interpretive approach. This process was done by this researcher and it involved sieving, cleaning and omitting unusable and irrelevant data that this researcher has collected. Various methods were used to analyse both quantitative and qualitative data that was collected according to the objectives of the study. Data on demographic and socio-economic characteristics that included age, level of education and marital status of the respondents were analysed for the 3 wards. Microsoft Excel 2010 and Statistical Package for Social Scientists (SPSS) version 20 were used for entry and analysis of rainfall and temperature data. For the qualitative research components, SPSS was used to enter and analyse qualitative data from the questionnaires where graphs were used to present the study findings. Descriptive techniques in the form of percentage, mean, median, range, standard deviation, bar charts, line graphs and pie graphs were used to summarise data.
3.8 Research Ethics

Ethical issues in research are concerned mainly in balancing the rights of people to privacy, safety, confidentiality and protection from deceit with the pursuit of scientific endeavour (Goddard and Melville, 2001).

3.8.1 Privacy, Confidentiality and Anonymity

Researchers commonly assure participants that anything discussed between them will be kept in strict confidence (Kumekpor, 2002). During the course of the study, the researcher assured the respondents that the study would be conducted for academic purposes. Confidentiality and anonymity were assured. A statement was made that confidentiality of recovered data would be maintained at all times, and identification of participants would not be available during or after the study. Confidentiality is an active attempt to remove the research records from any elements that might indicate the subjects’ identities. The respondents were coded to maintain anonymity.

3.8.2 Informed Consent and Voluntary Participation

Care was taken to ensure that the participants fully understood the nature of the study and the fact that participation is voluntary. Respondents therefore voluntarily participated in the research. The respondents also had the freedom to respond or not. Informed consent was therefore sought from individuals.

3.9 Chapter Summary

Chapter 3 presented the methodology that was used in the study. The chapter described the location of the study area, Wards 2, 6 and 33 of Mt Darwin District. Furthermore, the chapter discussed in detail the research methodology that was used to collect data for the study. The study used a case study research design. Quantitative and qualitative research strategies were
employed, thus resulting in a mixed methods approach. The strengths and weaknesses of each method and approach that was used were explained. Various data collection tools were used to collect data and these included interviews, focus group discussions and observations. The data collection tools were used to complement the questionnaire and the research ethical standards were also outlined. SPSS version 16 and MicroSoft Excel 2010 were used to analyse the surveyed data. The next chapter discusses the research findings.
CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction

This chapter focused on results, presentations, analysis and discussions of data obtained from households, traditional leaders, Government officers, councillors and key district informants to determine drought trends, their impacts and natural resources utilization in Mt Darwin District. The chapter discusses the results on rainfall and temperature data from the Mt Darwin Meteorological Services Department and farmers’ perceptions on drought and natural resources utilisation in the study area. The chapter also identifies current response strategies to droughts with a bias towards natural resources. The results are presented and analysed following the orders in which research questions and objectives were stated in chapter one.

4.2 Socio-economic profile of respondents

The socio-economic aspects discussed in this section are gender distribution, the age group categories of respondents, the marital status of respondents and the household size, educational level of the household head and the religion of the household head.

4.2.1 Gender distribution of respondents

The majority of the respondents in the questionnaire survey were male headed households, 78.5% of the respondents were male and 21.4% were female as presented in Table 4.1. The household heads were the primary units of analysis and in Ward 2 results revealed that 76% of the households were headed by males while 24% were female-headed, while in Ward 6 it was also found that male-headed households dominated accounting for 78% of the respondents and 23% were female-headed households, and similarly in Ward 33, male headed households
constituted 82% and female headed households comprised 18%. Results from the 3 study sites showed male dominance in the study sample and this was consistent with ZimStat (2012) census results. From the Mashonaland Central provincial census report, male headed households constituted 61.17% while female-headed households accounted for 38.33% (ZimStat, 2012).

Table 4.1: Gender Distribution of Respondents

<table>
<thead>
<tr>
<th>Variable</th>
<th>Ward 2</th>
<th></th>
<th>Ward 6</th>
<th></th>
<th>Ward 33</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N*</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>42</td>
<td>76%</td>
<td>31</td>
<td>78%</td>
<td>37</td>
<td>82%</td>
</tr>
<tr>
<td>Female</td>
<td>13</td>
<td>24%</td>
<td>9</td>
<td>23%</td>
<td>8</td>
<td>18%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>55</td>
<td>100%</td>
<td>40</td>
<td>100%</td>
<td>45</td>
<td>100%</td>
</tr>
</tbody>
</table>

Note:  N* represents number of respondents in a category
Source: Research Survey (2016)

4.2.2 Age Distribution of Respondents

From the survey results, the majority of the people in the survey were between the age range of 15-64 years and they accounted for 91% of the respondents in Ward 2, 94% of the survey respondents in Ward 6 and 89% of the respondents in Ward 33. From the survey 6% of the respondents were above 64 years of age while 3% were below the age of 15 years.

Table 4.2: Age Distribution of Respondents

<table>
<thead>
<tr>
<th>Variable</th>
<th>Ward 2</th>
<th></th>
<th>Ward 6</th>
<th></th>
<th>Ward 33</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N*</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;15</td>
<td>2</td>
<td>4%</td>
<td>1</td>
<td>3%</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>15-24</td>
<td>7</td>
<td>13%</td>
<td>5</td>
<td>13%</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>25-34</td>
<td>12</td>
<td>22%</td>
<td>11</td>
<td>28%</td>
<td>4</td>
<td>9%</td>
</tr>
<tr>
<td>35-54</td>
<td>26</td>
<td>47%</td>
<td>18</td>
<td>45%</td>
<td>21</td>
<td>47%</td>
</tr>
<tr>
<td>55-64</td>
<td>5</td>
<td>9%</td>
<td>3</td>
<td>8%</td>
<td>13</td>
<td>29%</td>
</tr>
<tr>
<td>≥65</td>
<td>3</td>
<td>5%</td>
<td>2</td>
<td>5%</td>
<td>4</td>
<td>9%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>55</td>
<td>100%</td>
<td>40</td>
<td>100%</td>
<td>45</td>
<td>100%</td>
</tr>
</tbody>
</table>

Note:  N* represents number of respondents in a category
Source: Survey results (2016)
4.2.3 Marital status of the respondents

Marital status is an important factor determining the level and extent of natural resource utilisation and household heads that are married are more likely to have diversified natural resource needs than those unmarried (Okere & Shittu, 2013). Married household heads constituted a large proportion in all 3 Wards with 80% in Ward 2, 75% in Ward 6 and 80% in Ward 33. This was higher but consistent with ZimStat (2012) provincial results that revealed that the majority of population (64%) in Mt Darwin District were in the “married” category.

A respondent substantiated this by explaining that:

“Households of married people have the highest demand for natural resources such as firewood and water. In drought times, they are the ones with the most demands for fruits and wild vegetables to feed their families. They also have the biggest pieces of land for farming and a lot of livestock that need pastures for grazing.” Respondent 9 [25 August (2016)].

Table 4.3: Marital Status of Respondents

<table>
<thead>
<tr>
<th>Variable</th>
<th>Ward 2</th>
<th>Ward 6</th>
<th>Ward 33</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N*</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Marital Status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>3</td>
<td>5%</td>
<td>5</td>
</tr>
<tr>
<td>Married</td>
<td>44</td>
<td>80%</td>
<td>30</td>
</tr>
<tr>
<td>Divorced</td>
<td>7</td>
<td>13%</td>
<td>3</td>
</tr>
<tr>
<td>Widowed</td>
<td>1</td>
<td>2%</td>
<td>2</td>
</tr>
<tr>
<td>TOTAL</td>
<td>55</td>
<td>100%</td>
<td>40</td>
</tr>
</tbody>
</table>

Note: N* represents number of respondents in a category
Source: Research Survey (2016)

Key informant interviews and council records revealed that early child marriages were rampant in the area with most people especially girls marrying at a tender age and before completing ordinary education levels. It is also observed from Table 4.3 that less than 10% in the 3 Wards had never married while proportions for the divorced/separated category were relatively smaller.
in both Wards. This showed that people in both communities value the marriage institution. From the survey it also emerged that 2% in Ward 2 were widowed while in Ward 6 the figure stands at 2% and in Ward 33, 9% were widowed. It was also found that 13% of the respondents in Ward 2 and 5% of the respondents in Ward 6 were in the divorced/separated category, while 9% in Ward 33 also fell in the same category. The figures of those divorced/separated were slightly higher in both Wards as compared to that of ZimStat (2012) which was at 3.7%.

4.2.4 Household size

The survey results further indicated that Ward 2 had the highest proportion (64%) of household sizes ranging between one to four members while Ward 6 was dominant in the household size ranging from five to eight members and it accounted for 65% of the survey respondents. For the household size range of greater than eight members Ward 33 accounted for 31% of the respondents. During Focus Group Discussions it was indicated in Ward 33 that average household sizes exceeded 6 members. Polygamy was found to be common in all 3 Wards and this is the reason why large family sizes were recorded.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Ward 2</th>
<th></th>
<th>Ward 6</th>
<th></th>
<th>Ward 33</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N*</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Household size</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-4.</td>
<td>35</td>
<td>64%</td>
<td>11</td>
<td>28%</td>
<td>9</td>
</tr>
<tr>
<td>5-8.</td>
<td>18</td>
<td>33%</td>
<td>26</td>
<td>65%</td>
<td>22</td>
</tr>
<tr>
<td>&gt;8</td>
<td>2</td>
<td>4%</td>
<td>3</td>
<td>8%</td>
<td>14</td>
</tr>
<tr>
<td>TOTAL</td>
<td>55</td>
<td>100%</td>
<td>40</td>
<td>100%</td>
<td>45</td>
</tr>
</tbody>
</table>

Note: N* represents number of respondents in a category
Source: Research Survey (2016)

A respondent explained that:

“Polygamous families have large household sizes. To survive, the families farm large tracts of land and have various income generating activities that are natural resource
based such as selling wild fruits, brickmaking and floodplain cultivation.” Respondent 23 [11 August (2016)].

4.2.5 Education level of respondents

Most of the household heads in Wards 6 and 33 attended school up to primary level (43% and 40% respectively) while 56% had reached secondary level in Ward 2 (Table 4.5). In Wards 2 and 33, 11% and 10% respondents respectively, had attained tertiary education. Overall, 17.8% of the survey respondents had not attained any formal education. The low education levels were attributed to the lack of tertiary institutions in the study area.

As one respondent further explained:

“Very few people have reached tertiary level of education in the valley because there are no tertiary institutions in the valley, so people can only do jobs that depend on and use natural resources for sustenance because of lack of skills. NGOs like World Vision and departments like Vet and Agritex sometimes provide basic skills to our community, through training in such skills as basic crop production and livestock production”

Respondent 4 [8 August (2016)].

Table 4.5: Education Level of household head

<table>
<thead>
<tr>
<th>Variable</th>
<th>Ward 2</th>
<th>Ward 6</th>
<th>Ward 33</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N*</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Education level of household head</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>5</td>
<td>9%</td>
<td>9</td>
</tr>
<tr>
<td>Primary</td>
<td>13</td>
<td>24%</td>
<td>17</td>
</tr>
<tr>
<td>Secondary</td>
<td>31</td>
<td>56%</td>
<td>13</td>
</tr>
<tr>
<td>Tertiary</td>
<td>6</td>
<td>11%</td>
<td>1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>55</td>
<td>100%</td>
<td>40</td>
</tr>
</tbody>
</table>

Note: N* represents number of respondents in a category
Source: Research Survey (2016)
4.2.6 Religion

Christianity was found to be the dominant religion in the three Wards and it accounts for 55%, 50% and 47% in Wards 2, 6 and Ward 33 respectively. The Christian churches that were dominant in the area are the Apostolic sect. The survey results also revealed that African Tradition Religion (ATR) was the second largest religion in the 3 Wards with Ward 33 having 40%, Ward 6 with 35% and Ward 2 with 27%. Focus group discussions revealed that people under the ATR believed in spirit mediums (masvikiro) and ancestral spirits (midzimu). Ceremonies that were reported and were in line with ATR are ancestral ceremonies (bira) and culture and dance ceremonies (mafuwe). It was also established that Ward 2 constituted a significant percentage of the Muslim followers 18%, compared to Ward 6 (15%) and Ward 33 (13%). Non-followers and other religions were classified under others and did not account for any responses during the survey.

On ATR religion a respondent stated that:

   “Those who follow ATR also provide us with weather forecasts, and when the rain season has arrived, they do rain making ceremonies so that we receive rains. If there are any concerns from the ancestral spirits, we are advised of what needs to be done”

   Respondent 29 (11 August, (2016)].
Table 4.6: Religion of Respondents

<table>
<thead>
<tr>
<th>Variable</th>
<th>Ward 2</th>
<th></th>
<th>Ward 6</th>
<th></th>
<th>Ward 33</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N*</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Religion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Christian</td>
<td>30</td>
<td>55%</td>
<td>20</td>
<td>50%</td>
<td>21</td>
<td>47%</td>
</tr>
<tr>
<td>Muslim</td>
<td>10</td>
<td>18%</td>
<td>6</td>
<td>15%</td>
<td>6</td>
<td>13%</td>
</tr>
<tr>
<td>ATR</td>
<td>15</td>
<td>27%</td>
<td>14</td>
<td>35%</td>
<td>18</td>
<td>40%</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>0%</td>
<td>0</td>
<td>0%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>55</td>
<td>100%</td>
<td>40</td>
<td>100%</td>
<td>45</td>
<td>100%</td>
</tr>
</tbody>
</table>

Note: N* represents number of respondents in a category
Source: Research Survey (2016)

On ethnicity, the entire population was of African origin. Citizens of Zimbabwe constituted 98% of the total sampled households and only 2% were from other African countries. Citizens of Mozambique constituted 80% of the non-Zimbabweans and were mostly in Wards 2 and 33 which are found along the border with Mozambique. Equally of significance was that more than 75% of the respondents were of the VaKorekore tribe, while 20% were from other Shona tribes that included VaKaranga. It was also revealed that most household members were related to the household head except those who worked for the household.

4.2.7 Access to land and tenure issues

From Key Informant Interviews and participants of Focus Group Discussions it was revealed that land allocation was done by village heads (Sabhuku). A family was found to be only apportioned a piece of land upon agreement with the village head and meeting of all the requirements. As highlighted by community members during a focus group discussion, the arable plots allocated to individuals have been continually subdivided into smaller units over time and this was done when the owners of these plots pass on land to their grown-up sons. Population growth has also increased the subdivisions of villages as reported by village heads during interviews and focus group discussions. For example, Chiutsi village in Ward 2 has been subdivided into four small
villages; Chiutsi A, B, C and D, and each village subdivision has its own Sabhuku but however all were reported to be under the original Sabhuku Chiutsi.

Overall, all the households in all 3 Wards were owners of land, and it was found that 81% of the survey respondents reported to have been traditionally allocated the land by the village heads of their respective villages, while 18% were found to have inherited the land from their parents and only 1% had purchased the land.

The research survey revealed the average size of land that is owned by the respondents (Table 4.7). The findings showed that 68% of the survey respondents in Ward 2 had pieces of land that exceeded 2 hectares, while 36% of the respondents in Wards 6 and 33% of the respondents in Ward 33 also owned land pieces of more than 2 hectares each. It was noted however noted that that 67% of the households in Ward 33 and 65% of the households in Ward 6 had land holding sizes below 2 hectares whereas 32% in Ward 2 had land sizes in that category. The Agritex extension officers in Ward 2 highlighted that the land holding size for people in Ward 2 was 3 hectares on average and those with large pieces of land had inherited them from their parents. For Wards 6 and 33, the extension officers highlighted that the average land size was 2 hectares and on those with smaller land sizes, it was reported that they had given the other portion to household members mostly their sons. Key informant interviews (KII) and focus group discussions (FGDs) highlighted that in both Wards population growth has caused the reduction in land holding sizes that has resulted in the fragmentation of the landholdings. In Ward 2, the major cause of the reduction in land holding sizes was the expansion of Mukumbura Growth Point as reported by key informants. A respondent explained land tenure issues:
“The population is increasing and Mukumbura border is expanding so we do not have adequate fields for growing crops anymore. Our children need land but there is no space, so we are now extending our fields to the river banks and in floodplains.” Respondent 28 [11 August (2016)].

<table>
<thead>
<tr>
<th>Landholding</th>
<th>Ward 2</th>
<th>Ward 6</th>
<th>Ward 33</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hectares</td>
<td>N*</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>&lt;1.0</td>
<td>4</td>
<td>7%</td>
<td>10</td>
</tr>
<tr>
<td>1-2.0</td>
<td>14</td>
<td>25%</td>
<td>16</td>
</tr>
<tr>
<td>2.1-3</td>
<td>19</td>
<td>35%</td>
<td>9</td>
</tr>
<tr>
<td>3.1-4.0</td>
<td>10</td>
<td>18%</td>
<td>3</td>
</tr>
<tr>
<td>&gt;4</td>
<td>8</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>TOTAL</td>
<td>55</td>
<td>100%</td>
<td>40</td>
</tr>
</tbody>
</table>

Note: *N* represents number of responses in a category
Source: Research survey (2016)

Soil infertility was also reported in the study area and AEW ascribed this problem to improper farming methods, land use change and agricultural intensification among other factors. On soil fertility issues in Ward 2, 64% highlighted the soil was not fertile, while in Ward 33, 67% also concurred that soils were infertile and in Ward 6, 71% reported that soils were not fertile. KII and FGD revealed that soil infertility has greatly affected crop yields in the study area to the extent that people now rely on natural and artificial fertilisers. Furthermore, it was revealed that population growth and settlement has resulted in the reduction of land holding sizes per household except for a few individuals who inherited the land from their parents. It was also highlighted that population increase have reduced grazing area for livestock and people have to travel long distances to graze their livestock which was reported to be affecting livestock production in the area. Key informants also reported that arable land sizes for communal households have become unsustainably small due to environmental degradation which is being
accelerated by population increase and poor farming methods. Survey respondents reported that before settlement, the area was occupied by forests with a variety of vegetation types. KII and FGDs also revealed similar sentiments and added that population increase has led to land subdivisions and distribution resulting in the destruction of forests as people cleared more land for agricultural activities.

4.3 Agricultural Production

Under this section, the research explains various agricultural sectors that were explored under climate change. These are crop farming, garden production and livestock production.

4.3.1 Crop farming

Research findings revealed that inhabitants of the three Wards are predominantly smallholder farmers who depend on rain-fed agriculture. Crop cultivation is done on landholdings which are either located near the household or away from the household. According to interviews with Agriculture Extension Workers (AEW), it was reported that farmers in Ward 2 have crop-fields that are located at the periphery of the Ward encroaching into Mozambique and surrounding Wards, because the Ward is at the Zimbabwe border. The main crops grown in the 3 Wards for the 2015/2016 agriculture season included sorghum, maize (short season varieties), cotton, finger millet, soya-beans and tobacco (Table 4.8).
### Table 4.8: Crop production in 2015/2016

<table>
<thead>
<tr>
<th>Crops grown</th>
<th>Ward 2</th>
<th></th>
<th>Ward 6</th>
<th></th>
<th>Ward 33</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N*</td>
<td>%</td>
<td>Ha</td>
<td>Kgs</td>
<td>N</td>
<td>%</td>
<td>Ha</td>
<td>Kgs</td>
</tr>
<tr>
<td>Sorghum</td>
<td>48</td>
<td>87%</td>
<td>1</td>
<td>12</td>
<td>40</td>
<td>100%</td>
<td>0.5</td>
<td>1.83</td>
</tr>
<tr>
<td>Maize</td>
<td>16</td>
<td>29%</td>
<td>0.41</td>
<td>0</td>
<td>33</td>
<td>83%</td>
<td>0.1</td>
<td>7</td>
</tr>
<tr>
<td>Cotton</td>
<td>19</td>
<td>35%</td>
<td>0.34</td>
<td>0</td>
<td>10</td>
<td>25%</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Finger millet</td>
<td>0</td>
<td>0%</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>18%</td>
<td>0.2</td>
<td>0</td>
</tr>
<tr>
<td>Soya beans</td>
<td>0</td>
<td>0%</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tobacco</td>
<td>1</td>
<td>2%</td>
<td>0.31</td>
<td>3</td>
<td>1</td>
<td>3%</td>
<td>1</td>
<td>2.4</td>
</tr>
</tbody>
</table>

*Note:*  
N* indicates number of respondents farming a crop  
Ha* indicates average hectarage of crop grown per household  
Kgs* indicates average Kilograms of crop harvested

Source: Research Survey (2016)

It was revealed from the study that there was cash crop production and food crop production. According to key informants, tobacco, cotton and soya beans are grown mostly for cash while maize, finger millet and sorghum are grown for consumption, however the 2015/2016 cropping season resulted in very low yields. While there was significant production of sorghum in all 3 Wards (87% of the respondents in Ward 2, 100% in Ward 6, and also 100% in Ward 33), the yields were extremely low (12kgs per household in Ward 2, 1.83kg in Ward 6 and 8.61kg in Ward 33).

Maize was grown by a few farmers in Ward 2 (29%) because maize is not suitable for production in the valley area, and there was absolutely no yield. However, according to key informants, farmers use short season varieties in anticipation of significant yields. Most farmers in Wards 6 and 33 (83% and 100% of the respondents respectively) grew maize during the 2015/2016 season. The 2 Wards also realized very low maize yields (7kgs per household in Ward 6 and 5kgs in Ward 33).
Cotton production also saw Wards 2 and 33 not harvesting anything, while Ward 6 yields averaged 8kgs per household. Finger millet was only produced in Ward 6 by 7 of the respondents and the crop failed completely recording no harvests. Soya beans also realized no harvests in Wards 2 and 6, while Ward 33 recorded 4kgs that was harvested by the one respondent who grew the crop. According to AEW, tobacco production is fairly new to the valley and is not encouraged by Agritex because it is not suitable for the area. However because farmers are desperate for cash crop production, a few brave farmers have ventured into tobacco production. The 2015/2016 season therefore saw one respondent in each of Wards 2, 6 and 33 having grown tobacco on an average plot of less than one hectare. The resultant yield was also low (Ward 2 realised 3kgs, Ward 6 realised 2.4kgs and Ward 33 had 0 kgs).

According to Agritex Mt Darwin office, the 2015/2016 saw very poor yields of all crops produced throughout the district and most significantly in the valley area. The department attributed the poor yields to the low rainfall recorded during the season. It was also revealed by key informants that the shift to tobacco farming has brought environmental problems which include deforestation and soil erosion. According to the respondents, because of the low crop yields, there was nothing to sell. None of the respondents sold any crops, the harvests were of poor quality and quantity. According to Agritex Mt Darwin office, people were receiving drought relief assistance from World Vision, World Food Program (WFP) and Department of Social Services to augment food production.

A respondent lamented the 2015/2016 farming season:

“The season was very bad, we did not harvest anything, less than a gallon of sorghum, and this will not take us to the next season. We do not even have any crops to sell. We
now depend on food relief from Government and NGOs.” Respondent 87 [13 August (2016)]

4.3.2 Garden production

The study of gardens helped to establish activities that depend on natural resource utilisation and that are dependent predominantly on land and water resources. The survey results revealed that most of the respondents were in possession of a garden, where 95% of the respondents in Ward 2 have gardens, while 73% in Ward 6 have gardens and 96% of the respondents in Ward 33 also have gardens (Table 4.9). The average garden sizes ranged below 0.5 hectares, indicated by 89% of the responses from Ward 2, 65% from Ward 6 and 96% from Ward 33.

Table 4.9: Garden Ownership

<table>
<thead>
<tr>
<th>Variable</th>
<th>Ward 2</th>
<th>Ward 6</th>
<th>Ward 33</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garden-holder</td>
<td>N*</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Yes</td>
<td>52</td>
<td>95%</td>
<td>29</td>
</tr>
<tr>
<td>No</td>
<td>3</td>
<td>5%</td>
<td>11</td>
</tr>
<tr>
<td>Size of garden</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;0.5ha</td>
<td>49</td>
<td>89%</td>
<td>26</td>
</tr>
<tr>
<td>0.5-1ha</td>
<td>3</td>
<td>5%</td>
<td>1</td>
</tr>
<tr>
<td>&gt;1ha</td>
<td>0</td>
<td>0%</td>
<td>2</td>
</tr>
<tr>
<td>No response</td>
<td>3</td>
<td>5%</td>
<td>11</td>
</tr>
</tbody>
</table>

Note: N* represents number of responses in a category
Source: Research survey (2016)

Because of water scarcity in the valley area, most gardens were located along a river / stream. This was indicated by 95% of the respondents in Ward 2, 73% of the respondents in Ward 6 and 82% of the respondents in Ward 33. Only 6 (13%) respondents in Ward 33 had gardens located on upland. Sources of water for the gardens were therefore revealed to be along rivers and streams, and this was indicated by 95% of the respondents in Ward 2 who indicated that their gardens were along rivers and streams, as did 73% of the respondents in Ward 6 and 82% of the
respondents in Ward 33. None of the gardens source of water were said to be near a deep well, but in Ward 33, six (13%) of the respondents indicated that their source of garden water are boreholes.

Table 4.10: Garden location and type of water source

<table>
<thead>
<tr>
<th>Gardens</th>
<th>Ward 2</th>
<th>Ward 6</th>
<th>Ward 33</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>N*</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Location of garden</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riverine</td>
<td>52</td>
<td>95%</td>
<td>29</td>
</tr>
<tr>
<td>Upland</td>
<td>0</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>None</td>
<td>3</td>
<td>5%</td>
<td>11</td>
</tr>
<tr>
<td>Type of water source</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep well</td>
<td>0</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>Boreholes</td>
<td>0</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>River/stream</td>
<td>52</td>
<td>95%</td>
<td>29</td>
</tr>
<tr>
<td>No response</td>
<td>3</td>
<td>5%</td>
<td>11</td>
</tr>
</tbody>
</table>

Note: N* represents number of responses in a category
Source: Research survey (2016)

A respondent explained why gardens were mostly located along rivers:

“Gardening along the river banks and in floodplains is the only way we can access water. Water is a problem in the valley. We used to have good harvests but now with droughts, gardens are not doing well.” [Respondent 51 (13 August (2016)].

All the garden holders who responded in all the Wards confirmed that their gardens are less than 30m from the water source (95% of the responses in Ward 2, 73% of the responses in Ward 6 and 96% of the responses in Ward 33). Only those who did not have gardens comprised the remaining respondents, but pertinent to the responses, none of the gardens are located more than 30m from the water source.
Table 4.11: Garden characteristics and yields from gardens

<table>
<thead>
<tr>
<th>Gardens</th>
<th>Ward 2</th>
<th>Ward 6</th>
<th>Ward 33</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>N*</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Distance from water source</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;30m</td>
<td>52</td>
<td>95%</td>
<td>29</td>
</tr>
<tr>
<td>30-100m</td>
<td>0</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>&gt;100m</td>
<td>0</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>None</td>
<td>3</td>
<td>5%</td>
<td>11</td>
</tr>
<tr>
<td>Type of fencing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wire fencing</td>
<td>0</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>Live fencing</td>
<td>0</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>Brushwood</td>
<td>52</td>
<td>95%</td>
<td>29</td>
</tr>
<tr>
<td>None</td>
<td>3</td>
<td>5%</td>
<td>11</td>
</tr>
<tr>
<td>Average Yields (kgs) 2015/2016</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10kgs</td>
<td>52</td>
<td>95%</td>
<td>29</td>
</tr>
<tr>
<td>10-20kgs</td>
<td>0</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>&gt;20kgs</td>
<td>0</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>No response</td>
<td>3</td>
<td>5%</td>
<td>11</td>
</tr>
<tr>
<td>Average Yields (kgs) good year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10kgs</td>
<td>0</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>10-20kgs</td>
<td>15</td>
<td>27%</td>
<td>21</td>
</tr>
<tr>
<td>&gt;20kgs</td>
<td>37</td>
<td>67%</td>
<td>8</td>
</tr>
<tr>
<td>No response</td>
<td>3</td>
<td>5%</td>
<td>11</td>
</tr>
</tbody>
</table>

Note: N* represents number of responses in a category
Source: Research Survey (2016)

The type of fencing used to protect the gardens is indicative of the amount of effort and value ascribed to the gardening activities. The majority of the respondents (95% from Ward 2, 73% from Ward 6 and 96% from Ward 33) indicated that they use brushwood material to fence their gardens (Table 4.11). According to AEW, the choice of the materials is a result of lack of income to buy mesh-wire fencing, and live fencing takes too long to establish itself while gardens will be exposed to domestic animals such as cattle, goats and chickens.

The 2015/2016 season saw gardening production yielding harvests of less than 10kg in all 3 Wards. In Ward 2, 95% of the respondents harvested less than 10kg, while 73% of the
respondents from Ward 6 and 96% from Ward 33 also harvested less than 10kgs of garden crops during the 2015/2016 season. AEW in the Wards attributed the poor garden yields (Table 4.11) to the low rainfall received in 2015/2016. Comparatively in a good year average garden yields for all 3 Wards are 10kgs and more as indicated by 94 % of the respondents in Ward 2, 73% of the respondents in Ward 6 and 95% of the respondents in Ward 33.

![Figure 4.1: Garden with wilted vegetables in Ward 33](source: Research Survey (2016))

**4.3.3 Constraints faced in crop production**

The major constraints that were highlighted by survey respondents are presented in Table 4.12. The constraints were reported to be reducing the yield for the crops especially food crops grown by households. The main constraint alluded to in all 3 Wards was inconsistent rainfall as
indicated by 53% of the respondents in Ward 2, 55% of the respondents in Ward 6 and 56% of
the respondents in Ward 33. AEW concurred that rainfall distribution in all 3 Wards was erratic
and unreliable which had resulted in poor crop performance in the valley area.

Climate related disasters were also found to have an effect on crop production as reported by
29% of the survey respondents in Ward 2, 23% of the respondents in Ward 6 and 40% of the
respondents in Ward 33. The climate related disasters that were reported by survey respondents
included droughts and floods. Unreliable rainfall patterns were also highlighted by survey
respondents and these were linked to climate change and variability. This was also confirmed
during FGDs whereby the village elders highlighted that droughts and floods have increased in
frequency and severity and also rainfall has become unpredictable and the amount received has
been reduced. This is consistent with the results of Kanyepi and Tanyanyiwa (2014) who noted
that there have been many years in which rainfall received in Mt Darwin district was far below
the annual average. In addition this is consistent with Met office rainfall figures presented in the
study.

Table 4.12: Constraints faced in crop production

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Ward 2</th>
<th></th>
<th></th>
<th>Ward 6</th>
<th></th>
<th></th>
<th>Ward 33</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N*</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Inconsistent rainfall</td>
<td>29</td>
<td>53%</td>
<td>22</td>
<td>55%</td>
<td>25</td>
<td>56%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Climate related disasters</td>
<td>16</td>
<td>29%</td>
<td>9</td>
<td>23%</td>
<td>18</td>
<td>40%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land Degradation (Soil infertility, erosion etc)</td>
<td>8</td>
<td>15%</td>
<td>5</td>
<td>13%</td>
<td>2</td>
<td>4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>4%</td>
<td>4</td>
<td>10%</td>
<td>0</td>
<td>0%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note:  *N* represents number of responses in a category
Source: Research Survey (2016)

The prevalence of land degradation was reported by 8 (15%) of the respondents in Ward 2, 5
(13%) in Ward 6 and 2 (4%) of the respondents in Ward 33. Land degradation was found to be in
the form of soil infertility and soil erosion among other problems. The respondents complained
of poor soils that have been over-utilised. Land clearance for establishment of new fields and settlements and continued use of land without incorporating soil conservation principles were cited as responsible for land degradation. The results concur with Walingo et al. (2009) who attributed the shrinking natural resources and land degradation to population pressure and human activities in the Lake Victoria Basin of Kenya. Key informants recommended the use of contours to address soil erosion and the implementation of conservation agriculture principles.

![Figure 4.2: Land degradation in Ward 6](image)

Source: Research Survey (2016)

Key informants reported that most of the land has been degraded therefore arable land has become limited resulting in the decrease in expected yields. On soil fertility, AEW in the three
Wards acknowledged that the soil was no longer fertile, and was increasing in erodibility and this was also seen by river siltation and the prevalence of gullies in the valley area (Figure 4.2).

Droughts destroy flora and fauna, thus disturbing ecosystem processes and reducing land cover (Feresu, 2010). The reduction in land cover results in land becoming more vulnerable to soil erosion. Furthermore, as households cope with the effects of drought, they end up extensively farming on fragile lands like floodplains where they have greater chances of harvesting in drought conditions, further contributing to land degradation (Feresu, 2010). Key informants also emphasised that rainfall is no longer reliable as its pattern fluctuates almost every year in the region. This was attributed to climate change and AEW reported that they recommended to communal farmers the growing of small grains and drought tolerant crops as an adaptation measure.

4.3.4 Livestock ownership

Livestock are important cultural resources and it was revealed from KII that communal households owning livestock especially cattle are concerned with maximising herd numbers and not the quality of the herd therefore the stocking rates were high though grazing fields were limited. It was found that households in the valley keep livestock that include cattle, goats, sheep and indigenous chicken (Table 4.13). Tropical Livestock Units (TLU) were calculated for the predominant livestock types in the study area. The TLU conversion factors used in this study were adopted from Livestock Production Systems and Livestock development in Africa by Jahnke (1982). The TLU conversion factors were 0.7 for cattle, 0.1 for goats and sheep, and 0.01 for poultry (chickens).
Table 4.13: Average Livestock Population in Tropical Livestock Units (TLU)

<table>
<thead>
<tr>
<th>Livestock type</th>
<th>Ward 2 N*</th>
<th>Ward 6 N</th>
<th>Ward 33 A*</th>
<th>TLU N</th>
<th>A</th>
<th>TLU N</th>
<th>A</th>
<th>TLU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>123.60</td>
<td>100.67</td>
<td>1.76</td>
<td>272.79</td>
<td>6.06</td>
<td>4.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goats</td>
<td>64.43</td>
<td>156.28</td>
<td>0.39</td>
<td>88.92</td>
<td>1.98</td>
<td>0.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheep</td>
<td>7.57</td>
<td>5.67</td>
<td>0.01</td>
<td>6.24</td>
<td>0.14</td>
<td>0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicken (Indigenous)</td>
<td>101.16</td>
<td>107.56</td>
<td>0.03</td>
<td>291.11</td>
<td>6.47</td>
<td>0.06</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: *N* represents the number of livestock possessed by survey respondents
*A* represents average number of livestock reported by survey respondents

Source: Research Survey (2016)

It can be noted from Table 4.13 that TLU for cattle in all 3 Wards under investigation is diverse with the highest at 4.24 in Ward 33, followed by 1.76 in Ward 6 and 1.57 in Ward 2. TLU for goats were highest in Ward 6 at 0.39, followed by Ward 33 with 0.20 and Ward 2 with a TLU of 0.12. The TLU for sheep was the same across the 3 Wards at 0.01 as few respondents owned sheep in the 3 Wards. Indigenous chicken TLU was highest in Ward 33 at 0.06, followed by 0.03 in Ward 6 and the lowest TLU was Ward 2 at 0.02. The figures show that the herds in the study area comprised of mostly cattle and it was revealed by AEW, Vet extension staff and LPD officers that communal pastures are under stress considering the limited grazing fields during KII and FGDs.

A respondent emphasised the importance of livestock in the valley:

“Livestock is an important asset for the communities’ livelihood, but droughts result in serious water shortages and no pastures for our livestock” Respondent 14 [11 August (2016)].

According to key informants, it was reported that there was no limit to the number of livestock that a household could have in relation to the carrying capacity and the researcher noted that this has compromised the quality of cattle in the study area as natural fodder was found to be limited.
The LPD indicated that there is no grass-cover in most areas in the valley because of the high salt concentration in the soils even though these are favorable for mopane tree growth. So while the veld value is considered sweet veld, it has a low carrying capacity and is very sensitive to overgrazing with highly erodible soils. Bush encroachment in this type of veld is evident with a lot of invader weeds which are not palatable and a poor veld. Thus according to key informants, grazing has deteriorated since the district did not receive adequate rainfall to the extent that livestock are feeding on mopani leaves. On the other side however, the higher TLU for large ruminants also indicates that more manure is available to communal households from their herd. Manure was being used to improve soil fertility for crop productivity.

From the survey it was revealed that cattle constituted 90% of the ruminants reported by the survey respondents in the study area whereas goats had a share of 8% and sheep 1% (Table 4.14). This is consistent with Maburutse et al. (2012) who found that in communal areas cattle are the dominant livestock type followed by goats. Livestock in the 3 Wards was found to be biased towards ruminants that are grazers therefore rangeland management is of paramount importance in the study area. The categories of domesticated livestock as highlighted by Jahnke (1982) are large ruminant animals for example cattle; small ruminant animals such as goats and sheep; equines, pigs and chickens. From the study findings, it was revealed that ownership of livestock was high in the 3 Wards especially for large ruminants. Participants of focus group discussions highlighted that the livestock numbers were even higher in the late 1990s and early 2000. They further pointed that grazing lands in the 3 Wards have shrunk due to population growth which has necessitated the proliferation of settlements and this, coupled with environmental factors that include successive dry spells and droughts have led to farmers to resort to livestock selling therefore reducing the number of livestock in the area.
Table 4.14: Livestock population species in numbers and in Tropical Livestock Units

<table>
<thead>
<tr>
<th></th>
<th>Ruminants</th>
<th></th>
<th></th>
<th></th>
<th>Poultry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cattle</td>
<td>Goats</td>
<td>Sheep</td>
<td>Chicken</td>
<td>(Indigenous)</td>
</tr>
<tr>
<td>Ward 2</td>
<td>124</td>
<td>64</td>
<td>8</td>
<td>101</td>
<td></td>
</tr>
<tr>
<td>Ward 6</td>
<td>101</td>
<td>156</td>
<td>6</td>
<td>108</td>
<td></td>
</tr>
<tr>
<td>Ward 33</td>
<td>273</td>
<td>89</td>
<td>6</td>
<td>291</td>
<td></td>
</tr>
<tr>
<td>Total Number</td>
<td>498</td>
<td>309</td>
<td>20</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>TLU conversion factor</td>
<td>0.7</td>
<td>0.1</td>
<td>0.1</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Total TLU</td>
<td>348.6</td>
<td>30.9</td>
<td>2</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Share in total TLU (%)</td>
<td>90%</td>
<td>8%</td>
<td>1%</td>
<td>1%</td>
<td></td>
</tr>
</tbody>
</table>

Source: Research Survey (2016)

4.3.5 Challenges faced in livestock production

The major constraints that were highlighted by survey respondents are inadequate natural fodder, poor quality natural fodder, inadequate water for livestock and unreliable water source (Table 4.15). Inadequate forage was reported by 89% of the respondents in Ward 2, 83% in Ward 6 and 80% of the respondents in Ward 33.

Table 4.15: Constraints in livestock production

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Ward 2</th>
<th></th>
<th></th>
<th></th>
<th>Ward 6</th>
<th></th>
<th></th>
<th></th>
<th>Ward 33</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N*</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Inadequate forage</td>
<td>49</td>
<td>89%</td>
<td>33</td>
<td>83%</td>
<td>36</td>
<td>80%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor quality of forage</td>
<td>11</td>
<td>20%</td>
<td>6</td>
<td>15%</td>
<td>8</td>
<td>18%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inadequate water</td>
<td>36</td>
<td>65%</td>
<td>29</td>
<td>73%</td>
<td>21</td>
<td>47%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of reliable water source</td>
<td>48</td>
<td>87%</td>
<td>37</td>
<td>93%</td>
<td>40</td>
<td>89%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: N* represents number of responses in a category
Source: Research survey (2016)

Key informants highlighted that natural feed faces seasonal deficiencies especially during the dry season and in drought years. The other factors that were revealed to be exacerbating the problem are poor quality of forage due to infertile soils in the study area and expansion of human settlements thereby reducing the available grazing area. Veld fires were also blamed by key informants and FGDs for the destruction of grazing lands in the study area.
Inadequate water for livestock was found to be a challenge affecting livestock production in the study area and it was reported by 65% of the respondents in Ward 2, 73% of the respondents in Ward 6 and 47% of the respondents in Ward 33. Of equal importance was the reported lack of reliable water sources. This constraint was reported by 87%, 93% and 89% of the survey respondents in Wards 2, 6 and 33 respectively. Most of the waterways were reported to dry up a few months after the rainy season. People from other villages in the study area had to walk long distances in search of water for their livestock. From KII and FGDs it was noted that climate change and variability was being linked to the problem of water crises. They cited that due to climate change the amount of rainfall decreased and the onset of the first rains has shifted to mid or late December. This has resulted in cattle searching for water along silted riverbeds as shown below in Figure 4.3.

“Long back rains used to come in October when we used to grow cotton but now the rains are unpredictable and can come at the end of December.” Respondent 10 [11 August (2016)]
4.3.6 Impact of farm activities on the natural resource base

The effects of soil erosion in crop fields were also observed by the researcher and these were in the form of rills and gullies. Key informants linked that to deforestation, poor farming methods, agriculture intensification and unsustainable land management practices among other farm related factors. Extension workers reported that soil erosion was leading to siltation of water ways in the study area thereby reducing water storage capacity of the rivers.

Rivers in the valley are either heavily silted or no longer flowing. A respondent stated that:

“In the 1960s, the valley was plush with flowing rivers and riparian vegetation. To date most of the mighty rivers; Nyautande, Tsenga, Musingwa and Mukumbura, flow during the rainy season only and are deeply silted, with severely degraded riverbanks”.

Respondent 10 [8 August (2016)]

No initiatives to protect the land from severe degradation and rehabilitate the gullies were reported in all 3 Wards. However key informants recommended measures such as contour ridging, afforestation and adoption of conservation agriculture principles.

Despite facing serious water challenges during drought periods, respondents from FGDs stated that livestock rearing remained a viable fall-back strategy against drought. Livestock serve as a ‘bank’ that can be used in times of need.

As such according to Respondent 13 [11 August (2016)]:

“During drought livestock are traded for grain, one beast in exchange for 5-6 bags of maize but other people relocate their livestock to upper Mt Darwin until the time when grazing lands flourish when livestock are returned to the valley.”
However, while the fall-back strategy is reasonable from a human perspective, the challenge with livestock is the extra burden they place on an already overgrazed and over-browsed natural resource base. Thus livestock numbers continue to increase against declining rangelands.

4.4: Non-farm diversification

Non-farm diversification takes into account activities that are non-agricultural and these can be done on-farm or off farm. The main non-farm activities that were identified were natural resource based livelihood strategies and were found to be important in all 3 Wards (Table 4.16).

Table 4.16: Non-farm Activities

<table>
<thead>
<tr>
<th>Non-farm Activity</th>
<th>Ward 2</th>
<th></th>
<th>Ward 6</th>
<th></th>
<th>Ward 33</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N*</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Firewood / charcoal selling</td>
<td>21</td>
<td>38%</td>
<td>13</td>
<td>33%</td>
<td>15</td>
<td>33%</td>
</tr>
<tr>
<td>Pottery (kuumba hari)</td>
<td>7</td>
<td>13%</td>
<td>8</td>
<td>20%</td>
<td>26</td>
<td>58%</td>
</tr>
<tr>
<td>Brick-making</td>
<td>16</td>
<td>29%</td>
<td>17</td>
<td>43%</td>
<td>11</td>
<td>24%</td>
</tr>
<tr>
<td>Wild fruit selling</td>
<td>44</td>
<td>80%</td>
<td>19</td>
<td>48%</td>
<td>20</td>
<td>44%</td>
</tr>
<tr>
<td>Gold / mineral panning</td>
<td>4</td>
<td>7%</td>
<td>38</td>
<td>95%</td>
<td>18</td>
<td>40%</td>
</tr>
<tr>
<td>Weaving (Ilala palm, reeds)</td>
<td>6</td>
<td>11%</td>
<td>12</td>
<td>30%</td>
<td>35</td>
<td>78%</td>
</tr>
<tr>
<td>Poaching</td>
<td>3</td>
<td>5%</td>
<td>29</td>
<td>73%</td>
<td>12</td>
<td>27%</td>
</tr>
<tr>
<td>Wooden products (migoti, majoki)</td>
<td>7</td>
<td>13%</td>
<td>27</td>
<td>68%</td>
<td>14</td>
<td>31%</td>
</tr>
<tr>
<td>Kapenta selling</td>
<td>33</td>
<td>60%</td>
<td>3</td>
<td>8%</td>
<td>5</td>
<td>11%</td>
</tr>
<tr>
<td>Cross border trading</td>
<td>39</td>
<td>71%</td>
<td>5</td>
<td>13%</td>
<td>22</td>
<td>49%</td>
</tr>
</tbody>
</table>

Note: N* represents number of responses in a category
Source: Research Survey (2016)

It was found that firewood / charcoal selling, pottery making and selling, brick-making, wild fruit selling, gold / mineral panning, weaving (using ilala palm, water reeds), poaching and wood products making and selling were the main natural resource based activities. Other non-farm activities that were identified were kapenta selling and cross-border trading.

Firewood / charcoal selling was being done by 38% of the respondents in Ward 2 and 33% of the respondents in both Wards 6 and 33. Firewood / charcoal selling is more prominent in Ward 2,
because according to key informants, the Ward has sparse vegetation cover owing to its mainly urban set-up along the Mukumbura border. The charcoal product is procured from Mozambique and is traded at Mukumbura business centre. As such according to the Immigration and ZIMRA Office at Mukumbura border, the charcoal is not only sold to residents of Ward 2, but is sold to customers from as far as Mt Darwin town and Harare who purchase the charcoal in truckloads. It was observed that though firewood selling was common business in the 3 Wards, it was also the one fuelling deforestation in the study area (Figure 4.4).

Earthen pottery making and selling was being done by 58% of the respondents in Ward 33, 38% of the respondents in Ward 2 and 33% of the respondents in Ward 6. The enterprise is mostly a skills based activity and requires the use of dug-out clay. The pottery products are sold locally.

![Figure 4.4: Firewood for domestic use](image)
Source: Research Survey (2016)
Brick making is also common in the study area and it was found that 29% of the respondents in Ward 2, 43% of the survey respondents in Ward 6 and 24% of the respondents in Ward 33 were into this activity (Figure 4.5). Key informants reported that households considered it as a viable task as the raw materials are locally available and are for free. It was observed that the raw materials are soil from anthills (zvuru) and water from local water sources. Key informants further added that people in the study area were building new and improved house structures and schools were into building projects. In Ward 2 council officials highlighted that brick making has increased because of expansion of Mukumbura Growth Point. It was however observed that brick making is fuelling land degradation in the study area through soil mining.

![Figure 4.5: Brick-making and land degradation in Ward 6](image)

**Source:** Research Survey (2016)

Wild fruit selling is a major but seasonal activity in the study area. The activity is very common in Ward 2 with 80% of the survey respondents engaging in the activity, while 48% of the respondents in Ward 6 and 44% of the respondents in Ward 33 also engage in wild fruit selling. According to key informants, masawu (*Ziziphus mauritiana*), marula (*Sclerocarya birrea*) and
baobab (*Adansonia digitata*) fruit are the most harvested, to the extent that they are harvested before ripening. The major wild fruits that are traded are masawu (*Ziziphus mauritiana*) and the fruits ripen between May and June. The fruits are sold fresh and dried. Masawu fruits are sold along the Mukumbura highway and are also marketed to Mt Darwin, Bindura and Harare. According to Forestry Commission officer, masawu trees are mainly found along rivers, some are found in gardens, but the gardens are located along the rivers. Marula and baobab fruits are also traded but not as intensively as masawu. Masawu fruit are dried and consumed as a fruit or ground into powder for making porridge, energy drink or mahewu. The fruit is also brewed to make an opaque beer (kachasu), for selling and consumption. Baobab fruit is also harvested and consumed as fruit, in porridge, as a beverage (coffee), yoghurt or as an energy drink. According to FGDs and KII during drought, both man and livestock are dependent on the fruits for sustenance. Masawu trading is so rife that communities are crossing the border (illegally) to Mozambique to harvest (without permission) masawu so as to trade them in the valley. This is because by the time the masawu ripening season will have started, communities will have completed harvesting / hoarding masawu so as to store until ripe / ‘kunopfimbika’.

Gold panning is most prominent in Ward 6, where 95% of the survey respondents attested to taking part in the activity. To a lesser extent 40% of the respondents in Ward 33 and 7% of the respondents indicated doing gold / mineral panning. According to the KII and FGDs, gold panning was being done along Musingwa river in Ward 6, while in Wards 2 and 33 various minerals were being traded across the border to Mozambique but informally. Gold panning activities have resulted in random pits being dug along the rivers, damaging the riverbanks and fueling land degradation.
“There are so many pits being dug for gold along Musingwa river. Droughts worsen the situation because it is the only livelihood that can bring money.” Respondent 18 [11 August (2016)].

Weaving was found to be more common in Ward 33, where 78% of the respondents indicated that they weave and sell baskets and mats (maponde) using ilala palm and water reeds. 30% of the respondents in Ward 6 and 11% in Ward 2 also weave mats and baskets. According to KII, ilala palm is also sold to markets in Harare. Poaching was found to be prevalent in Ward 6 where 68% of the survey respondents indicated that the activity was rife in the Ward, while 27% of the survey respondents in Ward 33 and 5% of the respondents concurred that the activity was fairly common in their Wards. However, according to FGDs with village heads, it was revealed that in Ward 6 the Mavuradonha mountain was the hunting ground for poachers in Ward 6, who sold the hunt to Dotito growth point and other Wards.

“We do not have as much wildlife as we used to long back because of the poachers. They come in their numbers and can kill about 8 animals per hunt.” Respondent 40 [15 August 2016]

Other natural resource based activities in the study area included selling of wooden farm implements (majoki), wooden utensils (migoti), and use of forest resources for building (getting nhungo and mbariro for house roofs). 68% of the survey respondents indicated that they sell wooden products, while 31% in Ward 33 and 13% in Ward 2 agreed to the same. Kapenta selling is most common in Ward 2 (60% of the respondents) because the kapenta is bought in Mozambique to be sold at Mukumbura growth point. 11% of the respondents in Ward 33 and 8% of the respondents in Ward 6 also take part in kapenta selling. Cross border trading was found to
be an important activity in Ward 2 with 71% of the respondents in Ward 2 indicating that they trade across the Mukumbura border, while 49% of the respondents in Ward 33 and 13% of the respondents in Ward 6 also attesting to the activity.

It was revealed during FGD that most non-farm and off-farm activities were seasonal and done on a part time basis. Agricultural activities dominated during the cropping season that starts from November to April whereas non-farm and off-farm strategies dominated in the non-cropping season from May to October. This was consistent with what Kune and Mberengwa (2012) found in their study.

4.5 Climate change perceptions

The majority of the respondents (98%) stated that rainfall patterns in the area have changed over the last 30 years. While Sachikonye (1992) suggested distinct periodic drought cycles averaging two or three per decade, Iliffe (1990) argued that in the pre-colonial period, the rainfall statistics suggested that the Shona tribe suffered droughts in roughly one year in five. Jayne, et al., (2006) claimed that by 2006, Zimbabwe had experienced nine droughts since the country’s independence in 1980. This confirms Sachikonye and Feresu’s (2010) two or three droughts per decade assumption. Meanwhile, from FGDs with traditional leaders in all three Wards it was reported that since the 1980s they are recording less rain and the frequency of dry-spells has increased. They indicated that a significant increase in the frequency of long dry-spells was found during the crop season. Respondent 56 [15 August (2016)] further indicated that:

“We used to experience a 10-year drought cycle, with the year ending with a two always being a difficult season, but now droughts happen every 2 years”
This tallies with the 1972, 1982, 1992, 2002 and 2012 below normal rainfall seasons that were also revealed in the climate data obtained from the Meteorological station. The village elders also claimed that the trend is now shifting to increased cases of drier seasons within the same decade.

To further corroborate the village elders perceptions of a shift towards a warmer climate, 47.2% of the respondents believe that the climate is changing and it is not the way it used to be 10 years ago (Figure 4.6). 27.9% of the respondents said they have observed the changes in the past 5 years, 47.1% in the past 10 years, 12.1% in the past 15 years, 9.3% in the past 20 years and 3.6% in the past 30 years. From FGDs it was indicated that the rainfall seasons used to be distinct and predictable. They highlighted increased variability of the rainfall distribution in the recent past with the 2012/13 being the most noted season. They also said there is a change in the onset of rainfall season, rains are perceived to be starting late and ending early in February and not in March.

![Figure 4.6: Period over which climate changes have been observed](source: Research Survey (2016))
Respondents indicated a number of perceived changes in climate (Figure 4.7). Fifty-three per cent of the respondents identified the late onset of rains as well as early cessation of the rainy season as one change. Ninety-three per cent (93%) identified the long dry spells during the rainy season. 52% of the respondents noted decreased groundwater as an impact of drought. Decreased precipitation was cited by 68% of the respondents as an indicator of climate change while seventy-nine per cent (79%) of the respondents argued that there were increased incidences of droughts. Ninety seven per cent of the respondents highlighted that summers in the valley were now much hotter while winters were a lot warmer and 19% of the respondents said the winter was now shorter. Respondents also stated that in the 1980s rainfall was evenly distributed from October to March. However in the past 5 years significant rains were being received in February although the rain was not evenly distributed over the rainy season.

![Figure 4.7: Perceived indicators of climate change](source: Research Survey (2016))
From the key informant interviews with Agritex, Vet, LPD and Met officials, it was noted that rainfall patterns were indeed changing with a greater tendency towards a warmer and drier weather regime in the valley with intermittent flash floods. The key informants indicated that the current trend from the 1990s to date, is that effective rains are being received from December to March which is in contrast to earlier years when effective rains were received from mid-October to April while late rains were received in May. They concurred that dry spells were experienced in January in the past, but nowadays, January and February are prone to excessive rainfall. The key informants also indicated that at times only showers are experienced in February and no rains are received in March and that the rainfall season is becoming shorter. They however noted that while the rainfall amounts do not have significant changes from the mean, it is the distribution of the rainfall that is changing. Thus rainfall is at times received over a short duration instead of the usual four months. The key informants also indicated a general increase in temperature, with a tendency to fluctuate between hot and cold temperature extremes during the same season.

Figure 4.8: Perceived causes of drought
Source: Research Survey (2016)
The questionnaire survey revealed that 56% of the respondents perceived the causes of drought to be natural, 25% perceived the causes to be human induced with deforestation as the underlying factor while 19% attributed drought to both natural and human causes.

**Source of weather information**

The sources of weather information for the community are Agritex (37%), radio (5%), newspapers (4%), NGOs (10%), Indigenous knowledge systems (20%) and traditional means (24%) (Figure 4.9). Information from Agritex, traditional means and indigenous knowledge systems was perceived to be the most reliable, while that from the radio and newspaper was perceived to be the least reliable.

![Figure 4.9: Source of weather information](image)

Source: Research Survey (2016)

**4.6 Environmental impacts of drought**

The respondents agreed that environmental impacts of drought had long-term effects on the ecosystem and were difficult to reverse. They also concurred that droughts resulted in a
reduction in species diversity (94.3% responses) and species richness (77.2% responses) through increased mortality or migration (Figure 4.10).

<table>
<thead>
<tr>
<th>% response</th>
</tr>
</thead>
<tbody>
<tr>
<td>reduced species diversity</td>
</tr>
<tr>
<td>reduced species richness</td>
</tr>
<tr>
<td>habitat damage</td>
</tr>
<tr>
<td>reduced forage</td>
</tr>
<tr>
<td>wildlife mortality increased</td>
</tr>
<tr>
<td>increased plant disease</td>
</tr>
<tr>
<td>reduced regeneration</td>
</tr>
<tr>
<td>reduced soil moisture</td>
</tr>
<tr>
<td>increased wind erosion</td>
</tr>
<tr>
<td>drying of rivers/streams</td>
</tr>
</tbody>
</table>

**Figure 4.10: Environmental impacts of drought**  
Source: Research Survey (2016)

From FGDs that were done with village elders, it was learnt that in earlier times, the valley was abundant with elephant, antelope, zebra, lions, fish and birdlife, but owing to recurrent droughts and habitat fragmentation, wildlife is now a rare feature. 21.1% of the respondents argued that droughts can cause habitat damage, while 95% felt that droughts reduce forage significantly. This observation was also made by the Vet, Agritex and LPD departments who indicated that the past droughts had negatively affected forage and grazing land in the valley, to the extent that wildlife compete for wild fruits and agricultural crops with humans. 37% of the respondents stated that prolonged and consecutive droughts result in increased wildlife mortality.

Respondents indicated that plant biodiversity is also affected by droughts and impacts were noted to be increased plant disease (68% responses) and reduced regeneration (80% responses).
This is a major problem in the valley which has seen the once predominant and major indigenous flora *colophosphermum mopane* species failing to regenerate and thrive. Other species that are said to have been common in the valley that have also been affected are *brachystegia boehmii* (mupfuti) and *julbernadia globiflora* (mnondo). Plant diseases that include leaf warping and leaf nodes were highlighted among plant diseases during extended drought periods.

Soil is also affected by the long dry spells. 86.3% respondents stated that droughts resulted in reduced soil moisture which negatively affects crop production resulting in wilted maize crops, a staple in the valley. Soils in the valley are generally sodic, alluvial types that are loose and prone to erosion. 15% of the respondents felt that droughts created conditions suitable for increased wind erosion in the valley. Most of the respondents (97%) also felt that droughts cause the drying of rivers and streams. The valley is said to have been plush with flowing rivers and streams, but to date most of the rivers are heavily silted and only flow during the rainy season.

**4.7 Drought Coping strategies**

The study found that the mid Zambezi valley experiences droughts recurrently. This certainty of droughts occurrence implies that the communities have developed diverse means of coping with the impacts of droughts (Table 4.17), and the coping measures have a direct bearing on the natural resource base. It must be noted that the community has other socio-economic fall back strategies such as doing casual jobs (piece-work), food for work, migration, remittances, etc., but for the purposes of this study, the emphasis was on natural resource based coping mechanisms (Table 4.17) so as to confine the thrust of the research.

Only 24% of the respondents indicated that they do some form of conservation farming in both Wards 2 and 33, while in Ward 6, 25% of the respondents alluded to the same. From KII with
AEW it was highlighted that some farmers use minimum tillage and organic fertilisers (such as manure) as conservation farming techniques, however according to the AEW, the practices are on a very small scale, as farmers claim that conservation farming techniques are labour intensive.

Eighty-seven percent (87%) of the respondents in Ward 33 and 85% of the respondents in Ward 2 indicated that they grow small grains as a drought mitigation strategy while 55% of the respondents in Ward 6 indicated the same

“Sorghum seed is donated to us by World Vision, it produces better yields than maize especially during droughts.” Respondent 47 [15 August (2016)]

Expanding land cultivation was attributed to the increase in population in the area as well as declining soil fertility as explained by the AEW. From discussions with AEW it was revealed that youths were being given pieces of land for cultivation by their village heads, which saw some of the youths being allocated pieces of land in marginal areas. It was also revealed that some farmers were expanding their land for cultivation by also encroaching into marginal areas inorder to increase acreage under cultivation. 58% of the respondents in Ward 6 indicated that they had at some point expanded land for cultivation, while Wards 2 and 33 had 44% of the respondents alluding to the same.

A respondent further explained:

“Some people have expanded their crop- fields into grazing land and floodplains because their plots of land are too small” Respondent 48 (15 August (2016)]

Grazing land expansion is more prominent in Wards 2 and 6 as indicated by 80% and 75% of the respondents respectively. According to LPD Mt Darwin officers, expanding grazing land was a result of declining forage which was most significant during drought times, coupled with a low
carrying capacity for the increasing numbers of livestock in the valley area, farmers are forced to expand grazing land inorder to find forage for their livestock. From KII with Vet and AEW it was revealed that during drought periods, livestock in Ward 6 are sent to graze in the Mavuradonha mountains, while livestock in Ward 2 are herded into neighbouring Mozambique in search of forage.

Gold panning is a major fall-back strategy in Ward 2 as revealed by 78% of the respondents in Ward 2. According to EMA Mt Darwin office statistics, gold panning is concentrated along Musingwa River, which has resulted in damaged river-banks, increased soil erosion general land degradation along Musingwa River. Only 24% and 11% of the respondents in Wards 2 and 33 confirmed taking gold panning as a fall-back strategy.

In-order to cope with drought by managing forestry resources, 42% of the respondents in Ward 2 indicated that they plant shrubs and trees while 28% of the respondents in Ward 33 and 25% of the respondents in Ward 6 do the same. According to Forestry Commission, there is little tree planting in the valley area owing to the climatic conditions thus fast growing exotic trees such as eucalyptus species do not thrive well, while equally fast growing indigenous trees such as Acacia also fail to thrive because they are eaten before maturity by livestock. Agroforestry is being done on a small-scale by 20% of the respondents in Ward 6, 10% of the respondents in Ward 33 and 7% of the respondents in Ward 2. A respondent explained why few people planted trees or did agro-forestry:

“*We have more droughts than normal rains, so if we plant trees they die because of lack of water or get eaten by goats.*” Respondent 8 [19 August (2016)]
Forestry Commission revealed that forestry and wildlife utilisation tended to increase during drought periods. This was also indicated from the questionnaire survey, as the gathering of wild vegetables (such as “kadududza”) and roots (such as “manyanya”) was a major drought fall-back strategy as indicated by 90% of the respondents in Ward 6, 72% of the respondents in Ward 2 and 58% of the respondents in Ward 33. The wild vegetables and roots are mostly for sustenance, with very little being for sale. A female respondent lamented:

“Most of us have lost a lot of weight because of the drought, we are just eating wild fruits, vegetables and roots which we gathered and preserved through drying.”

Respondent 17 [11 August 2016]

Wild fruits such as masawu are commonly harvested for sale in the valley. This was indicated by 95% of the respondents in Ward 2, 53% of the respondents in Ward 33 and 45% of the respondents in Ward 6. According to KII with Forestry Commission, masawu are harvested between April and May, but because they are an important source of income that is in high demand among the households in the valley, the fruits are mostly harvested before they are ripe and usually the trees are damaged during the harvesting. Other fruits that are harvested for consumption and most significantly during drought periods are baobab and marula. A respondent had this to say about masawu

“We harvest and sell masawu every year, and it is a very important livelihood during drought because we will not have harvested anything. Most masawu trees are found along the rivers, and some of the trees are in our gardens because our gardens are along the rivers.” Respondent 39 [15 August (2016)].
<table>
<thead>
<tr>
<th>Drought coping strategies</th>
<th>Ward 2</th>
<th></th>
<th>Ward 6</th>
<th></th>
<th>Ward 33</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N*</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td><strong>Land</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conservation farming</td>
<td>21</td>
<td>38%</td>
<td>15</td>
<td>38%</td>
<td>32</td>
<td>71%</td>
</tr>
<tr>
<td>Small grain cultivation</td>
<td>47</td>
<td>85%</td>
<td>22</td>
<td>55%</td>
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<td>87%</td>
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<tr>
<td>Expand land cultivation</td>
<td>24</td>
<td>44%</td>
<td>23</td>
<td>58%</td>
<td>20</td>
<td>44%</td>
</tr>
<tr>
<td>Expand grazing land</td>
<td>44</td>
<td>80%</td>
<td>30</td>
<td>75%</td>
<td>19</td>
<td>42%</td>
</tr>
<tr>
<td>Gold panning</td>
<td>13</td>
<td>24%</td>
<td>31</td>
<td>78%</td>
<td>5</td>
<td>11%</td>
</tr>
<tr>
<td><strong>Forestry / wildlife</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tree planting</td>
<td>23</td>
<td>42%</td>
<td>10</td>
<td>25%</td>
<td>11</td>
<td>28%</td>
</tr>
<tr>
<td>Agroforestry</td>
<td>4</td>
<td>7%</td>
<td>8</td>
<td>20%</td>
<td>4</td>
<td>10%</td>
</tr>
<tr>
<td>Wild vegetables, roots</td>
<td>39</td>
<td>71%</td>
<td>36</td>
<td>90%</td>
<td>26</td>
<td>58%</td>
</tr>
<tr>
<td>Wild fruits</td>
<td>52</td>
<td>95%</td>
<td>18</td>
<td>45%</td>
<td>24</td>
<td>53%</td>
</tr>
<tr>
<td>Poaching</td>
<td>2</td>
<td>4%</td>
<td>29</td>
<td>73%</td>
<td>5</td>
<td>11%</td>
</tr>
<tr>
<td><strong>Water</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riverbed wells</td>
<td>53</td>
<td>96%</td>
<td>39</td>
<td>98%</td>
<td>37</td>
<td>82%</td>
</tr>
<tr>
<td>Floodplain cultivation</td>
<td>54</td>
<td>98%</td>
<td>37</td>
<td>93%</td>
<td>39</td>
<td>87%</td>
</tr>
<tr>
<td>Dams / weirs</td>
<td>9</td>
<td>16%</td>
<td>7</td>
<td>18%</td>
<td>6</td>
<td>13%</td>
</tr>
<tr>
<td>Irrigation</td>
<td>0</td>
<td>0%</td>
<td>0</td>
<td>0%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Livestock selling</td>
<td>16</td>
<td>29%</td>
<td>11</td>
<td>28%</td>
<td>12</td>
<td>27%</td>
</tr>
<tr>
<td>Livestock relocation</td>
<td>2</td>
<td>4%</td>
<td>9</td>
<td>23%</td>
<td>15</td>
<td>33%</td>
</tr>
<tr>
<td>Food Aid</td>
<td>55</td>
<td>100%</td>
<td>45</td>
<td>100%</td>
<td>40</td>
<td>100%</td>
</tr>
</tbody>
</table>

*Note: N* represents number of responses in a category
Source: Research survey (2016)*

Poaching is significant in Ward 6 as indicated by 73% of the respondents. This could be attributed to the Mavuradonha Mountains which form the western boundary of Ward 6. According to KII with Pfura RDC, poaching reports are highest during drought periods, where poachers can kill up to 8 antelope at a time for re-sale in other Wards. The wildlife are easily captured during drought because they leave their usual secure habitats and move closer to human settlements in search for water.
Water is the most affected natural resource during drought, as it becomes a major fall-back strategy for humans and livestock. According to the responses, 98% of the respondents in Ward 6, 96% of the respondents in Ward 2 and 82% of the respondents in Ward 33, are all dependent on riverbed wells “mifuku” during drought times. The riverbed wells are a source of water for both humans and livestock during droughts. Equally prevalent during drought is floodplain cultivation indicated by 98% of the respondents in Ward 2, 93% of the respondents in Ward 6 and 87% of the respondents in Ward 33. According to AEW, floodplain cultivation is most significant along Nyautande and Mukumbura rivers in Ward 2 as well as Musingwa river in Ward 6. According to KII with village elders most rivers in the valley have become heavily silted owing to these activities.

The water challenge has seen earth dams and small weirs being constructed in the valley area as indicated by 22% of the respondents in Ward 33, 18% of the respondents in Ward 6 and 16% of the respondents in Ward 2. The poor water holding capacity of most soils in the valley and their high erodibility has resulted in most of these earth dams and weirs being heavily silted and only flowing during the rainy season. Even the main rivers in the valley are ephemeral, hence water availability is generally very low. There are no irrigation activities in the valley area owing to the lack of a reliable water supply, this was indicated by the responses to the questionnaire survey (Table 4.17).

4.8 Natural resources utilisation

Natural capital assets are important to rural households and this refers to the natural resource stocks from which resource flows and services useful for livelihoods are derived (DFID, 1999). Examples of natural capital in the area include land, water and small woodlots. This form of
capital was found to be important for communal households who derived their livelihoods from natural resource-based activities that include crop and livestock production, firewood gathering and brick moulding among other activities. However, these activities have brought a lot of environmental problems to natural capital and these include deforestation, soil erosion and siltation.

During Focus Group Discussions that were held with village-heads in wards 2, 6 and 33, it was revealed that the natural resource base in the valley has been severely degraded over the years with increased soil erosion, frequent dust storms, a proliferation of gullies, silted river beds, invasion of shrubs, depletion of indigenous forests, depletion of grazing land and depletion of wildlife. A respondent indicated that:

“The environmental situation is unpleasant because the people in the valley are dependent on the degraded natural resource base for sustenance, which paints a bleak future for the community and the environment. Rivers are silted, there are so many gullies and there are no trees and wildlife left.” Respondent 27 [11 August (2016)].

According to AEW, most of the land was reported to be no longer productive due to soil infertility. The expansion and intensification of agriculture over the past decade, has resulted in cultivation of marginal areas and clearance of important natural habitats such as forests and wetlands. Such conversion was found to be a driving force behind land degradation. Focus group discussions revealed that vegetation cover has changed over the years and what were dense forests in the study area are now sparsely vegetated. Key informants revealed that some people have to walk over five kilometres in search of firewood. Destruction of natural protective cover
has been found to be mostly by indiscriminate cutting down of trees leading to deforestation, overgrazing of the vegetative cover and veld fires.

Soil degradation was observed in the area and this was linked to unsustainable land use practices and destruction of the natural protective layer. Brick making was also observed to be contributing to land degradation through soil mining activities. Focus group discussions and key informant interviews highlighted that they were aware of the environmental problems in their villages and they acknowledged that some areas have gone out of use and some small roads that links villages are no longer used due to soil erosion and environmental degradation. Key informants highlighted that gullies are now hazards to people in the communities and they reported cases of injuries especially for children when they are playing.

According to LPD officers it was further highlighted that population increase has reduced grazing area for livestock and people have to travel long distances to graze their livestock and this was reported to be affecting livestock production in the area. Key informants also reported that arable land sizes for communal households especially in Ward 6, are becoming unsustainably small due to environmental degradation which is being accelerated by population increase and poor farming methods. Small arable farm holdings are insufficient to provide their owners with a means of subsistence (Ellis, 2000). Survey respondents reported that before settlement, the area was occupied by forests with a variety of vegetation types. KII and FGDs also revealed similar sentiments and added that population increase has led to land subdivisions and distribution resulting in the destruction of forests as people cleared more land for agricultural activities.
4.9 Institutional arrangements on drought and natural resources management

Natural resource problems belong to a class of complex environmental policy problems whose remedy necessitates institutional adaptation and innovation. According to KII with the District Administrator and Met department, the rainfall forecasting responsibility in Zimbabwe lies with the Zimbabwe Meteorological Services Department. In addition, Agritex, the Famine Early Warning Systems Network (Fewsnet), World food Programme (WFP), Drought Monitoring Centre (DMC) and the Food and Nutrition Council in collaboration with ZimVac assess and monitor drought hazards, maintain early warning systems and provide rainfall forecasts for the forthcoming seasons. The thrust of these structures and assessments is on agricultural production and man’s vulnerability to drought.

Further discussions with Agritex Mt Darwin office revealed that the Southern African Regional Climate Outlook Forum (SARCOF) gathers climate experts and the user community to make seasonal and half-seasonal forecasts and helps in interpreting them for the benefit of the public. However, it has been noted that the challenge with the forecasts is on interpreting and using the information as several interpretations are driven from the seasonal probabilities that are produced. There also appears to be a gap between the predictions from the climate experts and the policies implemented by the government and other stakeholders regarding preparedness.

Apart from national strategies, a District Drought Relief Committee that is chaired by the District Administrator exists at the local / district level. This committee responds to and coordinates drought concerns during drought times. Again the committee’s thrust is man’s vulnerability to drought and not the environment’s vulnerability to drought.
Zimbabwe has a recently adopted climate change strategy. The climate change response strategy’s vision is to create a climate change resilient nation and the mission is to ensure sustainable development and a climate proofed economy. This is hoped to be achieved by engaging all stakeholders and recognizing the vulnerable nature of Zimbabwe’s natural resources and society. The strategy will go a long way in managing the environment if the government develops policies that support the strategy. Currently the country does not have policies on drought or climate change.

The Ministry of Environment, Water and Climate houses 4 departments EMA, Forestry Commission, ZINWA, DNPWLM (National Parks) and Meteorological services. The departments have sector-specific mandates and legislative pieces such as the Environmental Management Act Cap 20:27, the Forest Act Cap 19:05 and the Water Act. While the pieces of legislation focus on protecting the environment, they do not incorporate drought and climate change issues. Hence efforts to protect the environment are divorced from mitigating / protecting the environment from drought / climate change related impacts. Infact the department’s mandates are reactionary to weather extremes and other environmental hazards.

4.10 Observed mean climate parameters in Mt Darwin District over the last 5 decades

According to Unganai (1996), features of the climate system that are critical for vegetative growth include: temperature, wind, humidity, atmospheric carbon dioxide (CO₂), and precipitation. The study therefore looked at rainfall and temperature trends for Mt Darwin District.
4.10.1 Rainfall patterns in Mt Darwin District

To validate the perceptions on droughts, quantitative analyses of rainfall that were done revealed a high variability in annual rainfall (Figure 4.11). The highest amount of rainfall was 1321mm (1996/97 season) while the lowest amount of rainfall was 410mm (1991/92 season). The mean annual rainfall for Mt Darwin district using the rainfall data of 1970 – 2016 is 763mm. Generally 1991/92, 1983/84, 2015/16, 2012/13, 1986/87 and 2004/05 seasons received the lowest recorded rainfalls of 410mm, 465.9mm, 486mm, 501mm, 540mm and 541mm respectively while 68% of the seasons recorded below average rainfall. Low rainfall totals were also received after 2000, making the post 2000 era a dry period in the district.

![Figure 4.11: Rainfall patterns in Mt Darwin District from 1970 to 2016](Image)


The rainfall anomalies (shaded areas) in Figure 4.12 are deviations from the long term mean rainfall. Areas above the horizontal axis indicate a positive anomaly, that is, above normal rainfall seasons while areas below the horizontal axis are negative anomalies and they indicate
below normal rainfall seasons where; between 1970 and 1980 four seasons had below normal rainfall, between 1980 and 1990 four seasons also recorded below normal rainfall, between 1990 and 2000 three seasons recorded below normal rainfall. However most of the years after the year 2000 were characterised by below normal rainfall seasons where, between 2000 and 2016 ten seasons recorded below normal rainfall. This general pattern shows a gradual shift from a wetter climate towards a drier climate.

![Figure 4.12: Rainfall anomalies for Mt Darwin District from 1970 to 2016](image)


The rainfall in the mid Zambezi Valley is highly seasonal (90% occurring between November and March), often with a mid-season dry spell that occurs during critical periods of crop growth (Mavhura et al., 2015). The Mt Darwin monthly rainfall analysis (Figure 4.13) shows that the onset of rainfall for the district is in November and there is a short period of heavy rain that occurs mostly in December, January or February at the peak of the rainfall input. Rainfall is highly variable through the seasons, recording an entire season’s total in one month (Figure 4.13)
and a minimum of 0mm in another month. This scenario, coupled with the agro-ecological (region IV and V) characteristics of the mid Zambezi valley, the high variability of rainfall makes the area more susceptible to drought (Mavhura et al., 2015).

![Figure 4.13: Monthly mean distribution of rainfall, Mt Darwin](source: Mt Darwin Meteorological station, 1970 - 2016)

4.10.2 Temperature

The temperature trends of the district were collected from the Meteorological station in Mt Darwin District for the period 1970 – 2016. Figure 4.14 shows the time series plot of mean annual temperature for Mt Darwin from 1970/1971 to the 2015/2016 season. Indications are of warming temperatures for the district and the 2015-2016 season recorded the highest mean annual temperature of 29.91°C. Fluctuations between high and low temperatures were experienced between 1982 and 1996. However, there was a downward trend in the mean temperatures between 1996 and 2007 which then rose sharply between 2006 and 2009 from
25.51°C to 29.84°C, only to record a gradual decline again, showing that Mt Darwin is experiencing a continued warming.

![Graph showing mean annual temperature trend]

**Figure 4.14: Mean annual temperature, Mt Darwin District**

### 4.11 Emerging trends of Drought Prevalence

Results from the survey show a gradual increase in drought occurrences over the past five decades. Responses from the survey (questionnaire and interviews) corroborate well with the observed climate data from the Mt Darwin Meteorological station that droughts are occurring more frequently in Mt Darwin District. In the 1970s droughts occurred once in every decade, then in the 1980s and 1990s droughts increased in frequency and occurred every 3 to 5 years. At the turn of the century (year 2000), droughts increased in frequency of occurrence, and occurred after every 2 to 3 years. The increase in droughts has resulted in rains becoming more erratic and temperatures becoming warmer in Mt Darwin District. Furthermore, the rainfall distribution has changed with rains not being spread evenly across the rainy season. Using the ACT framework that guided the research, the recurrent drought trends and their increase in frequency over the
decades indicate a shift towards more droughts. Thus the future climate scenario based on the results of the survey for Mt Darwin District is of erratic rainfall and warmer temperatures. From the results there were no conservation strategies in place to conserve the natural resources in Mt Darwin valley. Thus conservation strategies have to be identified that protect the natural base in light of the recurrent droughts in the valley area.

4.12 Chapter Summary

The above chapter presented and discussed study findings that were derived from questionnaires, key informant interviews, focus group discussions, personal observations as well as secondary data sources from government and private institutions. The next chapter will provide a summary of the study, conclusion and recommendations.
CHAPTER FIVE : CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter provides conclusions that were drawn from the results of the study that were analysed and discussed in the previous chapter. The chapter outlines recommendations for adoption, which may help in effective and sustainable natural resources management.

5.2 Conclusion

The study sought to establish drought trends in the study area and to determine the state and extent of natural resource utilization in the middle Zambezi Valley. Furthermore the study sought to review the current response strategies to the impacts of droughts and to identify and suggest sustainable strategies to natural resource management.

From the findings of the research it was shown that Mt Darwin District is prone to recurrent droughts. Since 1957 droughts have been a common feature of Mt Darwin District. However, in recent decades and most significantly at the turn of the 21st century, droughts in the district have shown an increase in frequency and intensity. Since 2000, Mt Darwin District has recorded droughts every two to three years, compared to previous decades when droughts occurred after every 5 to 10 years.

Consecutive droughts combined with poor natural resource management practices and inappropriate policies will result in environmental degradation and thus a serious reduction in the productive capacity of the land (FAO, 1997). Droughts are also characterized by a reduction in river basin water resources over time and space, with negative socio-economic and
environmental impacts sustaining beyond the drought period (Wilhite et al. 2007; Logarand et al. 2013; Tsakiris et al. 2013). As vulnerability to drought has increased globally, greater attention should be directed at reducing risks associated with its occurrence.

The common perceptions of communities in Mt Darwin valley are that climate has changed for the worse with less rainfall amounts and increased frequency of drought events in the last two decades. These perceptions corroborated well with rainfall analyses that evidenced frequent dry-spells and rainfall distribution changes in the periods stated by the respondents. However while rainfall and temperature data were used in the study there is need to analyse and determine the relationships of these variables in influencing the extreme weather patterns.

The study revealed that communities in the valley are aware of drought occurrences in the area and this has influenced their decisions on coping strategies. It was also evident that the communities were coping with recurrent droughts through a range of strategies and since the main livelihood in the area is dryland cropping, it makes the households vulnerable to droughts. However, coping strategies by the communities put a great burden on the already vulnerable natural resource base.

The study showed that Zimbabwe has strong institutional and technical capacity to manage droughts, and Agritex cooperates with different partners mostly United Nations Food and Agricultural Organisation (UN-FAO) to perform a number of functions that help to counteract droughts. Despite the involvement of these institutions, drought management systems are still weak in Zimbabwe and furthermore while the existing structures address human vulnerability to drought they do not take cognizance of the environment’s vulnerability to drought.
5.3 Recommendations

After the study, the researcher identified several gaps which can be filled through the following recommendations:

- National policies on drought and climate change need to be formulated by Government. The policies need to have an integrated approach that are not only reactive but are also proactive so as to prepare for droughts before they occur. The policies should also strike a balance by having strategies that meet human needs and protecting the environment.

- Public information should be treated as such at most of Zimbabwe’s government institutions so that the public is kept aware of the drought and climate change issues in their areas. Dissemination of climatic information can help improve the community preparedness. The study recommends that climate information in the form of weather forecasts be made available to communities in the mid Zambezi valley.

- It is recommended that environment bodies that include EMA, ZINWA, Forestry Commission, Meteorological Department, RDCs, Department of National Parks and Wildlife invest in research on best strategies to manage, preserve and protect the delicate natural resource base in the mid Zambezi valley against the background of recurrent droughts and a changing climate. The research and policy focus should strike a balance between human and environmental vulnerabilities. Contextual implementation of policies may be informed by research, as implementation of policies in a crisis differs with implementation of policies in times of normalcy.
• There is need for Pfura Rural District Council, to ensure that functional by-laws that protect the ecological integrity of the valley are implemented and are upheld with a thrust on climate change and recurrent droughts.

• It is equally important to extend access to water supply and ensure that targeting and technology decisions are informed by an understanding of groundwater conditions. While irrigation schemes can help communities to increase food production and raise rural incomes irrigation may create conditions that can damage the environment through soil salinization etc, it is pertinent that government invest in improving water availability and accessibility in the valley so that there is less pressure on the limited water resources.

• REDD+ and Campfire programs need to be lured so that there is the creation of tradable offsets through emissions reduction or carbon sinks especially through avoided deforestation or reduced emissions from deforestation and forest degradation (REDD+). While there are no major forests to protect, the Mavhuradonha mountain range can be a starting point. It should be remembered that the mid Zambezi valley was once abundant with wildlife and was a main habitat and corridor for elephant movement. The community should continue to derive benefits from the natural resources however, they need to be instilled with a culture of ecological sensitivity and equipped with appropriate environmental management skills, as the environment provides the basis for their existence. Watching the continued degradation and deterioration of the natural resource base in the valley is a recipe for disaster from both the human and environment perspective.
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APPENDIX 1

Questionnaire – Household

My name is Lynn Guwah. I am a student at Bindura University of Science Education. I am conducting a study on drought trends, their impacts and natural resource utilization in Mt Darwin valley. This is part of my studies and the information you will provide will be treated with confidentiality and used for the purpose of this study only. Therefore I sincerely request your cooperation in responding to the following questions, which will take a few minutes of your time.

INSTRUCTIONS

- Do not write your name or any other person’s name in this questionnaire
- Please tick [ √ ] where applicable
- Write your responses in the spaces provided
- Answer all questions.

SECTION A

Identification of area

Date…………………………………………………………

District Name…………………………………..Ward Number …………………….

Household Characteristics

1. Gender: Male [ ] Female [ ]

2. Age:
   <15years [ ]  15 to 24years [ ]  25 to 39years [ ]
   40 to 54 years [ ]  55 to 64 years [ ]  > 64 years [ ]

3. Marital status
   Single [ ] Married [ ] Divorced [ ] Widowed [ ]
4. Number of household members

1-4 [  ]     5-8 [  ]     >8 [  ]

5. Level of Education:

No education [  ] Primary school [  ] Secondary school [  ] Tertiary [  ]

6. Religion

Christian [  ] Muslim [  ] ATR [  ] Other [  ]

**Access to land and tenure issues**

7. What is the size of your land / plot

<table>
<thead>
<tr>
<th>Hectares</th>
<th>Tick the appropriate</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1.0</td>
<td></td>
</tr>
<tr>
<td>1 – 2.0</td>
<td></td>
</tr>
<tr>
<td>2.1 – 3.0</td>
<td></td>
</tr>
<tr>
<td>3.1 – 4.0</td>
<td></td>
</tr>
<tr>
<td>&gt;4.0</td>
<td></td>
</tr>
</tbody>
</table>

**Agricultural production**

8. Crop farming

<table>
<thead>
<tr>
<th>Main crops grown</th>
<th>Hectares planted</th>
<th>Average harvested (kgs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cotton</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finger millet</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Soya beans  
Tobacco

Garden production

9. Do you own a garden  YES [   ] No [   ]
If yes to the previous question, what is the size of your garden
0.5 hectares [   ] 0.5-1 hectare [   ] >1 hectare [   ]

10. Garden location
Riverine [   ]
Upland [   ]

11. Type of water source used for garden
Deep well [   ]
Borehole [   ]
Stream / river [   ]

12. Distance of garden from water source
<30m [   ]
30-100m [   ]
>100m [   ]

13. Type of garden fencing used
Wire [   ]
Live fencing [   ]
Brushwood [   ]

14. Garden harvests

<table>
<thead>
<tr>
<th>Yield in kgs</th>
<th>Average yield 2015/2016 season</th>
<th>Average yield in a good year</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

15. Constraints faced in crop production
Inconsistent rainfall [   ]
Climate related disasters [   ]
16. Livestock production

<table>
<thead>
<tr>
<th>Livestock type</th>
<th>Total number owned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td></td>
</tr>
<tr>
<td>Sheep</td>
<td></td>
</tr>
<tr>
<td>Goats</td>
<td></td>
</tr>
<tr>
<td>Poultry</td>
<td></td>
</tr>
</tbody>
</table>

17. Constraints in livestock production

- Inadequate forage
- Poor quality forage
- Inadequate water
- Lack of reliable water source
- Non-farm diversification

18. Non-farm activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Tick the appropriate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firewood / charcoal selling</td>
<td></td>
</tr>
<tr>
<td>Pottery</td>
<td></td>
</tr>
<tr>
<td>Brickmaking</td>
<td></td>
</tr>
<tr>
<td>Wild fruit selling</td>
<td></td>
</tr>
<tr>
<td>Gold / mineral panning</td>
<td></td>
</tr>
<tr>
<td>Weaving (ilala palm, reeds)</td>
<td></td>
</tr>
<tr>
<td>Poaching</td>
<td></td>
</tr>
<tr>
<td>Wooden products (migoti, amjoki)</td>
<td></td>
</tr>
<tr>
<td>Kapenta selling</td>
<td></td>
</tr>
<tr>
<td>Cross border trading</td>
<td></td>
</tr>
</tbody>
</table>

19. Years observed climate change

- Past 5 years
- Past 10 years
- Past 15 years
20. Indicators of climate change

<table>
<thead>
<tr>
<th>Indicators of climate change</th>
<th>Tick the applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced precipitation</td>
<td></td>
</tr>
<tr>
<td>Warmer summer and winter</td>
<td></td>
</tr>
<tr>
<td>Late onset of rain and ends early</td>
<td></td>
</tr>
<tr>
<td>Mid-season dry spell</td>
<td></td>
</tr>
<tr>
<td>Increased droughts</td>
<td></td>
</tr>
<tr>
<td>Long dry spells</td>
<td></td>
</tr>
<tr>
<td>Reduced groundwater</td>
<td></td>
</tr>
</tbody>
</table>

21. Causes of drought

Natural [ ]  Human [ ]  Both [ ]

22. Sources of weather information

Agritex [ ]  Newspaper [ ]  Radio [ ]
NGOs [ ]  IKS [ ]  Traditional [ ]

23. Which of the following environmental impacts of drought have you noticed?

<table>
<thead>
<tr>
<th>Environmental Impacts of Drought</th>
<th>Tick the applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declining species richness (number of species population)</td>
<td></td>
</tr>
<tr>
<td>Reduced species diversity (variety of species)</td>
<td></td>
</tr>
<tr>
<td>Habitat damage</td>
<td></td>
</tr>
<tr>
<td>Decreasing forage</td>
<td></td>
</tr>
<tr>
<td>Wildlife mortality</td>
<td></td>
</tr>
<tr>
<td>Increased plant diseases</td>
<td></td>
</tr>
<tr>
<td>Reduced plant regeneration</td>
<td></td>
</tr>
<tr>
<td>Reduced soil moisture</td>
<td></td>
</tr>
<tr>
<td>Increased wind erosion / dust storms</td>
<td></td>
</tr>
</tbody>
</table>
24. Which of the following drought coping strategies do people use in this area?

<table>
<thead>
<tr>
<th>Land</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservation farming</td>
</tr>
<tr>
<td>Small grain cultivation</td>
</tr>
<tr>
<td>Expand land cultivation</td>
</tr>
<tr>
<td>Expand grazing land</td>
</tr>
<tr>
<td>Gold panning</td>
</tr>
<tr>
<td>Forestry / wildlife</td>
</tr>
<tr>
<td>Tree planting</td>
</tr>
<tr>
<td>Agroforestry</td>
</tr>
<tr>
<td>Wild vegetables, roots</td>
</tr>
<tr>
<td>Wild fruits</td>
</tr>
<tr>
<td>Poaching</td>
</tr>
<tr>
<td>Water</td>
</tr>
<tr>
<td>Riverbed wells</td>
</tr>
<tr>
<td>Floodplain cultivation</td>
</tr>
<tr>
<td>Dams / weirs</td>
</tr>
<tr>
<td>Irrigation</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>Livestock selling</td>
</tr>
<tr>
<td>Livestock relocation</td>
</tr>
<tr>
<td>Food Aid</td>
</tr>
</tbody>
</table>

25. Are there any institutions implementing drought mitigation strategies that protect the environment in this area?  Yes [   ]  No [   ]

If yes, explain:.................................................................

Thank you for your time**********************************
APPENDIX 2

My name is Lynn Guwah. I am a student at Bindura University of Science Education. I am conducting a study on drought trends, their impacts and natural resource utilization in Mt Darwin valley. This is part of my studies and the information you will provide will be treated with confidentiality and used for the purpose of this study only. Therefore I sincerely request your cooperation in responding to the following questions, which will take a few minutes of your time.

Key Informant Interview

Name of Organisation:__________________________
District name:_______________________________

1. When did people begin to settle in the valley?

2. What are the population trends in the district and the valley? What has influenced this trend?

3. Are there any climate changes that you have observed in the valley in the past 30 years?

4. Which years have had droughts of record?

5. What is the status of natural resources in the valley?

6. Which natural resources have been affected by drought the most, and in which way?

7. What natural resource extraction activities are taking place in the valley?

8. Are there any specific drought mitigation strategies to protect the environment?

9. Which natural resource management strategies do you suggest to mitigate against drought?

Thank you
APPENDIX 3

Focus Group Discussion

Name of Ward: ______________________

Attendance: Male ____________________ Female ______

1. What do you think is a drought?

2. Which were the droughts of record in the valley?

3. What do you think are the causes of these droughts?

4. What climate changes have you observed in the valley?

5. What are the environmental impacts of droughts?

6. Are there any early warning systems on droughts before they occur?

7. What are the indicators of drought / rainfall

8. What coping / fall-back strategies are used at household level in order to cope with drought?

9. Can you draw 2 resource maps (a current map and one showing 10 years ago) of your area indicating the state of natural resources?

10. What natural resource extraction activities are done in the valley?

11. What institutional coping strategies are in place to mitigate environmental impacts of drought?

12. What sustainable natural resource management strategies do you suggest in light of recurring droughts?
APPENDIX 4
Observation checklist

<table>
<thead>
<tr>
<th>Items to observe</th>
<th>Observations (date, location, coordinates)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. State of the natural resources:</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td></td>
</tr>
<tr>
<td>Vegetation</td>
<td></td>
</tr>
<tr>
<td>Soil</td>
<td></td>
</tr>
<tr>
<td>Wildlife</td>
<td></td>
</tr>
<tr>
<td>2. Drought impacts on:</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td></td>
</tr>
<tr>
<td>Vegetation</td>
<td></td>
</tr>
<tr>
<td>Soil</td>
<td></td>
</tr>
<tr>
<td>Wildlife</td>
<td></td>
</tr>
<tr>
<td>3. Natural resource extraction / utilisation</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX 5

<table>
<thead>
<tr>
<th>SEASON</th>
<th>AREA PLANTED</th>
<th>YIELD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015/2016</td>
<td>26110.2</td>
<td>0.17</td>
</tr>
<tr>
<td>2014/2015</td>
<td>32298</td>
<td>0.5</td>
</tr>
<tr>
<td>2013/2014</td>
<td>36367</td>
<td>0.7</td>
</tr>
<tr>
<td>2013/2013</td>
<td>22330</td>
<td>0.47</td>
</tr>
<tr>
<td>2011/2012</td>
<td>27840</td>
<td>0.6</td>
</tr>
<tr>
<td>2010/2011</td>
<td>36540</td>
<td>0.65</td>
</tr>
<tr>
<td>2009/2010</td>
<td>24873</td>
<td>0.61</td>
</tr>
<tr>
<td>2008/2009</td>
<td>24803</td>
<td>0.41</td>
</tr>
<tr>
<td>2007/2008</td>
<td>34860</td>
<td>0.3</td>
</tr>
<tr>
<td>2006/2007</td>
<td>35450</td>
<td>0.6</td>
</tr>
<tr>
<td>2005/2006</td>
<td>41875.5</td>
<td>1.2</td>
</tr>
<tr>
<td>2004/2005</td>
<td>34409</td>
<td>1</td>
</tr>
<tr>
<td>2003/2004</td>
<td>24688</td>
<td>3</td>
</tr>
<tr>
<td>2002/2003</td>
<td>23670</td>
<td>0.9</td>
</tr>
<tr>
<td>2001/2002</td>
<td>22740</td>
<td>1.4</td>
</tr>
<tr>
<td>2000/2001</td>
<td>26471</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Source: Mt Darwin Agritex (2016)
### APPENDIX 6
### Rainfall data 1957-2016

<table>
<thead>
<tr>
<th>year</th>
<th>rainfall</th>
<th>year</th>
<th>rainfall</th>
<th>year</th>
<th>rainfall</th>
</tr>
</thead>
<tbody>
<tr>
<td>1957/58</td>
<td>531.3</td>
<td>1980/81</td>
<td>905</td>
<td>2001/02</td>
<td>488.9</td>
</tr>
<tr>
<td>1958/59</td>
<td>641.35</td>
<td>1981/82</td>
<td>565</td>
<td>2002/03</td>
<td>501</td>
</tr>
<tr>
<td>1959/60</td>
<td>551.3</td>
<td>1982/83</td>
<td>581.1</td>
<td>2003/04</td>
<td>818.2</td>
</tr>
<tr>
<td>1960/61</td>
<td>662.3</td>
<td>1983/84</td>
<td>465.9</td>
<td>2004/05</td>
<td>499.8</td>
</tr>
<tr>
<td>1961/62</td>
<td>509</td>
<td>1984/85</td>
<td>900.9</td>
<td>2005/06</td>
<td>735.2</td>
</tr>
<tr>
<td>1962/63</td>
<td>504.7</td>
<td>1985/86</td>
<td>734</td>
<td>2006/07</td>
<td>501</td>
</tr>
<tr>
<td>1963/64</td>
<td>541.8</td>
<td>1986/87</td>
<td>511.1</td>
<td>2007/08</td>
<td>983</td>
</tr>
<tr>
<td>1964/65</td>
<td>690.65</td>
<td>1987/88</td>
<td>786</td>
<td>2008/09</td>
<td>500.9</td>
</tr>
<tr>
<td>1965/66</td>
<td>507</td>
<td>1988/89</td>
<td>762.2</td>
<td>2009/10</td>
<td>617.5</td>
</tr>
<tr>
<td>1966/67</td>
<td>628.95</td>
<td>1989/90</td>
<td>747.5</td>
<td>2010/11</td>
<td>1040.3</td>
</tr>
<tr>
<td>1967/68</td>
<td>423.25</td>
<td>1990/91</td>
<td>807.5</td>
<td>2011/12</td>
<td>552</td>
</tr>
<tr>
<td>1968/69</td>
<td>600.25</td>
<td>1991/92</td>
<td>406.5</td>
<td>2012/13</td>
<td>501</td>
</tr>
<tr>
<td>1969/70</td>
<td>611.2</td>
<td>1992/93</td>
<td>785</td>
<td>2013/14</td>
<td>824.8</td>
</tr>
<tr>
<td>1970/71</td>
<td>714.8</td>
<td>1993/94</td>
<td>687.2</td>
<td>2014/15</td>
<td>743.1</td>
</tr>
<tr>
<td>1971/72</td>
<td>569</td>
<td>1994/95</td>
<td>518.1</td>
<td>2015/16</td>
<td>486</td>
</tr>
<tr>
<td>1972/73</td>
<td>578.3</td>
<td>1995/96</td>
<td>686.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1973/74</td>
<td>921</td>
<td>1996/97</td>
<td>1105.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1974/75</td>
<td>745</td>
<td>1997/98</td>
<td>677.1</td>
<td></td>
<td></td>
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<td>1975/76</td>
<td>807</td>
<td>1998/99</td>
<td>1013.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1976/77</td>
<td>776.1</td>
<td>1999/2000</td>
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<td>1977/78</td>
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<td>1978/79</td>
<td>729.6</td>
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<tr>
<td>1979/80</td>
<td>562.7</td>
<td></td>
<td></td>
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</table>

Source: Mt Darwin Meteorological station (2016)