Mopane worm use, livelihoods and environmental change in Limpopo Province, South Africa

Masters Dissertation

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This thesis is presented in partial fulfilment of the requirements for the M(Phil) in Environment, Society and Sustainability degree and was supervised by Associate Professor Rachel Wynberg and co-supervised by Jaci van Niekerk.

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Submitted: November 2016

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Acknowledgements

I would first like to thank my supervisor Associate Professor Rachel Wynberg and co-supervisor Jaci van Niekerk for the guidance, support, advice, patience and encouragement. Their guidance consistently allowed this research to be my own work, but steered me in the right direction whenever I needed. It has been a great learning experience. I would also like to acknowledge the National Research Foundation and Department of Science and Technology for their funding assistance which supported this research through the DST/NRF South African Research Chairs Initiative. I would like to express my sincere gratitude to Fahdelah Hartly, the secretary to Associate Prof R. Wynberg, who assisted immensely with fieldwork-related bookings and arrangements. The long hours of field data collection and interviews would not have been fun had it not been for the selfless help of my translators and assistants, namely: Irene Raphalalani, Nsovo Ntsemi, Khumbelo Mukhala and Mukhethwa Simeli; their contribution to this study is greatly appreciated. I also would like to thank all the respondents for their willingness and enthusiasm to participate in the study. I must express my very profound gratitude to my family for providing me with unfailing support and continuous encouragement throughout my years of undergraduate study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them. Thank you!

Abstract

For centuries, nontimber forest products have been key aspects of household diets throughout the world. In southern Africa, mopane worms are widely harvested for household consumption and traded for income generation. This study investigated the contribution of mopane worm harvesting to rural livelihoods, and the effects of environmental change on mopane worm harvesting in rural households in order to understand how households attain sustainable livelihoods under different tenure types in rural areas in Limpopo Province, South Africa. Specific objectives were to determine the current significance and contribution of mopane worm harvesting and trading to rural livelihoods; to gauge the perceptions of harvesters and traders on forms of environmental change which have affected mopane worm availability and how consumption and trade patterns have changed in the last 20 years; to assess access and management of mopane resources under different tenure types; and, to explore mopane worm use in the context of the sustainable livelihoods framework.

The research was conducted in the villages of Bokmakierie, Matiyani, Ha Gumbu, Masisi, Zwigodini, and Mphambo in Vhembe district and Nkomo village in Mopani district in the Limpopo Province, South Africa. Additional interviews were conducted with traders at markets in Thohoyandou, Makhado, Malamulele, Giyani and Elim in the Vhembe and Mopane districts, Limpopo Province. The study employed qualitative methods to collect data and included semi-structured household and key informant interviews. The respondents and key informants were identified through snowball sampling techniques.

The significance of mopane worms in the study area is three-fold: it is an important source of food, it is a valuable trading commodity, and it is an intrinsic part of local cultural practices. The findings of this study indicated that the historical value placed on mopane worms as a food source and trading commodity has been passed down for generations. Trading was found to be important form of employment for rural people who have limited prospects of formal employment, and had the potential to generate higher income levels than wage labour in rural contexts. The decline in mopane tree density, vegetation change, lower-than-normal precipitation, and higher-than-normal temperatures were the leading forms of environmental change which have significantly affected mopane worm availability and outbreak events. Household consumption and trade patterns were altered as a result of the weather and climatic conditions shock arising from the El Niño phenomenon. Land

tenure type was found to be the primary determinant of resource management and access regimes in the harvesting areas.

Within the context of the sustainable livelihoods framework, the following findings were made. The limited availability of mopane worms presented a key constraint for the households and traders. The high availability of labour from family of the harvesters suggests human capital is strong. Furthermore, the strong social links and networks which resulted from family-level and community-wide participation strengthened the social capital opportunities. Physical and financial capital were found to have greatest threat to the attainment of sustainable livelihood. Households suffer poverty and are not easily able to access financial resources. This served as a hindrance for households and limited their income earning potential.

In respect of these findings the following recommendations are made: further empirical investigations should be undertaken to determine the status of mopane worm populations; improved cooperation between traditional leaders, harvesters and local government is suggested as an option for management of the communal harvesting areas; the interplay between access, land tenure and harvesting requires further research.

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Abbreviations

Contralesa	Congress of Traditional Leaders of South Africa
CPC	Climate Prediction Centre
DFID	Department for International Development
DST	Department of Science and Technology
ENSO	El Niño Southern Oscillation
NTFP	Non-timber Forest Product
LEDET	Limpopo Economic Development Environment and Tourism
NRF	National Research Foundation
SANParks	South African National Parks
SASSA	South African Social Security Agency
StatsSA	Statistics South Africa

Chapter 1: Introduction

1.1. Background

A wide range of forest products, categorised as timber and non-timber forest products (NTFPs), are relied upon by people across the world to maintain their livelihoods (Quang & Anh, 2006). This dependence is more pronounced within rural communities where poor households collect, process and trade natural resources from forests, woodlands, grasslands and rivers (Shackleton, *et al*., 2007; Heubach, *et al*., 2011). Households manage diversified livelihood portfolios to ensure availability of alternative resources in times of need as a buffer against uncertainty of natural resource availability and as a coping strategy (Kamanga, *et al*., 2009). Such portfolios include a wide range of activities such as keeping livestock, cultivating staple crops, and producing and trading traditional crafts such as mats and beer (Shackleton, *et al*., 2007). Mopane worms are one of the widely harvested NTFPs in Southern Africa. These NTFPs play an important role by providing employment, fulfilling vital needs and generating income (Makhado, *et al*., 2009a). Other intangible benefits include reduced household vulnerability, improved quality of life, independence, psychological wellbeing and perpetuation of traditions (Shackleton, *et al*., 2007).

Mopane worm is not technically a worm, rather it is the caterpillar phase of the emperor moth *Imbrasia belina*. However, for the purpose of familiarity and clarity, mopane worm will be used throughout the dissertation as a widely used and commonly known term. As a NTFP that is harvested and traded within the countries covering the geographical distribution of mopane woodlands (Makhado, *et al*., 2014). This is an ecoregion in southern Africa dominated by mopane trees (*Colophospermum mopane*) and extending over an estimated 555,000 km^2, thus forming a widespread vegetation type covering areas in Angola, Botswana, Namibia, Zimbabwe, Zambia, Mozambique, Malawi and South Africa (Makhado, *et al*., 2012).

Mopane worm is consumed as both a staple food and a delicacy within the southern African region. However, because of the geographical distribution of mopane woodlands and climatic variability, mopane worms do not occur evenly across the region, as a result some countries have been importing the mopane worms to meet the demand. This importation from countries of abundance to countries of scarcity has led to a thriving and lucrative trade, thus serving as a means of generating important income in poor rural households (Illgner & Nel, 2000; Kozanayi & Frost, 2002). Dedicated groups of traders and harvesters have become part of a trade network which deals exclusively with mopane worm trade in the southern Africa region. In this trade network, South Africa serves as the most lucrative market, thus enticing traders to import mopane worms from as

far as Zambia in times of scarcity in neighbouring Zimbabwe and Botswana (Kozanayi & Frost, 2002). However, this trade is not based exclusively on export and imports into countries of relative scarcity, intra-country transfer is also practiced and equally flourishing. Harvesters, usually in the rural areas, often trade their harvest in the towns and major cities (Thomas, 2013). This practice has an added benefit of increasing profitability due to the increased disparities between demand and supply. In this chain, on the one hand, harvesters may cooperate together and form groups in order to transport their stock in bulk and to minimise transportation costs. On the other hand, some harvesters may opt to trade their stock to intermediaries at informal markets, who then trade to consumers at towns and cities (Thomas, 2013).

Mopane worm outbreaks are highly dependent on a number of factors which range from the prevailing climatic conditions, habitat, predation and harvesting pressure on populations (Makhado, *et al*., 2009a; Makhado, *et al*., 2012). This dependency often means that constant availability of mopane worms cannot be guaranteed for the harvesters and traders who depend on the worms for their livelihoods (Phiri, *et al*., 2004). Given the dependency of mopane worms on environmental factors, the need to understand the impact of such factors on the worms and the resulting effect it has on the harvesters and traders in the context of rural poor households is important (Dube & Phiri, 2013). Moreover, given the value of mopane worms, especially in the effort to reduce poverty and ensure food security, securing the sustainable harvest of mopane worms is highly significant.

While mopane worm NTFP networks are vast and extend throughout the southern African region, this study is situated in some particular areas in order to contextualise the contribution of mopane worms to rural livelihoods. This study focuses on the contribution of mopane worm to rural livelihoods in rural villages in the Vhembe and Mopani districts of Limpopo Province, South Africa.

1.2. Relevance of the Study

The effects of environmental change in Southern Africa are becoming more evident, rendering rural people more vulnerable and threatening their livelihoods (Phiri, *et al*., 2004; Dube & Phiri, 2013). The prevailing climatic patterns are changing, characterised by an increase in the frequency of occurrence of extreme weather events (Lubchenco & Thomas, 2012). Rainfall and temperature are the two most important factors influencing the outbreaks and scale of availability of mopane worms and any extreme changes in either have been shown to have an effect on populations (Dube & Phiri, 2013). Similarly, mopane worm habitat destruction through deforestation and cutting down of mopane trees has been continuing, due to the demand for mopane wood. The wood is known for its

strength which makes it ideal as a building material and for firewood (Makhado, *et al*., 2009a). The combination of these pressures could result in mopane worm population declines, thus increasing the vulnerability of rural households which depend on mopane worm harvesting for food and income generation.

While deforestation and extreme changes in both rainfall and temperature are known to have an effect on mopane worm outbreak events and availability (Dube & Phiri, 2013), the impact of these factors in the context of harvesters and traders in rural areas of South Africa's Limpopo Province has not received in-depth attention. The changes in mopane worm availability has a snowball effect which has negative implications for mopane worm livelihoods. Increase in household vulnerability, threat on food security, reduced income earning potential and malnutrition are among the potential consequences of sudden unavailability events.

1.3. Aim

The aim of the study is to investigate the use and contribution of mopane worm harvesting to rural livelihoods, and the effects of environmental change on mopane worm harvesting in rural households, in order to understand how households attain sustainable livelihoods under different tenure types.

1.4. Objectives

- To determine the current significance and contribution of mopane worm harvesting and trading to rural livelihoods in Limpopo Province.
- To gauge the perceptions of harvesters and traders on forms of environmental change which have affected mopane worm availability and how consumption and trade patterns have changed in the last 20 years.
- To assess access and management of mopane resources under different tenure types.
- To explore mopane worm use in the context of the sustainable livelihoods framework.

1.5. Thesis Outline

This thesis comprises of six chapters. The first chapter is introductory and provides a brief

background of NTFPs, mopane worm trade, relevance of the study and finally outlines the aim and objectives of the research. Chapter 2 presents a review of literature under the following themes: contribution of NTFPs to rural livelihoods; sustainable livelihoods framework; sustainable use and regulation of NTFPs; environmental change and rural livelihoods; traditional leadership and NTFP management; and, mopane tree and its uses. Chapter 3 describes the study area, methodological approach, limitations and ethical considerations of the study. Chapter 4 presents the results of the study. Chapter 5 discusses the results in the context of the wider literature on NTFP sectors, environmental change, access and resource management in rural areas. Chapter 6 presents conclusion and recommendations drawn from the main findings.

Chapter 2: Literature Review

2.1. Contribution of Non-Timber Forest Products to Rural Livelihoods

The term non-timber forest product (NTFP) refers to "any wild biological resource (animal or plant) harvested from forested lands by rural households for domestic consumption or small-scale trade, with no, or limited capital investment. For example, it would include a small, rural enterprise of two people cutting and selling firewood or carving timber from a woodland, but would exclude timber felling and extraction by a large, commercial forestry company" (Shackleton, *et al*., 2007). A significant number of poor people around the world who live in or nearby forests and woodlands depend on these ecosystems for their livelihoods, welfare and income generation (Quang & Anh, 2006). In Zimbabwe, this dependence was found to be much more widespread among poor people and it fulfils important household needs (Kozanayi & Frost, 2002; Phiri, *et al*., 2004). Non-timber forest products support human wellbeing and livelihoods through direct household consumption, income generation, or provision of safety nets in cases of unexpected events; play important roles in local cultures and spirituality; and provide cash savings for households and governments (Shackleton & Pandey, 2014). Although NTFPs are known to have important socioeconomic value to rural households, there is still a lag in recognising their contribution to local and national economies especially in developing countries, where the dependency is high. (Shackleton, *et al*., 2001). In South Africa, it has been found that household and aggregate economic values of land-based livelihoods in communal areas were R13,28 billion (in 2000) (Adams et al., 2000 referenced in Shackleton, *et al* (2001).

Nonetheless, the NTFP sector receives significantly less attention in terms of policies aimed at fostering rural economic development, poverty alleviation (Shackleton & Pandey, 2014). Where such policies have been developed, they have been criticised for being inadequate to address the role of NTFPs in achieving poverty reduction (Ahenkan & Boon, 2010). This is driven by factors such as a lack of data on forestry-poverty linkages; general lack of knowledge on the linkages between forestry and poverty alleviation by decision-makers; and lastly, poor efforts in policy reform and investments towards the NTFP sector (Oksanen, *et al*., 2003). Nonetheless, the NTFP sector has the potential to be integrated into the supply chain for formal local, national and international markets (Shackleton & Pandey, 2014). To this end, several studies have attempted to provide the value of NTFPs in

monetary terms, demonstrating their significant contribution to rural and national economies (see for example, Delang, 2006; te Velde, *et al*., 2006; Kamanga, *et al*., 2009; Pokorny, *et al*., 2012).

The harvesting and trade of NTFPs serves as an important economic activity for people in rural areas where there are limited prospects of formal employment opportunities (Vedeld, *et al*., 2007). The contribution of NTFPs to household income can be very significant, it has been found to account for up to 90% of the household income (Shackleton, *et al*., 2008). This is a very important contribution of NTFPs to reducing poverty and household vulnerability. The use of NTFPs to generate income may happen in two ways. Firstly, as the primary source of income wherein NTFPs are harvested and traded as fulltime employment. This can provide a pathway out of poverty where economically valuable products are a major part of the traded resources (Shackleton, *et al*., 2008). Intensification and specialisation could be used as the means to maximise income from NTFP trading in order to enable the traders to venture into other capital-intensive income generating activities or to turn the trading into a valuable business. However, harvesting should be done sustainably in order to avoid undermining the resource base upon which livelihoods are based (Shackleton, *et al*., 2007; Vedeld, *et al*., 2007). Secondly, in instances where primary income generation is through formal employment, NTFP harvesting and trading would be done as a secondary source of income (Illgner & Nel, 2000). This happens predominantly where the availability of the NTFPs may be seasonal or dependent on climatic conditions (Greyling, and Potgieter, 2004 as cited in Thomas, 2013).

As a coping strategy during times of unfavourable events, rural poor households often find themselves having to utilise more NTFPs as a safety net to meet their household needs than under normal circumstances (Shackleton, *et al*., 2001). It is during difficult times such as the loss of income by the breadwinner or the occurrence of extreme weather events such as floods and droughts leading to loss of crops and livestock, that the emergency use of NTFPs is more evident (Shackleton & Shackleton, 2004; Paumgarten, 2005; Shackleton, *et al*., 2007; Shackleton & Pandey, 2014). Importantly, NTFPs provide a buffer to prevent households from plunging further into abject poverty (Shackleton & Shackleton, 2004; McSweeny, 2005). With changing climate, the frequency with which extreme weather events occur is increasing and this is known to impact significantly on poor people, mainly in developing countries, who are dependent on subsistence crop production and animal husbandry (Morton, 2007).

Although forest resources may not be the means to alleviate poverty for most rural people, Shackleton *et al*., (2007), argue that access to and the use of forest resources is important in preventing the intensification of poverty. Therefore access to the benefits provided by forest

resources is important in leveraging benefits for financial, spiritual and/or direct use purposes, especially in times of adversity until conditions improve (Shackleton, *et al*., 2007). For a few rural people, NTFPs may offer a pathway out of poverty, especially in the tourism and formal NTFP sector. In comparison with daily rates to casual or full-time workers in the agricultural sector in the rural areas, forestry related enterprises offers better returns to labour (Shackleton, *et al*., 2007).

Besides being a primary source of income for poor households, NTFPs have also been used as a means for cash-saving. By harvesting and utilizing the resources freely available in the forests and woodlands at relatively negligible or no cost, poor households can afford to save their scarce finances or use it to cover other household costs and livelihood necessities (Shackleton, *et al*., 2007). In households where the income generated by the breadwinner cannot provide for the entire family's living costs, NTFPs play a crucial supplementary role by providing food, energy, shelter and medicine, thus saving money for the families which can then be spent on other cash-intensive household needs and education (Shackleton, *et al*., 2007). Moreover, through provision of cash saving means to households, NTFPs help to lessen the extent and impact of poverty on poor households and therefore reduce the burden on the state. Therefore, by securing the availability and sustainable use of NTFPs, governments can take advantage of this relatively freely available cash-saving mechanism and alleviate the burden of poverty on state coffers. This however, should not be used to diminish the need to provide essential services to poor rural communities (Shackleton, *et al*., 2007; Shackleton & Pandey, 2014).

2.2. Sustainable Livelihoods: Framework for Analysis

The conceptual framework of sustainable livelihoods (Table 1) has gained popularity in application for understanding the adaptive strategies of rural households (Scoones, 1998). The emergence of the sustainable livelihoods approach was as a result of the need to develop responsive approaches to poverty alleviation (Carney, *et al*., 1999). As a result, this approach was perceived to provide a comprehensive and contextualised picture of the complexities that form part of rural and poor communities (Brocklesby & Fisher, 2003).

This approach combines the concepts of capabilities, equity and sustainability as the key preconditions for attaining a living. Each of these can be seen as both the means to and a result of a livelihood (Chambers & Conway, 1992). Within the sustainable livelihoods context, capability refers to an individual being able to find and make use of livelihood opportunities in order to cope with

stress and shocks (Chambers & Conway, 1992). Ensuring fair and equitable access to resources and empowering women is important in the fight against poverty. Sustainability refers to the ability to attain and improve livelihoods in a manner which minimises negative impacts and enhances the assets and capabilities on which livelihoods are based (Chambers & Conway, 1992).

Rural livelihoods investigations through the sustainable livelihoods framework take into account the various factors which may affect the survival strategies which a household may employ to reduce its risk or vulnerability. This provides a rounded contextual picture of the complexities which emanate from living within rural and poor communities (Brocklesby & Fisher, 2003). Factors adding to this complexity include capital assets, capabilities and access to the assets necessary for a household to make a living (Allison & Ellis, 2001).

For a household willing to pursue a livelihood strategy, a key consideration would be access to livelihood assets (*Category A in Table 1*) on which the livelihood is dependent. These livelihood assets and access thereto represent the household's strength, since the conversion of these assets to positive livelihood outcomes will lead to realisation of self-defined goals and desired outcomes (Kollmair & St-Gamper, 2002).

Hindrance or promotion of access or ownership of the assets are important determinants of the success of household livelihoods. Social relations, institutions and organisations are key (*Category B in Table 1*) (Allison & Ellis, 2001). Access to assets is furthermore influenced by the context within which the household finds itself (*Category C in Table 1*). These are largely external factors which are beyond the control or influence of the household (Allison & Ellis, 2001). Such factors may be *Trends*, such as population growth, migration, macro-economic trends and world economic trends or *Shocks* which include disasters, diseases, and civil wars. It is within these contexts that a household may seek a portfolio of livelihood strategies to reduce its vulnerability level or risk (*Category D in Table 1*). While certain trends may be negative and thus unfavourable, trends in innovation and technological advances may provide new opportunities which could be used to secure livelihoods (Kollmair & St-Gamper, 2002). The livelihood strategies sought by the household are often made up of natural resource-based and non-natural resource based portfolios of activities (*Category E in Table 1*). The makeup of the portfolio depends heavily on access to assets which in turn influence institutional processes which govern or control access barriers. Equally influential in this regard are the issues of social relationships and power relations which form part of the institutional processes governing access (Scoones, 1998). Realisation of the desired livelihood outcome often results in livelihood security and environmental sustainability (*Category F in Table 1*).

According to Scoones (1998) a sustainable livelihood would result in creation of work; poverty reduction; well-being and capabilities; livelihood adaptation, and resilience; and natural resource base sustainability. For investigations of the rural livelihoods and contexts within which to analyse the strategies used by households to maintain sustainable livelihoods, this approach offers a "*thinking out of the box*". The sustainable livelihood framework appreciates the contexts and relationships that exist and thus influence and shape communities and households. To this end, this framework calls for context-specific approaches which take into account local perspectives in order to understand the livelihoods of households and communities (Serrat, 2010).

Table 1 Sustainable livelihood framework

A	B	C	D	E	F
Livelihood platform	Access modified by	In context of	Resulting in	Composed of	With effects on
Assets Natural Capital Physical Capital Human Capital Financial Capital Social Capital	*Social Relations* Gender Class Age Ethnicity *Institutions* Rules and Customs Land and sea Tenure Markets in practice *Organisations* Associations NGOs Local Admin State Agencies	*Trends* Population Migration Technological change Relative prices Macro policy National economic trends World economic trends *Shocks* Storms Recruitment failures Diseases Civil wars	*Livelihood Strategies*	*NR Based activities* Fishing Cultivation Livestock Nonfarm NR *Non-NR based* Rural trade Other services Rural manufacture Remittances Other transfers	*Livelihood security* Income level Income stability Seasonality Degrees of risk *Environmental sustainability* Soils and land quality Water Fish stocks Forests Biodiversity

Source: Allison & Ellis (2001)

2.3. Sustainable Use and Regulation of NTFPs

People living in or near forests depend on NTFPs for their wellbeing and livelihoods. However, the NTFP sector receives little or no meaningful attention in policies aimed at development of rural communities, poverty alleviation or economic development. In cases where regulations have been passed, they have been criticised for being inappropriate to deal with management of NTFPs or inadequately funded to achieve targets (Thomas, 2013; Shackleton & Pandey, 2014). The poor regulation of the NTFP sector with regards to management, use and trade has led to problems of corruption, overharvesting and exploitation of harvesters and producers (Laird, *et al*., 2010). Furthermore, the disincentive effect of criminalisation and excessive regulation of NTFP harvesting has led to a decline in resource base due to overharvesting and appropriation of the resource (Shackleton, 2010). Given the importance of NTFPs to rural livelihoods and poor households, any form of governance and regulation of the sector should be aimed at promoting sustainable use and providing protection of subsistence harvesters against commercial harvesters (Shackleton, 2009). However, efforts to deter NTFP harvesting and use by means of legislation can have serious negative impacts on rural livelihoods and increase poverty. For example, statutory laws and conservation guidelines that prohibit and criminalise NTFP harvesting often lead to conflicts between conservation authorities and local people, especially when this prohibition encroaches on the livelihoods of local people (Shackleton, 2010).

To ensure sustainable use and conservation of NTFPs, governance of resources should be responsive to the needs of local people who depend on these resources. One way of ensuring the sustainable use and conservation of NTFPs is for governments to cede the control of the resources to local people for local and customary oversight (Pierce & Bürgener, 2010; Shackleton, 2010). Such decentralised NTFP control can be supported by the formation of dedicated institutions aimed solely at providing training on resource management, sustainable harvesting and value addition of the products to local people who harvest NTFPs for household consumption and small-scale traders (Kaimowitz, 2003; Makhado, *et al*., 2014; Shackleton & Pandey, 2014). Decentralisation shifts the burden of responsibility for resource protection and sustainable use to local people and therefore discourages unsustainable utilisation practices while fostering a sense of resource ownership. Furthermore, Kaimowitz (2003), suggests that governments in developing countries need to: encourage equitable distribution; provide financial, marketing and technical services for villagers and small forest enterprises; bring livelihood and landscape approaches into conservation efforts to promote sustainable use of NTFPs.

2.4. Environmental Change and Rural Livelihoods

Rural poor people sustain livelihood strategies in order to earn an income for household use and to minimise the potential household risks and vulnerability. Such rural livelihoods are inherently dependent on the environment and thus the status of the environment is an important factor in their sustainability (Sunderlin, *et al*., 2005). Environmental conditions such as drought, deforestation and desertification are among the stressors which exert pressure on rural communities and thus result in unexpected livelihood outcomes. These stressors, in combination with a lack of institutional support and socioeconomic factors such as poverty, limited access to resources and property ownership may increase household vulnerability and adversely affect food security (Misselhorn, 2005). Most of the humanitarian crises on the African continent are associated with environmental conditions such as droughts (Connolly-Boutin & Smit, 2016).

In northern Africa three quarters of rain-fed cultivation land is estimated to be lost due to climate change, with similar projections made for Mozambique, Botswana and South Africa (Fischer, *et al*., 2002). In sub-Saharan Africa, the ability of people to grow food and keep livestock is being impacted negatively by the extreme drought conditions. As a result, pastoralists and agro-pastoralists have to find alternative ways to maintain their livelihoods under the changing water regimes (Misselhorn, 2005). Changes in the long-term climate norms and short-term frequency and severity of climate is a significant stressor with severe implications on livelihoods. These long-term and short-term changes are projected to result in changes in rainfall intensity, increase incidents of extreme weather events and increase desertification (Challinor, *et al*., 2007). Climate change poses a greater threat to food security and rural livelihoods in sub-Saharan Africa due to the high dependency on rain fed agriculture in the region. It is estimated that 70% of the population depend on rainfall for irrigation of small-scale, subsistence farms which are vulnerable to climate change impacts (Challinor, *et al*., 2007). The effects will be compounded by the biophysical, political, and socioeconomic stresses which increase the susceptibility and erodes the adaptive capacity in the region (Davidson, *et al*., 2003; Misselhorn, 2005).

Different livelihood strategies may have to be adopted by households in order to increase their adaptive capacity. Some households may intensify, others may diversify, and there may also be some who are best served by migrating (Paavola, 2008). However, some households may use a combination of strategies to form a portfolio which provides better adaptation against key stressors, given the contextual constraints regarding information, assets, power and access to resources. Their

livelihood strategies will be both constrained and enabled by society they are embedded in (Paavola, 2008). Such adaptation responses include livelihood diversification, migration and agricultural extensification.

Livelihood diversification involves the creation and adoption of a portfolio of farming and non-timber forest product livelihoods (Paavola, 2008). As a coping strategy against the effect of environmental change, livelihood diversification is usually undertaken in order to reduce vulnerability and increase the adaptability of the households. This requires a portfolio with different properties so that risks can be managed in anticipation and that recovery is easier post the shock (Paavola, 2008). From this perspective, an ideal livelihood portfolio would comprise of livelihood activities such as crop production, livestock keeping, wage employment and participation in the NTFP sector which provides a combination of different risk attributes (Mortimore & Adams, 2001; Paavola, 2008). Households may be forced to migrate due to issues such as conflict, development projects, nature conservation, or environmental stress (Castles, 2003).

Migration, as a coping strategy, enables households to change their opportunities and related risks. Rural households may embark on migrations in pursuit of markets, employment for remittances, land and resource access. Depending on the type of the migration, these could open up access to opportunities such as access to land, resources, markets and employment (Koczberski & Curry, 2005; Paavola, 2008). Agricultural extensification involves taking new units of land for expansion of low-input cultivation. Extensification may also provide new land units with different risk units as an incentive for reducing vulnerability. However, extensification is dependent on land availability and is in competition for land with population growth, gazetting of land for conservation. However in cases where land is not scarce, extensification remain possible as a coping strategy (Paavola, 2008).

In parts of Limpopo Province, and in other former Bantustan homelands[1] elsewhere, deforestation is a key environmental change which is having unintended consequences on rural communities. Main drivers for the high rate of deforestation are provision of energy from wood, urban expansion and agriculture (Thobejane, 2009). Overpopulation in the former homelands is also contributing to the pressures exerted on vegetation. In the former Venda homelands (currently part of the Vhembe district), overpopulation resulting from the policies of relocation and concentration during the apartheid era, resulted in the localised pressures on the forests and woodlands in the eastern slopes of the Soutpansberg for settlements and cultivation (Munyati & Kabanda, 2009). Elsewhere in Limpopo Province, it has been noted that causes of vegetation change include livestock raising and

[1] A Bantustan homeland was a territory set aside for black inhabitants of South Africa, as part of the policy of apartheid government before democracy in 1994.

mining. It is held that in some of the former homelands, over 50% of the vegetation has been degraded or altered due to over population and unsustainable agriculture (Thobejane, 2009). In addition, urbanisation has resulted in the loss of arable land through expansion of commercial and residential units. These have led to the decline in important ecosystem services such as: timber for housing, kraals and fencing; fruit as an important dietary supplement; bark for making ropes and weaving; medicinal products from bark, bulbs, leaves and roots; honey production; harvesting of insects, mushrooms and other edible plants; grass for thatching and weaving, and for grazing cattle; local craft industries (Thobejane, 2009). However, the declines have not been uniform, rather they vary from slight to severe along a continuum, depending on the land capability units (Wessels, *et al*., 2004). The environment and rural livelihoods have a reciprocal relationship, in which on the one hand environment supports rural livelihoods through natural resources provision, thus affecting the household vulnerability. On the other hand, exploitative harvesting techniques may result in the degradation of the environment (Thobejane, 2009).

In the period between late 2014-mid 2016, the southern African region experienced drought conditions resulting from the El Nino phenomenon (Manderson, *et al*., 2016). This is the warm phase of an irregular temporal changes in winds and ocean surface temperatures in the over the eastern Pacific Ocean. This phenomenon impacts and disrupts the climate and weather patterns thus resulting in intense storms in some areas and droughts in others. The frequency of El Nino has been increasing and it is thought to be exacerbated by climate change (CPC, 2012; Manderson, *et al*., 2016). The rural areas in South Africa were hardest hit and Limpopo Province was no exception with the lowest rainfall recorded since 1904 (De Jager, 2016; Manderson, *et al*., 2016). In Mopane district, households and small-scale farmers reported loss of livelihoods and a lack of capacity to adapt to the drought shock. Decreases in water supply, soil erosion, reduced vegetation coverage, loss of employment in farms were some of the impacts of the drought. Lack of institutional support and poor drought preparedness exacerbated the impact (Manderson, *et al*., 2016).

2.5. Traditional Leadership and Access

The role and positioning of traditional leadership within the South Africa governance framework has gained prominence in the last 20 years (Cousins & Claassens, 2004). The institution of traditional leadership is evolving within the context of post-independence politics in South Africa, as a result, the traditional leaders are positioning themselves as the intermediaries and decision-makers between government and society (Koelble & Li Puma, 2011). This rise of the institution of traditional

leadership is being actively created and negotiated within the governance discourse in South Africa. Key to this rise is the Congress of Traditional Leaders of South Africa (Contralesa). This organisation is actively asserting the power of the traditional leadership within the rural social and economic sphere. This has effectively positioned the traditional leaders as the link between government and the *people* within their jurisdiction, in which it is claimed that the traditional leaders represent the indigenous model of democracy (Koelble & Li Puma, 2011).

The history of the relationship between the traditional leaders and the apartheid government in South Africa continues to haunt the institution of traditional leadership (Khunou, 2009). The legitimacy of these authorities has been questioned and challenged in many quarters of the society due to the role they played during the apartheid period in South Africa and the land ownership patterns which came into existence thereof (van Kessel & Oomen, 1997; Khunou, 2009; Kompi & Twala, 2014). In serving as the administrators of the 'independent' homelands, the traditional leaders contributed to the legitimisation of a system whose objective was to entrench the control over natives in the homelands and across South Africa (Koelble & Li Puma, 2011). This was preferred by the apartheid regime as the traditional leaders were perceived as loyal and compliant to the apartheid regime. To this end, those traditional leaders who were opposing the apartheid regime were disposed and replaced with headmen who were compliant (Khunou, 2009; Koelble & Li Puma, 2011). Nonetheless in modern democratic South Africa, traditional leaders are recognised in terms of the recognition of customary law in the 1996 Constitution of the Republic of South Africa (Khunou, 2009).

The positioning of the traditional leaders in the context of their communities means that their role in the management, regulation and access to resources is unique and strategic. Traditional leaders occasionally conduct *imbizos*[2] with their communities. This close interaction between traditional leaders and communities has generally strengthened the communication links between the two. It is during such *imbizos* that important information that affects the community get disseminated. This allows the traditional leaders to be aware of any issues affecting the communities (Kapfudzaruwa & Sowman, 2009).

The influence of the traditional leaders permeates into the management and regulation of livelihood resources in the rural areas. This is primarily due to their unique role that they play in controlling access to land in the rural areas (Mwalukomo, 2008). Within the context of natural resource access and regulation, the role of the traditional leaders is varied, they promote conservation practices,

[2] Imbizo is a Zulu word which colloquially refers to community meetings held with and chaired by the traditional leaders in their communities. The meetings are held at the traditional leader's residence or *the kraal.*

control access, create awareness and enforce laws. For access purposes, traditional leaders decree rules and regulations which determine people who are eligible to access the resources and the conditions of such access (Shackleton, *et al*., 2002; Mwalukomo, 2008). In study conducted on grass harvesting in Qwa Qwa, it was found that traditional leaders instituted a rule which mandated harvesters to obtain permission from the village head before harvesting. Under this rule, both local and nonlocal harvesters were not permitted to harvest grass without such permission. In granting the permission, the traditional leaders had to consider the medicinal and conservation value of the targeted grass species. As a result, harvesting of grass with high medicinal and conservation value was strictly regulated (Mwalukomo, 2008).

The role of traditional leaders in management and access of resources is being eroded and this decline in authority has created a management vacuum within the context of woodlands in communal areas. This has led to the degradation of woodland resources, unregulated harvesting seasons, increased competition for resources, illegal harvesting of resources and commercialisation of communal resources by individuals (Makhado, *et al*., 2009b). The erosion of the role of the traditional leaders is further worsened by the confusion between the traditional leaders and local government on who has the responsibility to for management of such resources (Makhado, *et al*., 2012). Makhado *et al*., (2009a) suggests that in order to curb the deteriorating state of woodland resources in rural areas, an integrated approach is required. The approach should include local people, traditional leaders and conservation officials and highlight the value of woodland products in rural livelihoods.

2.6. The Mopane Tree and its Uses

The mopane tree (Fig. 1), *Colophospermum mopane,* a nitrogen-fixing leguminous tree with broad butterfly-shaped leaves belongs to the sub-family Caesalpinioideae (Pokhriyal, *et al*., 1990). The geographical distribution of mopane woodland covers areas within South Africa, Zimbabwe, Mozambique, Zambia, Botswana, Namibia, Angola, and Malawi (Fig. 2). The mopane tree is used by rural communities within its geographical range for firewood, construction material for traditional structures (Musvoto, *et al*., 2006), dry season livestock feed, medicinal use and it also hosts an important food source, mopane worm (Thomas, 2013). These uses make the mopane tree an important plant species within its range and also place it among the most widely utilised plant species in South Africa (Makhado, *et al*., 2014). Although there are a number of mopane tree uses

(see for example, Stack, *et al*., 2003; Makhado, *et al*., 2009a; Makhado, *et al*., 2012), this study focuses on mopane worms as a food source and trade commodity.

Figure 1 Mopane tree *Colophospermum mopane* in Nkomo. Source: Researcher

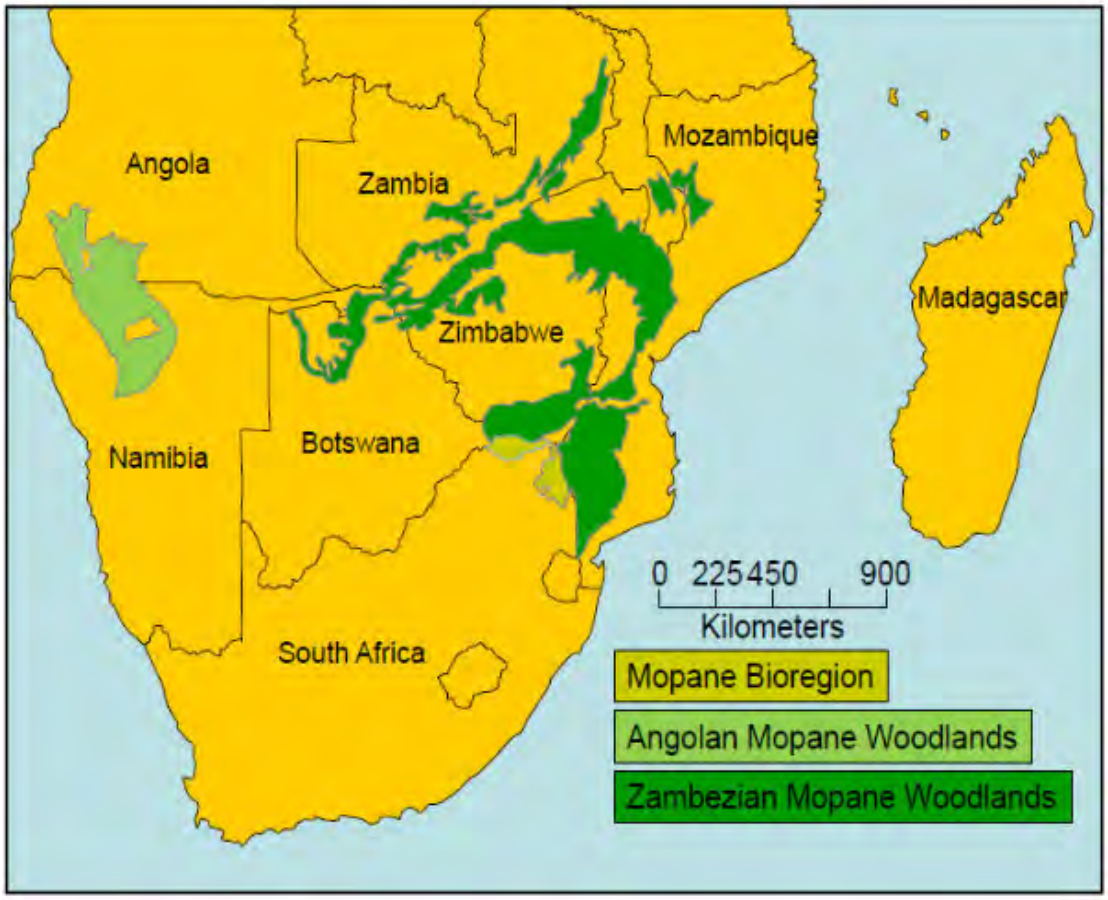

Figure 2 Map of the geographical distribution of mopane woodlands in southern Africa. Source: Makhado *et al*., (2012)

Mopane worm as a non-timber forest product

Mopane worm is a colloquial name of the caterpillar of the emperor moth, *Imbrasia belin*a (Makhado, et al., 2009) (Fig. 3), which feeds predominantly on the leaves of the mopane tree (Dube & Dube, 2010). Because of its high dependence on the mopane tree, the caterpillar is mostly found within the geographical range of *Colophospermum mopane* (Illgner & Nel, 2000). The caterpillar is widely consumed by rural and urban households within southern Africa, and due to its nutritional value and popularity, harvesting has been increasing and changing from a subsistence livelihood activity to a commercial one (Kozanayi & Frost, 2002; Thomas, 2013). The caterpillar outbreaks occur in two periods, the first from December to January, and the second from April to May (Makhado, et al., 2014). For rural and unemployed people, the two outbreaks create seasonal employment or income generating opportunities during the harvesting season and the subsequent trade (Makhado, et al., 2014).

Mopane worm processing involves the following stages. The first stage of processing mopane worms is degutting. This involves squeezing the caterpillar between the thumb and forefinger, from the head to the tail end, to remove the gut contents. Degutting in this way poses an injury risk to the processer because the spines on the caterpillar can puncture the palm and fingers. However, rubber gloves may be used to avoid injuries (Thomas, 2013). Plastic bottles can also be used to apply pressure on the caterpillar to push out the gut contents in a rolling movement (Kozanayi & Frost, 2002). The second stage of the processing involves roasting or boiling in brine for 20 to 60 minutes and then sun drying the caterpillar for about two to four days (Illgner & Nel, 2000). This stage is important in order to prolong shelf or storage life of the caterpillar (Thomas, 2013). Roasting removes the spines from the caterpillar and this makes them highly sought after by the buyers, unlike the boiled caterpillars, which still have spines (Kozanayi & Frost, 2002). As a result, only the caterpillars intended for household consumption by the harvesters are boiled.

Figure 3 Mopane worm feeding on the leaves of mopane tree. Source: Julian Donahue

Women and children are the major players in the supply chain, especially in the labour-intensive harvesting and processing of the mopane worms. Men act mainly as the intermediaries between the harvesters and markets (Ghazoul, 2006). The mopane worm trade takes place in several ways, through harvesters selling in bulk to other sellers, selling directly to consumers or engaging in bartering for food, clothing or household supplies (Gondo, et al., 2010). In terms of monetary sale,

Thomas (2013), reported a 50 kg maize meal sack of mopane worm grossing R716,95[3] in Namibia in 2013. In South Africa the price of a 80 kg maize meal sack of mopane worms ranged between R752,26 and R1002,98[4] in 2005 (Makhado, et al., 2014). The cross-border trade between Botswana, South Africa and Zimbabwe is valued at between R422 million and R638 million per year[5] (Makhado, et al., 2014). The domestic trade of mopane worms within southern African countries is relatively well understood (see for example, Kozanayi & Frost, 2002; Gondo, *et al*., 2010; Thomas, 2013).

Due to the seasonality and annual variability of mopane worm outbreaks, households may take part in a number of livelihood activities to either maximise income or reduce their vulnerability from dependence on one livelihood activity. Such activities include keeping livestock; subsistence crop farming; sale of staple crops; collection of natural resources for home consumption; sale of raw or processed natural resources; and exchange of goods and services for income (Shackleton, et al., 2001). There is evidence that mopane worm harvesting for consumption and trade, presents an important livelihood for rural people however environmental change in the rural areas may pose a threat to the sustainability of this livelihood activity. Poor regulation and management of mopane worm resources create an enabling environment for unsustainable resource exploitation. Investigations on the effects of environmental, cultural and socioeconomic change on mopane worm are thus important for livelihood and resource sustainability.

[3] Price adjusted at the 2013 average exchange rate of US$1 equivalent to R10,04
[4] Price adjusted at the 2005 average exchange rate of US$1 equivalent to R6,36
[5] Trade value (US$ 39 million and US$ 59 million) adjusted at the 2014 average exchange rate of US$1 equivalent to R10,83

Chapter 3 Methods

3.1. Study Area

The study was conducted in Limpopo Province in the villages of Matiyani, Mphambo, Nkomo, Ha Gumbu, Masisi, Zwigodini and Bokmakierie and in the neighbouring towns of Thohoyandou, Giyani, Malamulele, Elim and Makhado. The respondents were asked to identify villages wherein there are mopane worm harvesters and in each village the respondents were asked to identify any potential respondent who was either a harvester, trader or both. Broadly, the study sites fall within the districts of Vhembe and Mopani in the north and north-eastern parts of the Limpopo Province (Fig. 4).

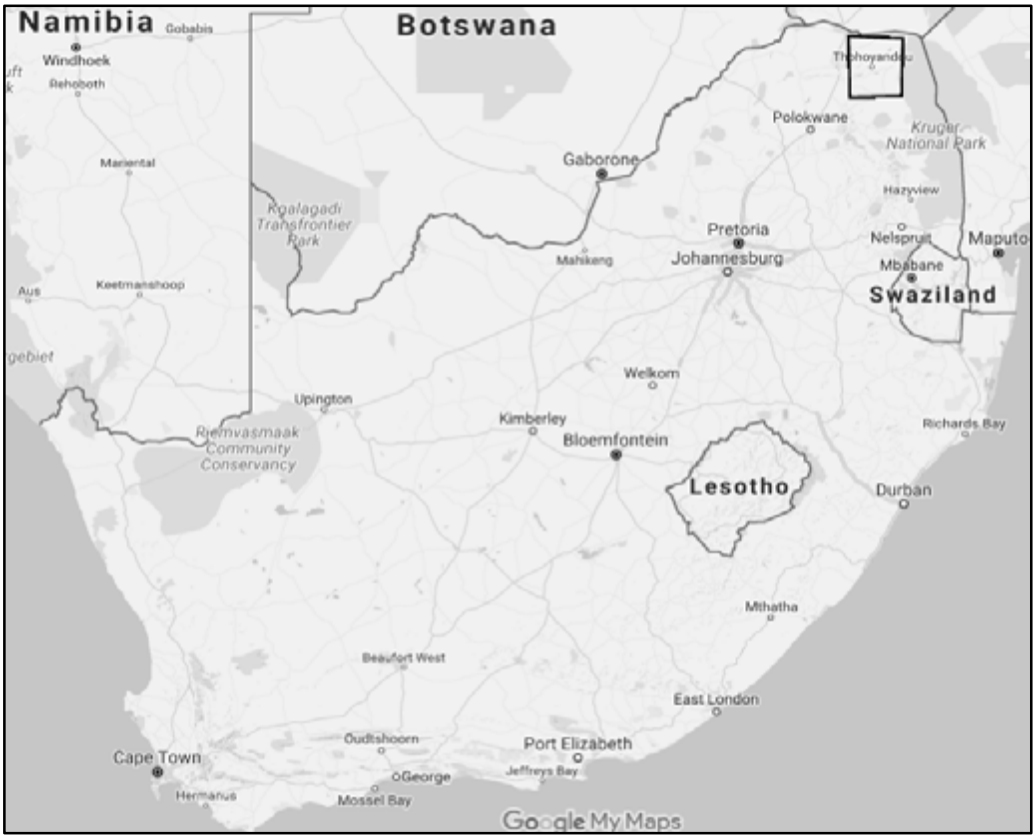

Figure 4 Google Maps image of the South Africa and the location of the study area (Black box)

The Vhembe district lies in the northernmost part of Limpopo Province and it shares borders with Zimbabwe to the north, Botswana in the north-west and Kruger National Park on the north-east (Fig. 5) (Vhembe, 2012). The district has a population of 1,294,722 people (StatsSA, 2012) and covers an area of 21,407 square km with only 1.1% of this categorised as urban area (Vhembe, 2012). The

major languages spoken in Vhembe are Tshivenda and Xitsonga, used by 67.3% and 24.9% of the population, respectively. The villages of Matiyani, Ha Gumbu, Masisi, Zwigodini, and Mphambo fall within the jurisdiction of Vhembe district. The village of Nkomo falls within the Greater Giyani Municipality which forms part of Mopani district, along with five local municipalities, namely Greater Letaba, Ba-Phalaborwa, Greater Tzaneen and Maruleng. Greater Giyani Municipality covers an area of 296,727 square km (Giyani, 2014) with a population of 244,217 (StatsSA, 2012). It shares borders with Ba-Phalaborwa o the south, Greater Letaba to the south-west, Makhado in the north-west, Thulamela in the north and the Kruger National Park in the east.

The history of Vhembe district, largely former Venda homeland, shares some similarities with many other former Bantustan homelands in South Africa. When the Native Land Act no 27 of 1913 was assented to, it effectively gave ownership of the 87% of the land in South Africa to the minority white population, while the majority of backs were squeezed into the remaining 13%. Provided for the demarcation of the land into portions falling into the following categories: state, private and communal land. In 1936, the Natives Land Amendment act was passed and it provided for the occupation of land for farming and other purposes by white South Africans. This ushered the period of forced removals without compensation for black South Africans (Tshamano & Mahosi, 2012). In the Vhembe area, people from Ratombo were evicted from their fertile lands to Mauluma in Nzhelele in order to make way for blue gum plantations and sawmills. Other forced removals took place in Levubu to Tshakhuma and Ha Mashau in order make way for banana plantations. These forced removals were exacerbated by the introduction of Crown Land which sought to expropriate fertile lands within the homelands for plantations and commercial farming (Tshamano & Mahosi, 2012).

In 1959, the Promotion of Bantu Self-Government Act was passed which led to the formation of Bantustan homelands from the native reserves. These supposedly, self-governing homelands, were effectively aimed to be labour reserves in which bantus would possess citizenship in the homeland of their origin (Evans, 2012). Moreover, these territories were intended to give a sense of control over state services and infrastructure projects. Between 1976 and 1981 four homeland territories were given independent status by South Africa. These are Venda, Bophuthatswana, Ciskei and Transkei. Nonetheless, these *states* never received international recognition (Evans, 2012). These states were later incorporated into South Africa in 1994. Venda became what is now Vhembe district.

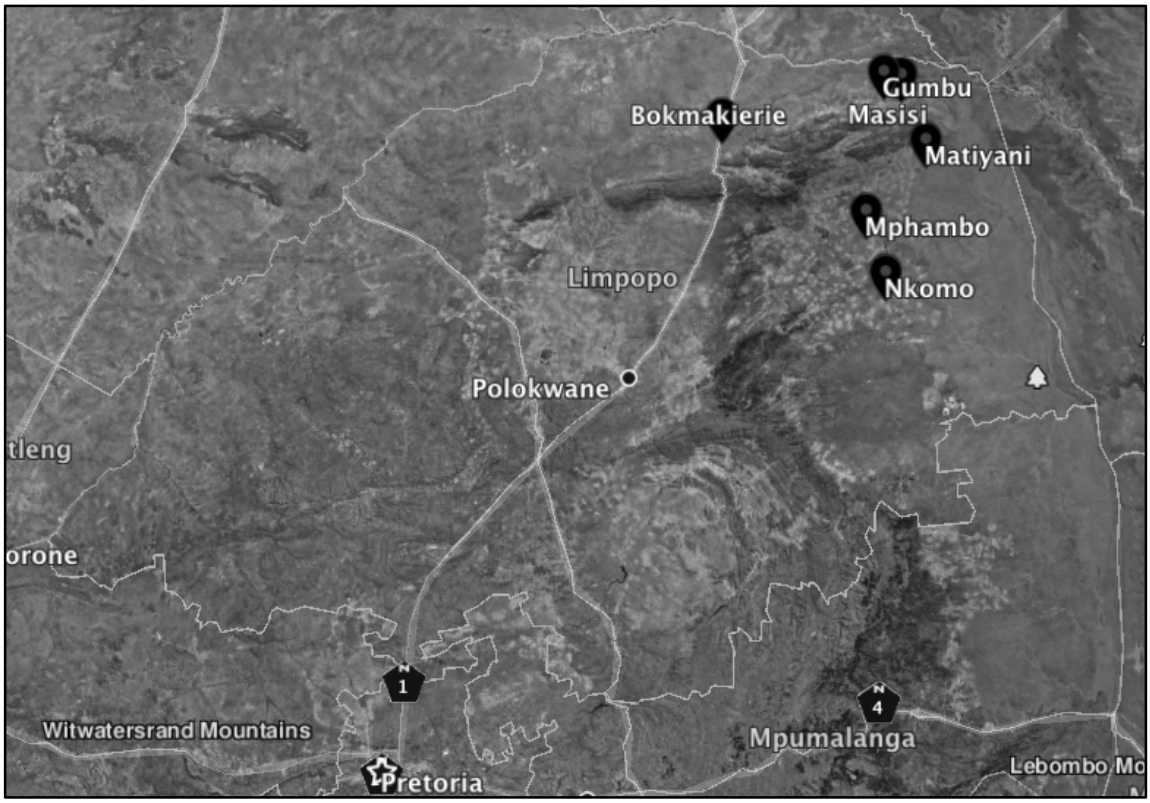

Figure 5 Google Earth image of the Limpopo Province and the location of the data collection sites in the study area

The study areas lie on the north eastern and south eastern slopes of the Soutpansberg mountain range. The east-west orientation of the mountain range strongly influences the climate of the area. The mountain range serves as an effective barrier between the south-easterly maritime climate influence of the Indian Ocean and the Inter-Tropical Convergence Zone and the Congo Air Mass from the north. This results in three distinct climatic regions: Humid on the southern and eastern slopes of the higher peaks; sub humid to the south of the range; and, semi-arid to the north of the Soutpansberg (Kabanda, 2003). The Vhembe area receives annual rainfall of approximately 500mm per annum. The rainfall amounts decreases from the east to the west in the district due to the Orographic effects of the Drakensberg and Soutpansberg mountains (Vhembe, 2012). The seasonality is characterised by the cool, dry season (May to August) and the warm, wet season (October to March), with April and September being transition months. There are frequent droughts experienced in the Vhembe district, especially in the predominantly semi-arid Mutale and Makhado local municipalities (Vhembe, 2012).

The study area comprises of variable topography which in turn results variable vegetation characteristics. The Vhembe district topography is highly influenced by the Soutpansberg mountain range with steep slopes. While to the southeast, the Greater Giyani area is largely characterised by

low lying areas. the vegetation in the study is highly variable, owning to the variable topography (Mulugisi, 2015). Within the study area there are two major bioregions, namely, Mopane bioregion and Lowveld bioregion. The vegetation ranges from closed woodland savannah with extensive cover of grasses on flat or gentle slopes to deciduous woodlands in sandy plains with endemic grass and herb species to tall shrub lands on extremely irregular plains on stony soils with deep sands with extensive erosion and some species poor forests of Afromontane character (Environomics, 2009).

The contribution of the NTFP sector to rural livelihoods in terms of subsistence use, informal trade, and as a coping strategy against shocks was found to be considerable in the Vhembe district. Households utilise forest products for subsistence, which include firewood, forest fruits and food (e.g. guava), construction wood, charcoal, thatch grass, bush meat/edible insect (e.g. Mopane worms), weaving fibre, fodder, medicinal plants, honey and mushroom. In a recent study, it was found that NTFP use was ranked highly by respondents in Thulamela and Makhado local municipalities. However, in Mutale the respondents ranked NTFP use relatively low. This was attributed to the poor state of the forests in Mutale and the semi-arid conditions in the area (Ofoegbu, et al., 2016).

3.2. Preliminary Site Visit

In December 2015 a scoping trip was undertaken by the researcher to the study sites to become familiar with the area, elicit information on trading markets, harvesting areas and to identify potential respondents. The scoping trip involved visiting known market places in Thohoyandou, Sibasa, Malamulele, Giyani, Elim and Makhado. Information was gathered from traders on the origin of the mopane worms; other market places used by traders in other towns; and the areas where people are known to harvest in Limpopo Province. As an outcome of this trip, data collection tools were refined and adjusted, and harvesting areas were identified.

3.3. Sampling

The snowball sampling (Goodman, 1961) technique was used to sample the respondents. The technique was used to purposefully target the community of harvesters and traders for their expertise and knowledge on mopane worms. This respondent-driven (Heckathorn, 1997) purposive non-random sampling technique entails identification of respondents through recommendations

from other respondents who are knowledgeable on the subject (Kim, *et al*., 2012; Cox, 2015). In using this sampling method, initial observations were used to guide the sampling of the subsequent observations through referral. This method is regarded as the most feasible and reliable in studies where access to remote respondents depends heavily on social networks, trust and human reputation (Cox, 2015). Moreover, the exploratory nature of snowball sampling enables the researcher to find subsequent study sites which would otherwise be unknown to the researcher. This technique is useful especially for qualitative, explorative and descriptive studies for making inferences bout populations which are difficult to enumerate through household surveys (Atkinson & Flint, 2001).

Nonetheless this technique has an inherent problem of lack of generalisability and introduction of bias. Snowball samples are more often than not, strongly biased towards individuals with relationships in the population. This raises the question of whether the results can be extrapolated to the wider population which shares the demographic characteristics or whether they are limited to a population that has undergone similar social experiences (Biernacki & Waldorf, 1981; Faugier & Sargeant, 1997). As a result, snowball sampling technique does not permit the researcher to use probability statistical methods because the sample would not be randomly drawn and is highly dependent on the individual choices of the originally selected respondents. This bias is inherently embedded in ethnographic methods which are used to recruit respondents in the initial stages of research in which widely known individuals are highly represented in the initial sample (Faugier & Sargeant, 1997).

3.4. Data Collection

This study used qualitative data collection and analysis techniques to investigate the contribution of mopane worms to rural livelihoods and the effects of environmental change on mopane worm availability, harvesting, trade and consumption patterns in rural households. Thirty semi-structured interviews were conducted in all the villages and 4 key informant interviews took place. Four market surveys were conducted at Elim, Makhado, Malamulele and Giyani to gather insights and perceptions of traders about mopane worm availability and trading fluctuations as a result of environmental change. The market surveys were conducted at markets which the researcher was referred to by traders and those found at taxi and bus ranks.

3.5. Semi-structured Interviews

Semi-structured interviews were conducted with both harvesters and traders of mopane worms, altogether 26 harvesters and 4 traders were interviewed. The questionnaire was divided into two sections. The first section comprised both open-ended and closed questions aimed at building a socioeconomic profile of the respondents. The second section comprised open-ended and Likert scale[6] questions in order to solicit information about the significance of mopane worms as a food source and trading commodity; perceptions of both harvesters and traders on forms of environmental change which are impacting on mopane worm availability and outbreak events; how environmental change alters mopane worm consumption and trade patterns; and, the role of traditional leaders in regulating access to mopane worms. The interviews and market surveys were conducted using English, Xitsonga, Tshivenda and Sepedi depending on the language preference of the respondent. Respondents were encouraged to use their mother tongue. This was aimed at ensuring that they were comfortable during the interview and thus could express themselves sufficiently without language hindrance.

3.6. Key Informant Interviews

Key informant interviews were held with four respondents[7] including a social science researcher, botanical researcher, local government administrator and traditional authority field ranger. The interviews were in the form of a discussion and were conducted in English, with the exception of the field ranger who preferred to have the discussion in Xitsonga. The key informants' expertise comprises of diverse backgrounds which are conservation, local government, traditional authority and botanical research. The sampling of the key informant respondents was purposefully done in order to include individuals with insights on the subject while representing various key players such as local government, conservation authority, research and traditional authority.

The social science researcher from SANParks was interviewed with regard to the historical and current significance of mopane worm harvesting and trade within rural households, the impact of the Kruger National Park mopane worm harvesting initiative and the effects of mopane worm shortages on traders and harvesters due to environmental change and the role of traditional leaders

[6] Likert scale is a scale used to represent people's attitudes to a given topic. Respondents are given a choice of five, seven or nine pre-coded responses and it allows respondents to express how much they agree or disagree with the statement.

[7] The names of these respondents have been altered for anonymity purposes.

in regulating and control of mopane worm harvesting. The interview with the botanical researcher was based on the interactions and beliefs of harvesters, the areas where mopane worms occur and the factors contributing to unreliable outbreak and availability patterns. The botanical researcher was asked about traditional harvesting techniques in comparison with modern techniques and their impacts. He was asked about the customary regulations for mopane worm harvesting and the prevalence of such regulations at different harvesting areas.

The interview with the municipality administrator responsible for local economic development focused on the role played by the municipality in promoting and protecting the traders and the harvesters, regulation of local and foreign traders and the contribution of the mopane worm trade to the harvesting and trading households as well as the local economy. He was also asked about the importance of the mopane worm trade in creating job opportunities and how this could be improved. The interview with the traditional authority field ranger focused on interventions in curbing deforestation and the harvesting of juvenile mopane worms. The respondent was also asked about the forms of punishment when perpetrators were caught and regulation by the provincial government.

3.7. Data Analysis

The interview data was translated then transcripted manually into Microsoft Word file. Once all data had been captured it was uploaded into Nvivo qualitative data analysis software for sorting and arrangement into different themes and codes based on the questions and topics explored during interviews. For graphical representation, Microsoft Excel was used to create graphs using the coded thematic data. The perceptions of the respondents were grouped according to key themes being explored in the thesis such as access; management; use and trade of mopane worms; household importance; pressures on populations and effects of environmental change.

3.8. Limitations

The majority of the respondents in this study were Vhavenda and Vatsonga. Since the researcher cannot communicate in either of these languages, interpreters were used to overcome the language barrier. However, it is acknowledged that the use of interpreters may be a limitation in terms of relaying accurate information during interviews. It was difficult to interview the municipality officials

during field work period because this coincided with the end-of-financial year in government and this was a busy period for the officials. Due to budgetary constraints the sample size was relatively small because of the limited time for field work. The study used a snowball sampling approach, as a result the researcher was only able to interview the respondents to whom were referred by fellow respondents. Some of the potential study sites were not visited due to remoteness and inaccessibility with the type of vehicle used. Some of the foreign traders declined the request for interviews and participation in the study. In the preceding months there were incidents of xenophobic attacks on foreign nationals in several provinces in South Africa and these individuals, Zimbabwean nationals, declined to participate in the study due to the fear of falling victim to such attacks should their nationality be communicated to strangers.

3.9. Research Ethics

This study followed the ethical standards of the Science Faculty at the University of Cape Town and ethical clearance for the research (FSREC 61–2015) was issued accordingly. The respondents' identity was kept strictly confidential. Before the commencement of the interviews the respondents were informed of the objective of the study and their rights to anonymity and termination of the interview at any stage that they so wish without prejudice or penalty. It was also explained that no compensation in any form should be expected from their participation in the study. The respondents were encouraged to answer the questions in their first language to ensure that they were comfortable during the interview. Pseudonyms were used in cases where identities may have been necessary. Feedback of this study will be provided to the communities involved.

Chapter 4: Results

4.1. Demographics of the Respondents

In total 30 interviews were conducted with harvesters and traders in the villages of Masisi (3), Zwigodini (5), Ha Gumbu (2), Matiyani (4), Mphambo (4), Nkomo (6), Bokmakierie (1) and Zwigonde (1) and in the towns of Giyani (1), Elim (1), Makhado (1) and Malamulele (1). The largest group (31%, n=10) in the sample was comprised of respondents aged between 30 and 39, followed by respondents aged between 20-29 and 40-49 each accounting for 23%. People aged 60 and above accounted for 13%, and those aged between 50-59 at 10 %. The majority of the respondents were female and accounted for 84% of the sample while their male counterparts accounted for 16%.

Mopane worm harvesting is predominantly undertaken as part of family activities, wherein parents and children work together. As a result, most harvesters get introduced to harvesting from an early age. This early introduction served two purposes. First, it engages as many family members as possible in harvesting, leading to an increase in available labour. Second, critical indigenous knowledge and skills get passed on in this way from one generation to the next. Forty-one percent of respondents indicated that they were introduced to mopane worm harvesting on or before reaching the age of 10 years. The majority of the respondents (44%) started harvesting when they were aged between 10 and 20 years old. Fifteen percent of the respondents were introduced to mopane worm harvesting after they had reached the age of 20. This finding indicates that a sizeable proportion of harvesters have been involved in harvesting since childhood and have grown up with mopane harvesting as a tradition in their households and villages. Most importantly, it suggests that for these harvesters, mopane harvesting is not a livelihood activity undertaken opportunistically later in life, rather it has been part of their upbringing and culture.

The majority of respondents in the interviews (57%) indicated that they were born outside of the areas where they were residing, with 43% resident in the areas where they were born. The high level of migration points to the mass relocations which took place in the former Bantustan homelands and forced evictions for state developments such as the construction of a military base due to the proximity of the study area to the South African border with Zimbabwe and Mozambique. Almost half of all the respondents had reached secondary school level. Thirty-nine percent of the respondents had attained primary school level education while thirteen percent did not have any form of schooling at all. None of the respondents had attained tertiary level education. More than

half of the respondents (63%) were from female-headed households, while the remaining 37% were from male-headed households.

More than two-thirds of the respondents (70%) were from households sized between 5-10 individuals, and 17% were from families with eleven or more members. This finding indicates typical family structure in which families comprising two or more generations were living in the same household. Such cases include instances where parents would leave their children with their grandparents to seek better employment opportunities elsewhere. Most of the respondents (64%) were unemployed, while 16 % were self-employed. Only 10% of the respondents were formally employed, and a further 10% were on pension. This finding is characteristic of many rural areas in South Africa where unemployment levels are high and are exacerbated by a lack of employment opportunities.

The most common form of transportation for mopane harvesting was by walking (49 %). This could be an indication that harvesting generally occurs in the areas closest to those where harvesters reside. This close proximity could be one of the motivating factors for actively engaging in mopane worm harvesting. Twenty-seven percent of the respondents utilised public transport to access the harvest areas, while 19% utilised hired transport. Only 5 % of the respondents used their own vehicle when going to harvest.

4.3. Land Tenure, Resource Management and Access

Land tenure is the main determinant of the access regime and resource management in the harvesting areas. Three different tenure types were found in the harvesting areas (Fig. 6), namely communal, private and public (state)[8]. Within the communal areas, depending on the access regime enforced by the traditional leaders, harvesters may be required to obtain permission to harvest, while in some villages no permission is required. The permission could be verbal or in the form of a written letter of permission. In private and state owned lands, access permission is strictly required. The only difference is that a permit fee is usually payable on private land while the state does not charge prospective harvesters. To determine the access regimes in the harvesting areas, the respondents were asked to indicate the access conditions and the tenure type in the harvesting areas that they utilise.

[8] Public (State) is used in this dissertation to refer to land under conservation and being managed by the state conservation authority, SANParks and/or provincial environmental affairs department, where applicable.

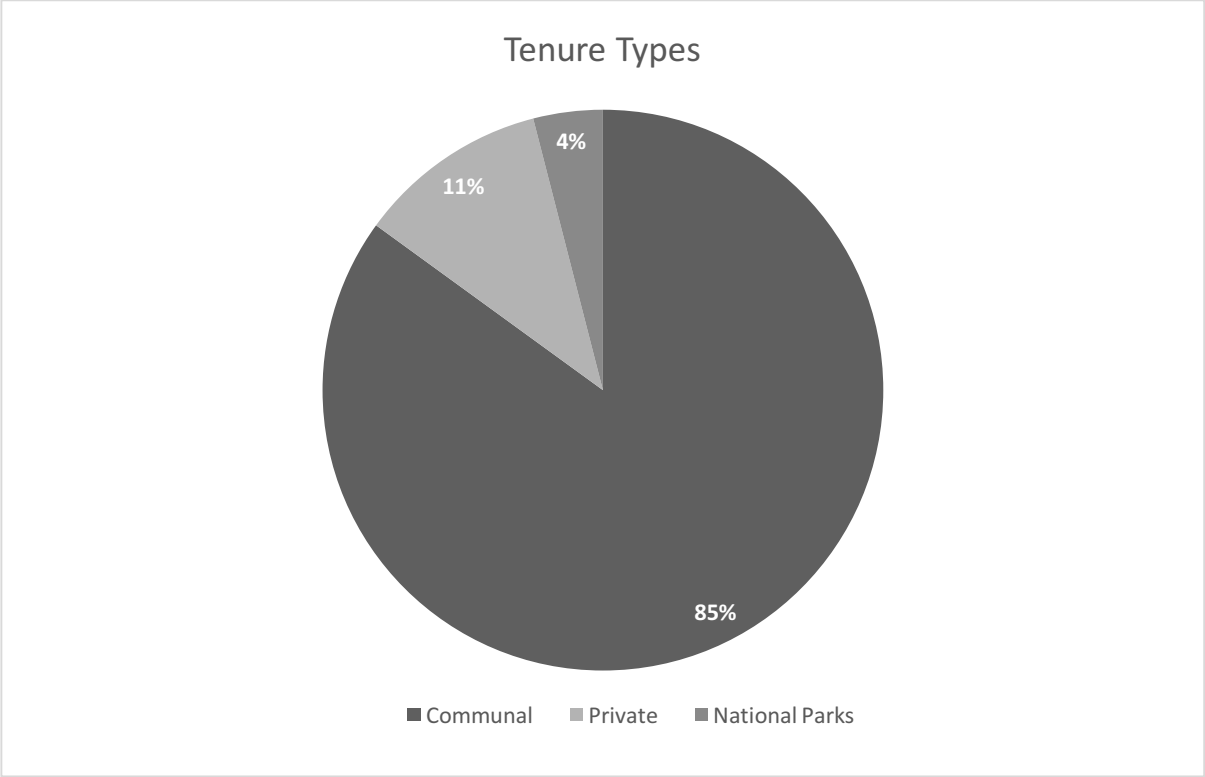

Figure 6 Land tenure types in the harvesting areas as indicated by the respondents

4.3.1. Communal areas

The majority of the respondents (85%) harvested within communal areas. These are villages within which they reside, led by the headman or chief together with a tribal authority. In these areas, the chief as the leader, is seen as the custodian of the common resources and thus has the powers to control access to and management of the resources. Management of the mopane worm resources in the villages is done indirectly through management of mopane trees. However, the degree of such powers varies from one village to another. Habitat protection is thus implemented as a way of managing mopane worm resources. The role of the chief is critical in this aspect. In the areas where the chiefs still enjoy high level of control they often effect bans on mopane tree felling to protect mopane worm habitat. Such bans are implemented through the use of tribal police[9] and assistance from the Limpopo Department of Economic Development Environment and Tourism (LEDET) field rangers for patrols. The respondents affirmed that:

[9] The tribal police are appointed by the tribal authority or council in the villages to serve as law enforcement personnel and they monitor compliance with some of the customary traditions and rules which the villagers are expected to comply with.

> *"There are people there in the bushes who prevent us from cutting the trees. These people have been mandated by the chief because people from far were going into the bushes without permission, while the locals here knew what was allowed and what was disallowed"* VN309, Zwigodini – 21 March 2016

However, given the widespread distribution of the mopane trees in the area, cutting of mopane trees may be unavoidable, especially in cases of clearing land for residential purposes. Nonetheless, tree clearing remained strictly regulated in this regard. Respondents described a permitting system under which villagers can obtain a permit to cut down mopane trees and any other species protected by the ban. One respondent commented on the permit application process:

> *"The applicant needs to apply at the tribal authority offices to the secretary. They would be issued with a letter by the secretary indicating that they are permitted to harvest mopane wood and the conditions under which the permit is issued. The applicant would have to comply with the conditions. Such conditions may be that the holder is only permitted to cut mopane trees when clearing land for a stand. There are payments which need to be made as part of the application, depending on the type of permit sought"* Tribal authority police, Malumani - 31 March 2016

The patrols conducted by the LEDET field rangers and tribal police in the communal areas often resulted in capture of offenders. When apprehended, offenders were charged and penalised with predetermined amounts with fines payable at the tribal authority. However, there is still a sense of defiance among the villagers regarding mopane tree felling, especially for firewood. This is despite the hefty fines which may be imposed if they are apprehended. Some of the respondents indicated that:

> *"If they find you cutting the mopane trees they would fine you around R600. In order to curb deforestation, I think what the way they are doing it is ok. The way that the nature conservation rangers are doing it is fine"* VN328, Nkomo – 31 March 2016

> *"People still cut down mopane trees for firewood. However, if you get caught you would be fined R1500. But that's the risk that people are willing to take"* VN330, Nkomo – 31 March 2016

The perception that mopane tree felling still continues although it has been banned was confirmed during the key informant discussions. Mopane wood is highly sought after for firewood because it burns excellently. In Masisi along the route to the Kruger National Park's Phafuri gate, villagers sold wood to holidaymakers on their way to the park. Evidence of such tree cutting was observed during

field work (Fig. 7). The financial incentives from such trade may encourage the villagers to harvest mopane wood even if such harvesting is banned and carries a punishment if they get caught. A key informant specialising in botany stated that:

> "*I don't know whether the laws or these rangers are strict in one area and not in the other, but now if you go to Masisi/Phafuri area you will find people with stacks and stacks of firewood (from mopane tree) but you won't find that around Phalaborwa and you won't find that around Messina but in Masisi where they harvest worms there are also selling mopane firewood but it's not taking place in other areas"* Botanical researcher, Thohoyandou – 22 March 2016

Figure 7 Mopane tree with branches cut off. Source: Researcher

In certain villages harvesters were not required to obtain any permission before harvesting. Those who harvested in such areas were local to the area and as a result, were not required to obtain prior permission from the chief or tribal authority. Similarly, the non-locals were also not obliged to obtain permission since there were no regulations to comply with. Some of the respondents indicated that:

> *"There is no one who controls or regulates harvesting because when I leave my home and go to harvest I don't seek some form of permission from anyone to harvest. People here go whenever they want to go harvest without first trying to get any approval from anyone. We don't even need to go to the chief for permission*" VN312, Masisi – 21 March 2016

> *"As a harvester you will be free to harvest as much as you want. There is no one who is controlling or regulating the harvesting"* VN314, Ha Gumbu – 21 March 2016

Although the locals may not need permission from the chief, this does not diminish the role of the chief as the community leader. Respondents indicated that it is the chief's responsibility to declare the commencement of the harvesting season. The declaration is implemented as a mechanism to curb harvesting of juvenile mopane worms. Essentially this implies a blanket ban on mopane worm harvesting until such time that the chief declares the harvesting season open. In this regard, once the chief has declared the harvest season 'open', harvesters would not be required to obtain any further permission to harvest. According to the respondents, this was the only form of regulation applied in the areas where they harvest,

> *"Harvesting the worms is not regulated or controlled. People are allowed to harvest as much as they can. The only control is that the chief is the one who has to announce to the community that the worms are ready for harvesting"* VN309, Zwigodini – 21 March 2016

> "*The community leaders do regulate the harvesting of mopane worms in such a way that people are not allowed to harvest them (worms) when they are still young (juvenile), people have to let them reach maturity then they can harvest them. If they can find me harvesting them while they are still young, they will arrest me and charge me because the law does not allow that. You cannot kill something while it is still small"* VN326, Mphambo – 23 March 2016

The lack of a requirement for harvesting permission for the non-local harvesters was perceived by local harvesters as a significant loophole in the effort to regulate the non-local harvesters. Locals believed that this weakness is taken advantage of by the non-locals to the detriment of the mopane worm population. One respondent affirmed this:

"At the moment there are no initiatives to regulate harvesting, that's why people from far away are coming here to harvest" VN336, Matiyani – 23 March 2016

It was stated by the respondents that in certain areas only non-locals were required to obtain permission from the traditional leader or chief. Eighteen percent of respondents harvested in the communal areas where this requirement was enforced. The respondents believed that mopane worms are communally owned on communal land and this sense of joint ownership among the villagers where the worms occur is the driver behind this requirement. Simultaneously, the requirement is implemented as a safety measure to account for the number of harvesters at any given time. Failure to comply with this requirement carries some form of punishment in the form of monetary fines. The respondents indicated their awareness of this requirement and adhered to it. Some respondents remarked that:

"If ever an outsider comes to our village and seeks to harvest mopane worms, by customary law they would have to go to the chief and report that they want to harvest mopane worms. With regards to the fine, I don't really know how much is charged because I have never been arrested" VN326, Mphambo – 23 March 2016

"When we get there in the morning we arrive at the house where we would be staying. Then they (the host) go to the chief on our behalf and inform him that there are people here who are going to the bushes to harvest the worms. So that in case we get lost there or there's a case of emergency they can send out a search party. Even when we are done harvesting, our host will go to the chief and inform him that we are leaving. We are not prevented from harvesting at all. They allow us to harvest and if the rangers find us there we can inform them that we had permission from the chief. But if you are caught without having obtained permission then you can get arrested and fined" VN324, Matiyani – 23 March 2016

4.3.2. Privately owned land

Only 11% of the respondents harvested on the privately owned farms in the Bokmakierie area. On these privately-owned game farms, land management and mopane worm harvesting control were undertaken by the landowners in order to meet their management objectives. In this regard, mopane worms were harvested in order to reduce competition with browsers such as impala and kudu[10]. At the same time the sustainability of the caterpillars must be protected to ensure future

[10] Mopane tree leaves and seeds are known to be high in condensed tannin load which make the leaves unpalatable to most animal species. However, kudu and impala are known to be browse mopane tree. See (Sponheimer, et al., 2003 and Hooimeijer, et al., 2005)

availability as it generates additional income from harvesting levy. The management approach adopted by the private landowners included close monitoring of the harvesting to ensure that mopane worms were only harvested while in the late instar stage in order to maximise harvesting without compromising the subsequent year's harvest. With regards to mopane trees, the landowners did not allow any form of tree cutting on their property. This was done in order to preserve the habitat integrity on the farm. This proved to be effective for mopane worm availability and sustainability. One respondent confirmed that:

> *"Here in the farms the owners don't cut the mopane trees and we are also not allowed to cut any mopane trees. So there are enough trees on which the worms can stay"* VN320, Bokmakierie – 22 March 2016

Harvesters were required to obtain permission from the owners in order to access and harvesting from the farms. The harvesters had to pay an access fee which was determined by the landowner. While the requirement for monetary payment to access resources may discourage potential harvesters, a cohort of harvesters who preferred harvesting in Bokmakierie were not deterred by the fee. According to the respondents, they go to harvest in such areas despite the entry fee that is required:

> *"If it is the outbreak season of mopane worms and they are not available here or the outbreak is poor, then we will have to go to the farms and harvest there. The owner usually charges a flat rate for entry onto his property. We will make camps there and harvest"* VN320, Bokmakierie – 22 March 2016

The landowners do not only impose an entry fee, they also determine the commencement and end of the season. This control feature which was common across the tenure types. This management precaution was taken to prevent harvesting juvenile or late instar[11] stage worms. This was done through monitoring the growth of the caterpillar throughout its development stages as well as closely monitoring the harvesting season as it progresses. One respondent mentioned that:

> *"Where we harvest in the farms at Bokmakierie the farm owners are controlling the harvesting. If the worms are still too young for harvesting, they (landowner) won't allow us to harvest. They will only allow us to harvest when they have reached maturity"* VN334, Mphambo – 29 March 2016

[11] Instar is the name given to the developmental stage of an arthropod between moults. Instar can be used for insects undergoing complete and incomplete metamorphosis. For example, a butterfly caterpillar can go through several instars before pupation.

In order to access the mopane worms in Bokmakierie, harvesters had to incur transport costs. However this did not deter them, as the outbreaks on the farms were perceived to be better than those in the communal areas, thus serving as an incentive. Some respondents indicated that:

> *"I am now harvesting in Bokmakierie and they are still occurring only if there is rain. The seasons have remained the same. We know that every year we always get the worms at the same time of the year, that has not changed"* VN334, Mphambo – 29 March 2016

> *"If there's an outbreak somewhere but not here, then we organise with fellow harvesters and go to such place like Bokmakierie to harvest to compensate for the poor outbreak at our area"* VN318, Zwigonde – 21 March 2016

4.3.3. Public lands and national parks

SANParks has in previous years allowed mopane worm harvesters from the villages adjacent to the Kruger National Park to harvest within the park. This was a strictly regulated and controlled exercise which was undertaken with assistance from the chiefs and the traditional authorities or councils in the villages. Given that Kruger National Park is a protected area under conservation laws, any natural resource exploitation or utilisation within the park is bound to be regulated in accordance with the relevant legal framework. Only 4% of the respondents indicated having taken part in this harvesting exercise. The implementation of the harvesting excursions was planned by SANParks, however the chiefs and their village forums determined the make-up of group of harvesters to take part in the excursion. This was confirmed during the key informant interview:

> "*So the forums are responsible for selecting the people who are participating. That gets done differently at different villages depending on how the forums decide to do it, we don't have much to do with that. We only said that it should be benefiting the poorest community members. But the way in which those are selected is done at the community level. It is not something that we would like to have control of and also if it is not done in a transparent way we'll get the blame"* SANParks Researcher, Phalaborwa – 22 March 2016

Mopane worm harvesting has to conform to the management objectives of the park. As a result, the harvesting takes place in predetermined zones, within which natural resource utilisation is allowed. Prior to harvesting, the field rangers monitor the outbreak to help determine the harvesting zones and the instar stages of the caterpillars. The declaration of the commencement of the harvesting season and its cessation is the responsibility of SANParks. Continuous monitoring is done by the field

rangers throughout the harvesting season to inform such declaration. Furthermore, the harvesters get accompanied by field rangers for safety purposes. One key informant commented that:

> "*They only harvest in the harvesting zone, so Kruger is zoned according to the degree of utilisation. On the one side you have high intensity leisure zones where there is a lot of tourism, on the other hand there is resource harvesting zones which are usually closer to the fence. Then there's a wilderness zone which people don't access. So the harvesting only happens in the harvesting zones and this happens in the seasons where there are a lot of worms. So the rangers go out and monitor and check if there are worms. The harvesters also get protected by the guards and they are only allowed to harvest when the worms are really big. There's a size class thing that we make sure that the worms don't get overharvested. There are no limits on the amount of worms that the harvesters can harvest"* SANParks Researcher, Phalaborwa – 22 March 2016

When harvesting in the Kruger National Park, the respondents indicated that they did not need to pay any fee to obtain a permit. Rather the process was managed by the village forums in partnership with SANParks. The role of the forums was to identify the individuals who satisfied the requirements, such as the unemployed people and those living in poverty. The permit issuing process served as a safety measure in order to have an account of the number of harvesters entering the park. One key informant remarked:

> *"So there's a total of about 10 villages now who have participated in the harvesting…but it's only a tiny subset of people who have participated in the harvesting from those villages. Out of a village of 5000 people like Matiyani there were about 10 people who have harvested"* Social science researcher SANParks, Phalaborwa – 22 March 2016

4.4. Environmental Change

The respondents were requested to rank the different forms of environmental change that they perceived to have impacts on mopane worm outbreaks and to explain the effects of such changes (Fig. 8). Forty-six percent of the respondents regarded vegetation change in the areas where they harvested to be significant while 19% perceived very significant vegetation change. Twelve percent of the respondents reported a moderate vegetation change, complemented by 23% of the respondents who reported an insignificant vegetation change. The high levels of vegetation change were due to firewood demand. A botanical expert noted that:

"When you go there (Masisi and *Phafuri) you would find stacks of firewood being sold to big companies with resorts, they like to go there and buy firewood from people selling them. The problem with that is that they are also cutting the very same trees which they are supposed to harvest mopane worms from. Because the demand for firewood is very high"* Botanical researcher, Thohoyandou – 22 March 2016

While the vegetation change driven by tree cutting for firewood and other uses was perceived to be high by the respondents, there seemed to be divergent opinions on mopane tree density. Forty-two percent of the respondents indicated a decline in mopane tree density, while a contrasting 39% reported an increase in density. Nineteen percent of the respondents did not know whether the tree density was increasing or decreasing. This finding suggests that mopane tree cutting still continues. However, interventions such as tree harvesting bans and patrols by field rangers and tribal police may have reduced the rate of deforestation.

The respondents were asked to rank the extent of settlement spread within the harvesting areas. Sixty-five percent of the respondents regarded the spread of settlements in the harvesting areas as insignificant, while eleven percent regarded spread of settlements to be significant. Eight percent ranked spread of settlement to be both very significant and eight percent moderate. A further 8% of the respondents could not rank the spread of settlements at all.

All respondents agreed that rain was the leading factor in determining mopane worm outbreaks. Poor outbreak incidents in the preceding two years were considered to be a direct result of poor rainfall. This in turn led to forfeiture of three harvesting seasons and any other potential income and benefit which could have resulted had there been an outbreak. All the respondents suggested that this occurrence was further exacerbated by the highly seasonal rainfall regime which characterises the savannah woodlands in the study area. One respondent remarked:

"I still do harvest when there is an outbreak. But this year we didn't harvest because there are no worms. Rain did not fall and that's why there are no worms. So the worms come when it rains" VN307, Zwigodini – 21 March 2016

"Nowadays we don't get rains at the times that we are used to. Since last year we haven't been getting good rains. Even this year we have not received good amounts of rain. Also it is very hot. Rain affects the worms because if there is no rain then there wouldn't be any worms. The worms come out after rain has fallen and trees had regrown leaves" VN309, Zwigodini – 21 March 2016

Temperature also ranked highly as a determining factor; 85% of the respondents agreed that temperature had a similar effect to rain on mopane worm outbreaks. It was suggested that the heatwaves experienced as a result of the El Niño phenomena in the preceding year caused the lack of mopane worm outbreaks. Some respondents remarked:

> *"It was too hot last year and I think that affected the worms because there was also drought which prevented us from doing things like farming. So I think this also affected the worms. Because if we found it to be too hot then it will be bad for the worms"* VN336, Matiyani – 23 March 2016

Sixty-nine percent of the respondents did not think that harvesting practices affected the outbreak. This was supported by the view that regardless of how one harvests, the harvesting does not put any pressure on the worm population. Instead some of the respondents asserted that the cause of the worm decline was the lack of respect for traditional beliefs and that mopane worm outbreaks occur in rotation between different areas - similar to the notion of crop rotation in agriculture. On the contrary, 31% of the respondents agreed that the harvesting practices impacted negatively on mopane outbreaks. This finding was supported by the views that climbing on trees to pick worms, harvesting juvenile worms and increasing number of harvesters are affecting the worm populations. Some of the respondents indicated that:

> *"Harvesting doesn't affect the outbreaks because the worms need only rain to come out. So the way you harvest them does not affect their availability"* VN303, Zwigodini – 21 March 2016

> *"Another thing is that people don't know how to handle the worms. You'd find people who cover the worms when cooking or storing in a vessel. This causes the worms to disappear. Sometimes this can be as long as 5 years. Just because they were covered with a lid. We know this as locals here but non-locals do not. So if this happens, it wouldn't matter how much rain we get, the worms won't return. It would take some time"* VN309, Zwigodini – 21 March 2016

> "*However in some seasons we don't find them there and we have to go looking for them in other areas. So let me give you an example, the worms work in a similar principle to rotational cultivation, so in one patch of land you would cultivate different crops at different times of the year in alternation. So the worms also rotate. There are times when we'll find them very close to the village but in other seasons they may be available at a different place but the breakout time would still be the same"* VN312, Masisi – 21 March 2016

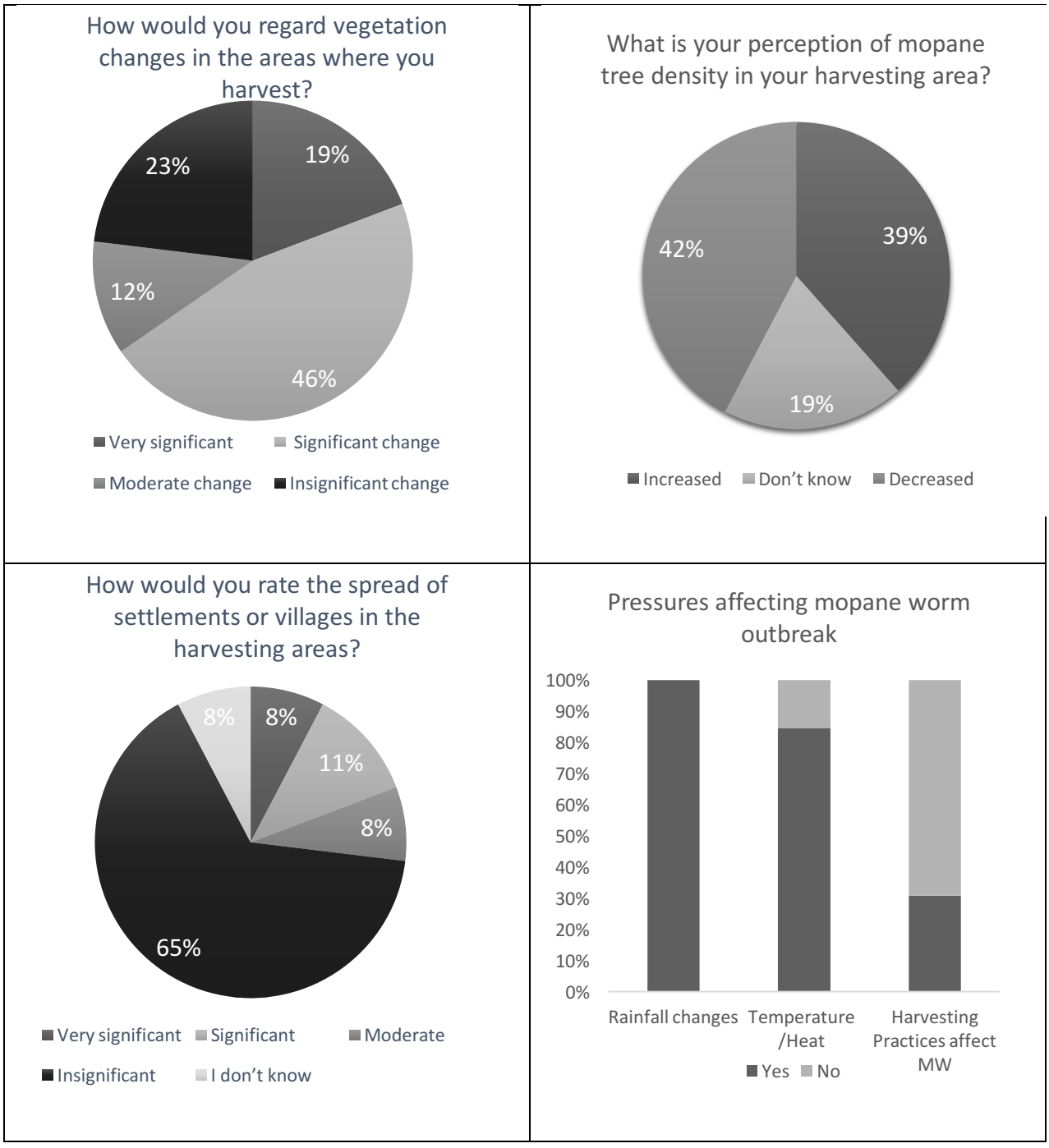

Figure 8 Perceptions of harvesters on forms of environmental change affecting mopane worm outbreaks

4.5. Effects of Environmental Change

4.5.1. Outbreak changes

The respondents were asked if they are still able to harvest mopane worms and if there had been any changes in the outbreak events (Fig. 9). Fifty-four percent of the respondents indicated that they were still able to harvest in the same way as when they first started harvesting and that there were no long-term changes in outbreaks. However, they went on to say that in the last two years this has not been the case because there were no worms due to the prevailing drought. It was indicated that if the conditions were conducive and there were sufficient rains, then they would be able to harvest from their usual harvesting areas. Some of the respondents indicated that:

> *"If the rain falls at the right time then there would be a lot of worms. The main determinant is the amount of rain, that's what the worms depend on. But if there are not sufficient rains then there would be worms but very scarcely unlike the previous outbreak seasons."* VN306, Zwigodini – 21 March 2016

> *"Yes, I am still able to harvest. However, this year and last year I couldn't because there are no worms at the moment."* VN308, Zwigodini – 21 March 2016

On the other hand, 46% of the respondents reported that they were no longer able to harvest mopane worms in the same way as when they first started harvesting and in the same areas. This finding could be attributed to the continuing decline in mopane worm outbreaks due to the pressures on the populations such as harvesting juvenile worms. One respondent indicated that:

> *"I am no longer able to harvest as well as I used to. Because there are no worms now. But sometimes we hear people saying they have found them somewhere but they are very scarce. Although they have not yet reached maturity."* VN315, Ha Gumbu – 21 March 2016

Another respondent attributed the poor outbreak to a combination of environmental factors and said the following:

> *"But you can see now there is nothing to harvest for this year. It is because of the drought and the heat as I have already said."* VN320, Bokmakierie – 22 March 2016

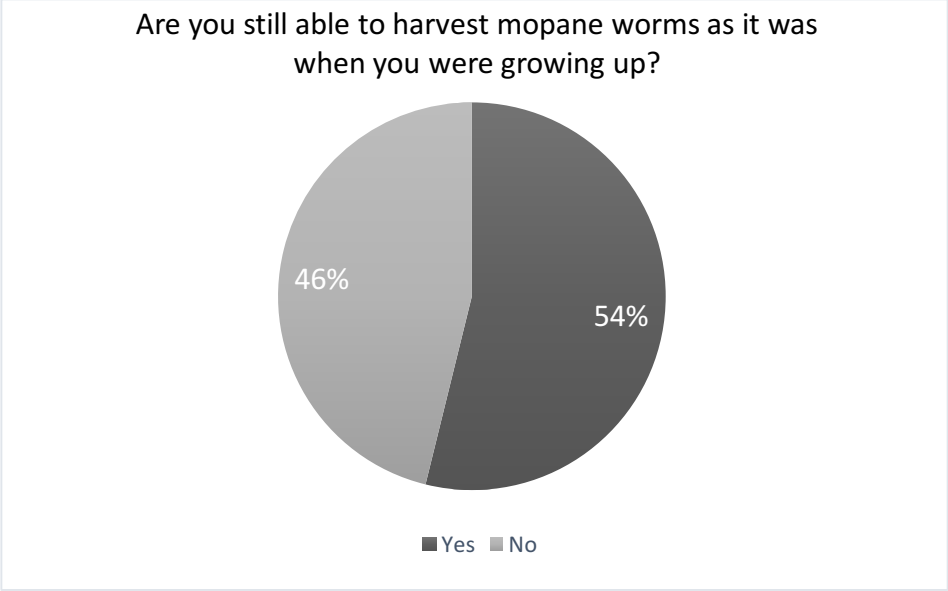

Figure 9 Harvesters' ability to harvest based on mopane worm availability and outbreak

4.6. Use and Trade of Mopane Worms

4.6.1 Reasons for harvesting

Mopane worm harvesting is an important household livelihood activity which requires very little or no input costs. In rural households, harvesters can be broadly categorised into three groupings depending on the underlying reasons for harvesting (Fig. 10). The first grouping includes individuals who harvest in order to trade for an income. The second grouping comprises those who harvest solely for household consumption and are not interested in selling their harvest. Third, there are those who engage in harvesting for both trading and household consumption.

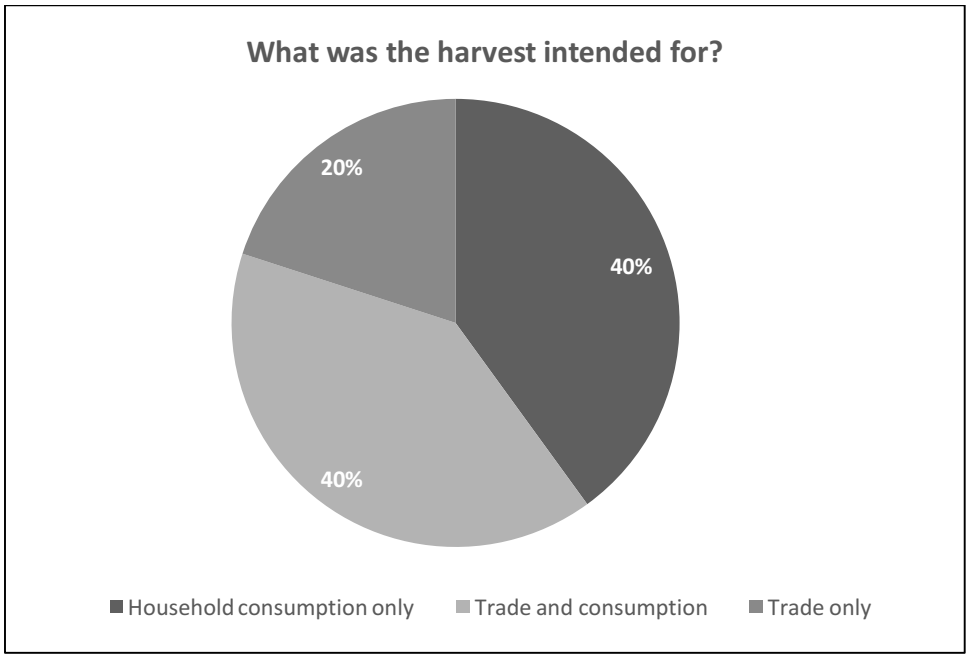

Figure 10 A breakdown of the categories of harvesters

4.6.2. Household consumption

Forty percent of the respondents harvested mopane worms only for household consumption without trading. Their perception was that household consumption was more important than trading. As a result, they preferred to store their worms during the harvesting season to ensure availability for the household consumption when the worms were out-of-season. The respondents indicated the following:

> *"We harvest for household consumption but most of the people here in the village would come to inquire if we were willing to sell our worms, especially if they run out of their supply. But I am reluctant to sell them because my family consumes them. So if I sell them then what will my family and grandchildren have to eat? That's why I don't like to sell them" VN337, Mphambo – 23 March 2016*

> *"Yes our harvest is for household consumption, we never trade our harvest because my husband does not like selling the worms"* VN336, Matiyani – 23 March 2016

As a food source (Fig 11), 67% of the respondents ranked mopane worms as very important while 30% regarded them as important. Only 3 % of the respondents ranked mopane worms as being of

little importance. Mopane worms were regarded as important because they are a nutritious and healthy alternative to protein sources like meat products while costing little to nothing to obtain. One respondent noted:

> *"Unlike meat that you have to buy at the shops, we can afford to go harvest and have the worms at home for consumption even if we are unemployed…we had times where there was absolutely no income whatsoever and in that period the worms would be the main source of protein and the only seshebo[12] available"* VN308, Zwigodini – 21 March 2016

Another respondent stressed the importance of mopane worms to household food security and cost saving:

> *"They are important as a food source, they are a very nutritious food and they also contribute to reducing the household food costs. Here is an important issue with the worms, you see in a household if we don't have the worms then we would have to eat something which has to be purchased. However, if we have the worms then that forms the basis of our diet and any other thing will be complementing the worms"* VN312, Masisi – 21 March 2016

The importance of mopane worms for nutrition was stressed. One respondent for example remarked*:*

> *"We depend on the worms for a large part of our diet. They were our main seshe*bo*. So if on a specific day the worms are cooked for consumption then we were going to have them. So eating them didn't come out of desire or anything else, it was out of necessity. The same thing happens if it was morogo[13]"* VN314, Ha Gumbu – 21 March 2016

[12] *Seshebo* is a term which refers to meat or vegetable which is consumed along with staple foods such maize meal porridge or mieliepap.
[13] Morogo is a colloquial term which refers to a wide variety of leafy wild and cultivated vegetables.

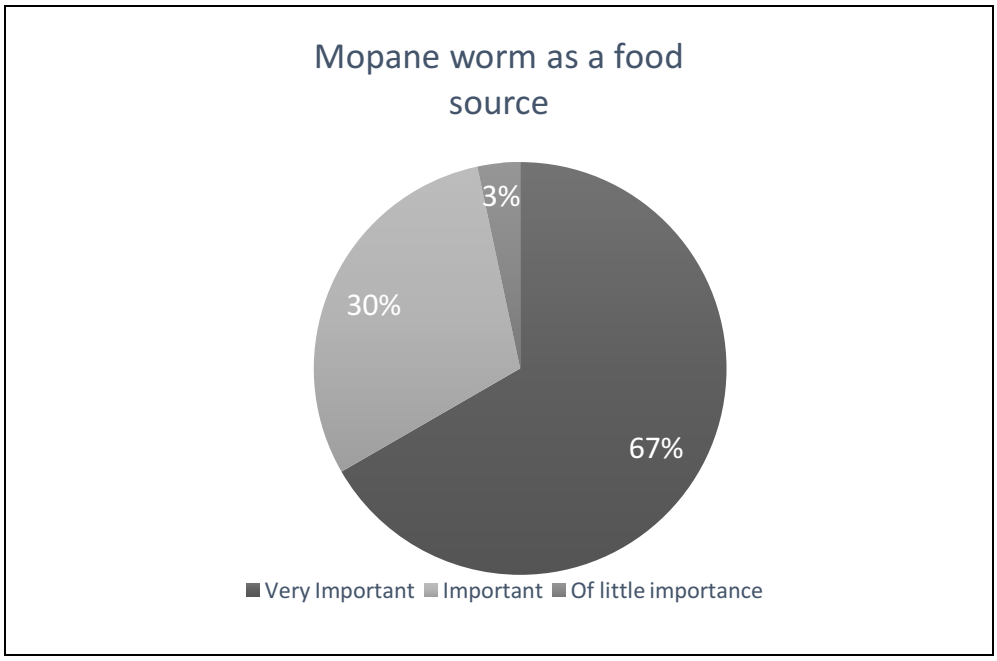

Figure 11 Ranking of mopane worm importance for household consumption

Mopane worm consumption has been part of the tradition of the respondents for many generations. This tradition is still held by the elderly who regard mopane worms as one of the best dishes they can find. With such views and deep-rooted traditions, it is no surprise that as a food source, mopane worms are regarded as very important. Even in the face of rural-urban migration, traditions such as mopane worm consumption still persist and are well maintained. Some respondents reported having harvested or bought worms in order to provide them to their relatives who reside in the cities. This was perpetuated by the long-held views that mopane worms are *real food,* where they are seen as healthier alternatives to frozen meat products. This was confirmed by the respondents, one held that:

> "*The worms are very important so much that when we don't have them we get worried. Because they form an important part of our diet and that they are very nutritious. That's why after eating the worms we feel that we are well fed."* VN320, Bokmakierie – 22 March 2016

4.6.3. Trade and consumption

Forty percent of the respondents indicated their reasons for harvesting as both trading and household consumption. The incentive for income generation appeared to be a significant factor for some respondents, especially with the selling prices fetching high amounts. Equally important was

the knowledge that mopane worms are an important food source for their households. Some of the respondents affirmed this:

> *"We traded and consumed the worms. If someone comes looking for the worms, we would sell the worms to them but at the same time we ate them because that's what we harvest the worms for"* VN304, Masisi - 29 March 2016

> *"The main reason is for household consumption but sometimes people do come and request to buy. In that case then we would sell the worms to such a person. The prices are as follows: R500 for a 20 litre bucket and a maize meal sack is R1000. I do know that a cup is sold for R5 while some traders say we have to sell it at R10"* VN314, Ha Gumbu – 21 March 2016

In the town markets mopane worms were sold for money by the traders, in the rural villages there is still a continuing practice of exchanging mopane worms for goods. Household consumables, tools and sometimes, appliances, may be part of the exchange. In such transactions, the quantity and quality of the exchanged items and the worms must satisfy both parties. One respondent said that:

> *"My harvest is both for household consumption and for trading. When I harvest I try to get as much worms as I can. Sometimes I can get 3 maize meal bags during the harvesting season while sometimes I can get about 2. Sometimes people come to me with washing powder and a new potjie*[14] *to exchange for a bucket of worms. I don't have a problem to engage in that kind of exchange. But if I am selling for money a 20 litre bucket is sold at R200 or R300. But a maize meal sack is R1500"* VN324, Matiyani – 23 March 2016

Another said that:

> *"It depends on who comes looking for the worms. If someone comes wanting to exchange goods for the worms, I do engage in the trade. But there are those who can come with money, I also trade with those"* VN328, Nkomo – 31 March 2016

4.6.4. Trading only

Individuals who are trading mopane worms may be harvesters who sell off their harvest to consumers and fellow traders or specialist traders who procure from bulk traders and sell to consumers. For those who harvest to trade (20%), consumption is not a motivation for their harvesting. Some of these perceive the income earned from trading to provide higher returns than

[14] Potjie refers to a cast iron three-legged pot

consumption, especially when such profit is the main source of household income. One respondent stated the following:

> *"Mainly I sell off my harvest in order to make some money for my children because I am not employed…When I was young we didn't sell the worms but our harvest was for consumption, but since I couldn't get a job I had to find a way to earn an income and I decided to use the worms for that. It is important in my family now"* VN334, Mphambo – 29 March 2016

The earning potential of mopane worm trading has also led to the emergence of specialist traders who sell mopane worms as a microbusiness. These are dedicated traders who acquire their stock from harvesters and intermediaries both within and outside South Africa. During the market surveys, eighteen Zimbabwean traders were encountered[15]. They source their stock from local harvesters and from intermediaries who source the stock from either Zimbabwe, Botswana or Zambia. One of these traders indicated the following regarding the origin and value chain of mopane worms:

> *"We stock from people from different countries, in fact there are some traders who go to Botswana to stock. They bring them in bulk and then we, the small scale traders, stock from them…there are several people who are harvesting mopane worms. Some are in Botswana some in Zimbabwe and some in Zambia that's where we get them from"* ML1, Malamulele - 09 December 2015

Another trader at Elim said:

> *"I started right here at the market working for someone else, buying mopane worms in bulk from Botswana traders. Then I started selling independently as my own small business, buying from Botswana traders too and selling and sometimes we would go and harvest wherever they are available during the outbreak season"* EL 1, Elim – 10 December 2015

[15] These traders declined the request for interviews and participation in the study. In the preceding months there were incidents of xenophobic attacks on foreign nationals in several provinces in South Africa and these individuals, Zimbabwean nationals, declined to participate in the study due to the fear of falling victim to such attacks should their nationality be communicated to strangers.

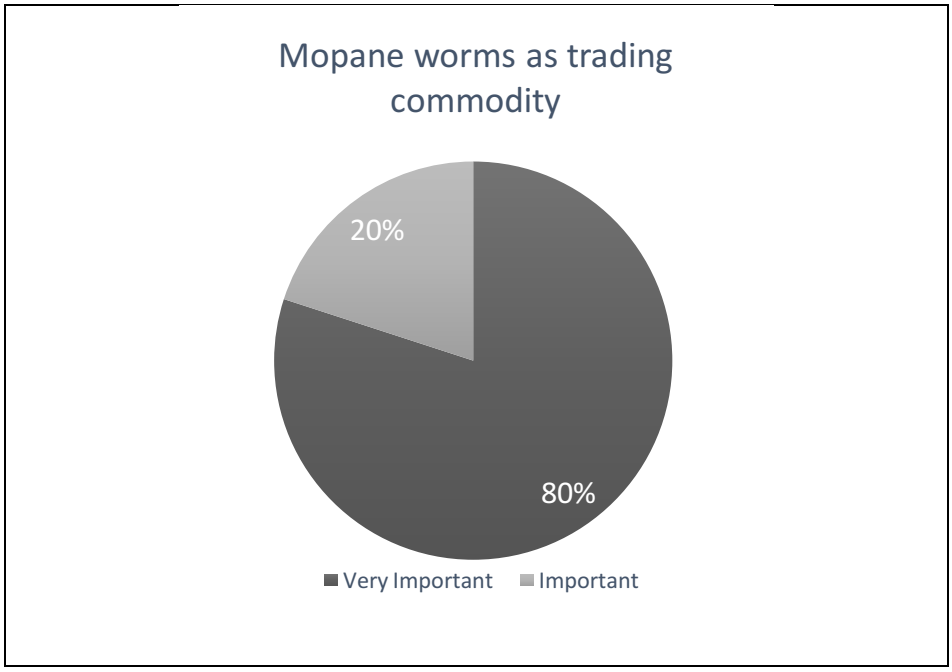

Figure 12 Ranking of the importance of mopane worms as trading commodity

As a trading commodity (Fig 12), in which the worms were sold for money or exchanged for other goods, the majority of the respondents (80%) regarded mopane worms as very important, whereas 20% regarded the worms as fairly important. The importance of the trade to the households was emphasised by the respondents, especially for income generation. In some households, such income served as the most significant source of household finances. The profitability of this trade was expressed by the respondents:

> *"Mopane worms are very profitable. You can be able to buy an item which costs money or even help you meet some significant household expenses. And also we as women have the social clubs and stokvels*[16] *which we are members and the income from the worms is very important as a source of income"* VN306, Zwigodini – 21 March 2016

The income earned from trading mopane worms served as the main source of income for the households which harvested and traded in bulk and those which sold in small quantities to consumers. This income is supplemented by other income sources which include state social grants (33%) and income earned by family members (13%).

However, in order to meet the demand for mopane worms and to make up for the interannual variability of outbreaks, some traders have been buying and supplementing their stock from bulk

[16] This is a financial investment society or club, usually formed by friends, neighbours or colleagues, in which members make regular contributions and receive a lump sum payment at the end of a given term or on special occasion or event.

traders from Zimbabwe. The traders source and import mopane worms from Zimbabwe, Botswana and as far as Zambia, depending on availability. The bulk trader from Zimbabwe who was selling at a market in Makhado indicated that the money earned from trading in bulk to local traders was remitted back home for their households. In some instances, the earned income was sufficient for university tuition fees:

> "*If I have got a lot of mopane worms, I can get something like R25 000 per month or R30 000. It provides me with money to send to my children to school."* LT1, Makhado – 10 December 2016

4.7. Changes in Purchasing and Consumption

Buying mopane worms for household consumption was done as part of the usual grocery shopping during seasons when the outbreaks were poor and there were no worms available to harvest. More than two-thirds of the respondents (69%) indicated that they buy worms once per month (Fig. 13). This is done usually when the respondents go to town and at the South Africa Social Security Agency (SASSA) grant paypoints, where traders seek to take advantage of the presence of pensioners who prefer mopane worm to most meat products. This provides an ideal meeting place between traders and potential customers. It is also at these SASSA paypoints where bulk traders sell to other traders, thus creating a blend of traders and different categories of clients. For the consumers, this finding is consistent with the view expressed earlier that the SASSA social grants (33%) are an important income source for poor households, thus the likelihood of buying mopane worms is higher at the paypoints due to the potential customers being in possession of money. One respondent said the following:

> *"In times where I am unable to harvest enough worms I would buy in town or at the Mudende*[17] *so that I can have them whenever I want to eat them but I don't buy very often"* VN337, Mphambo – 23 March 2016

[17] This is a colloquial term referring to the child support or old age grant. The terms is also used interchangeably to refer to the paypoints at which the grant recipients receive their grants.

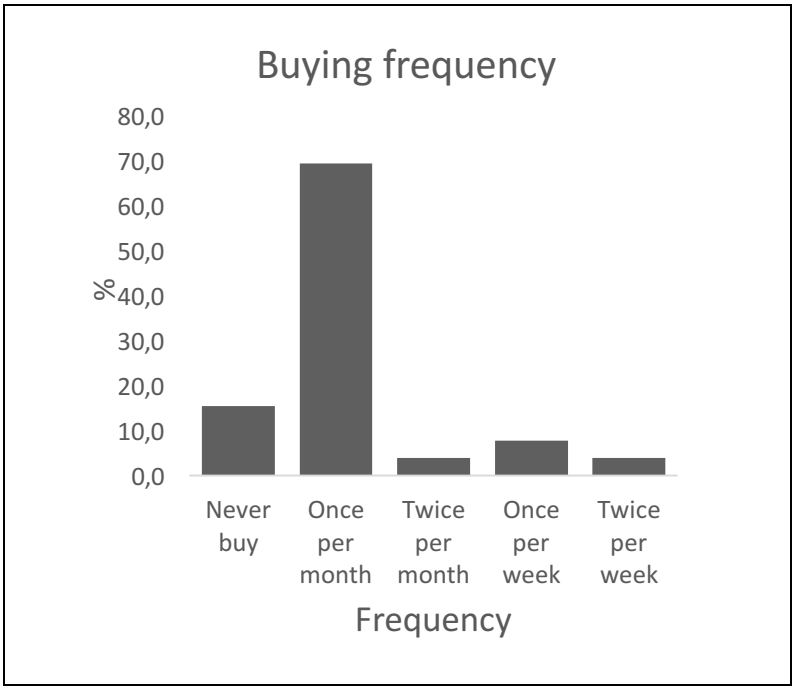

Figure 13 Graph showing the purchasing frequency of mopane worms in households

Eight percent of the respondents indicated a buying frequency of worms once per week while only 4% indicated that they prefer to buy twice per month and a further 4% would prefer to buy twice per week. These findings represent a low frequency of buying mopane worms for household consumption. The respondents cited low levels of disposable income, unaffordable prices and lack of desire for buying something which origins they are familiar with. Furthermore, 15% of the respondents indicated that they never buy mopane worms for consumption, they would rather harvest on their own.

During poor outbreak seasons and the period thereafter, the main source of mopane worms for households is traders. Respondents expressed that when buying, they have to get small quantities due to limited disposable incomes, unaffordability of the prices and that the frequency of buying is reduced because they can only get to town once per month. Almost two-thirds of the respondents (67%) reported that they were able to meet their household dietary needs during the seasons of poor outbreaks or availability (Fig. 14). To this end, some respondents indicated that they would buy from the traders in order to replenish their supply. In contrast, 33% of the respondents indicated that they find it difficult to meet their household dietary needs, especially with mopane worms as protein source, during periods of poor outbreak due to their inability to buy from the traders.

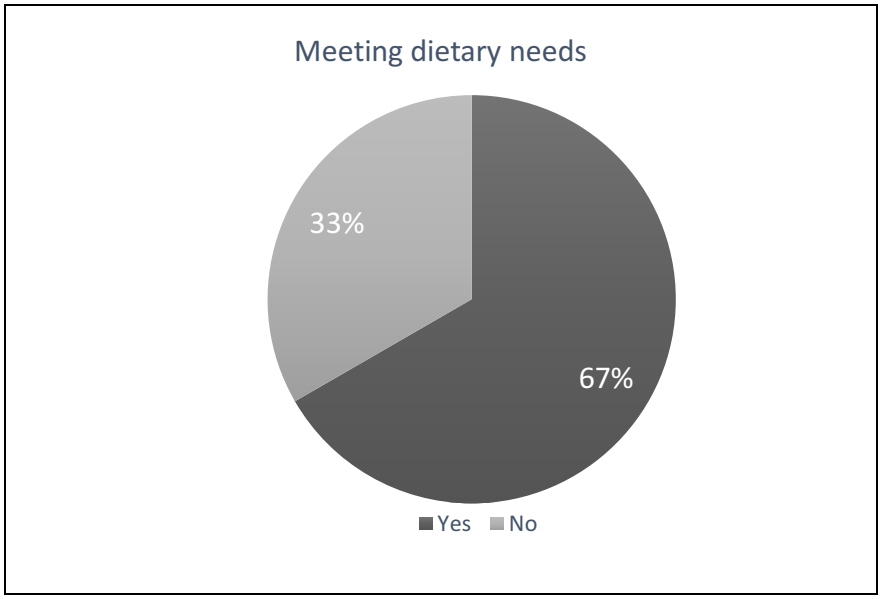

Figure 14 Chart showing the satisfaction of the respondents to meeting their dietary needs through mopane worm consumption as part of their diet

Fifty-four percent of the respondents inquired about the origin of the worms from traders (Fig. 15). This was done in order to try and solicit the names of areas where the worms are harvested in order to be used in future outbreak seasons. This strategy was used to broaden knowledge of potential harvesting areas which otherwise are closely kept as secrets by fellow harvesters. These efforts may of course be futile in cases where the area of origin is in another country such as is the case with Zimbabwe and Botswana. When asked further on the influence of such information on the decision to purchase, all the respondents indicated that origin did not influence purchase decision.

Forty-six percent of the respondents indicated that they never inquired about the place of origin of the worms. They indicated that mopane worms are all the same everywhere you go and that the only difference is a result of the processing. Furthermore, the respondents believed it would be futile to differentiate the worms depending on the place of origin.

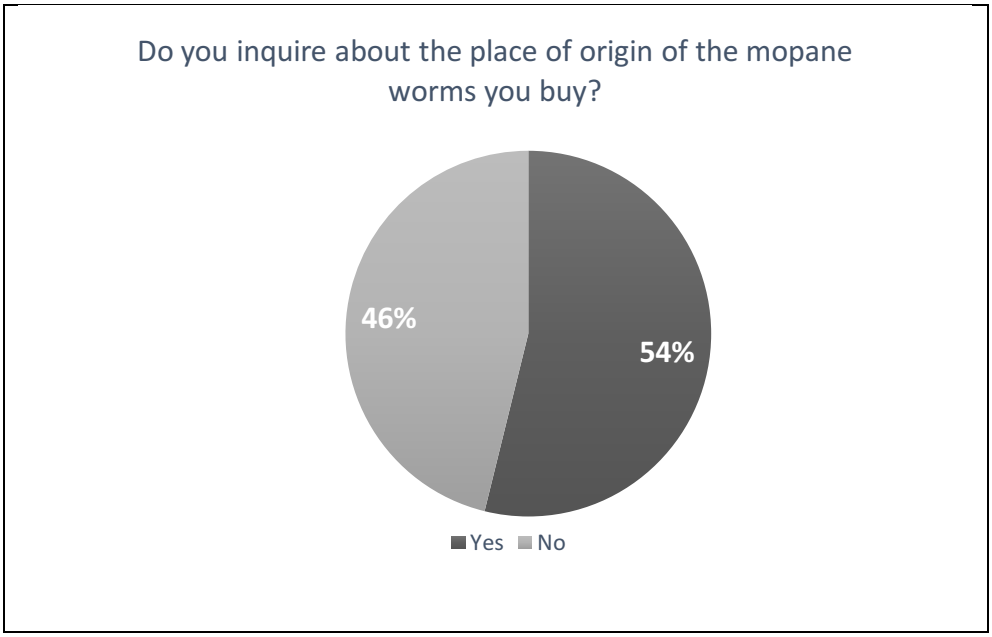

Figure 15 Chart indicating whether the respondents inquired about the origin of mopane worms when purchasing

4.8. Pressures on Mopane Worm Populations

4.8.1. Harvesting practices

The harvesting practices employed by the harvesters were varied and consequently may have varying degrees of impact on mopane worm populations. Sustainable forms of harvesting should protect the integrity of the habitat and allow the mature worms to pupate underground in sufficient amounts. However, some of the harvesting practices result in habitat destruction such as breaking tree branches and harvesting worms which are about to pupate underground. In an effort to harvest more worms, one respondent said the following:

> *"People collect them differently; some people climb up the trees to get them while some may even break off the branch so that they can easily collect them. I prefer to collect from the branches that I can reach but I won't break it"* VN337, Mphambo – 23 March 2016

Some harvesters reported preferring the worms when they had reached the late instar stage. During this stage, the worms no longer forage and go underground to pupate. This is preferred because minimal effort is required to clean the worms after harvesting. This was confirmed with the following comments:

"We are only supposed to harvest the matured worms. So if we only target the matured ones, we won't be able to harvest every one of them. There will be some which will escape underground to pupate. Also when the worm is about to go underground we don't harvest it, we leave it. But some people prefer them because they won't have to clean them because by then the worms would not be feeding anymore so the gut contents are clean" VN312, Masisi – 21 March 2016

"When I harvest I collect the worms that are on the trees and those crawling on the ground. So when we are harvesting we don't make a distinction between the worms on the tree and those on the ground or about to go underground" VN306, Zwigodini – 21 March 2016

The increased number of harvesters is also putting pressure on mopane worm populations leading to a perceived decline in the amount of worms which burrow and may lead to a decline in future outbreaks. However, the perceived decline could be due to the direct competition between harvesters thus resulting in a decline in the amount of worms that an individual would harvest and not population decline per se. Nonetheless the increase in number of harvesters is worrisome. Some of the respondents remarked that:

"The difference is that nowadays the number of harvesters has increased substantially but many years ago most people didn't harvest, they didn't care about them. But now a lot of people want the worms" VN307, Zwigodini – 21 March 2016

"There's lot of harvesters nowadays because people get attracted to harvesting due to the money that you can earn. So when there's so many people the competition increases and people end up harvesting juvenile worms in order to stave off competition. I think as harvesters we need to wait for the worms to reach maturity, but if you wait then others will take advantage" VN334, Mphambo – 29 March 2016

"There are a lot of people here who are involved in the harvesting. The entire village is full of harvesters and in my family too everybody goes to harvest whenever there's an outbreak" VN322, Matiyani – 23 March 2016

The majority of mopane worm harvesting was undertaken in areas where the harvesters had been harvesting consistently for many years. Eighty-five percent of the respondents indicated that they had been harvesting the same areas during each harvesting season since they began (Fig. 16). This

finding is indicative of the resilience and consistency of outbreaks in the area and the familiarity of the harvesters with areas which support better outbreak incidents. In well-managed harvesting areas such as Bokmakierie where the area is dominated by wildlife farms and harvesting is strictly regulated, there have been consistent outbreaks with stable mopane worm populations. This area attracts harvesters from far due to the added incentive that outbreaks result in relatively more worms being available than in communal areas due to less competition from harvesters. One respondent indicated that:

> *"In this place of Zwigodini there was never a lot of worms available during an outbreak unlike other known areas. It is for this reason that we have to go to other places like Bokmakierie to harvest. Although the worms do not occur in our area, we have always been going to the same areas (Bokmakierie) to harvest and the worms still occur at that place even today."* VN306, Zwigodini – 21 March 2016

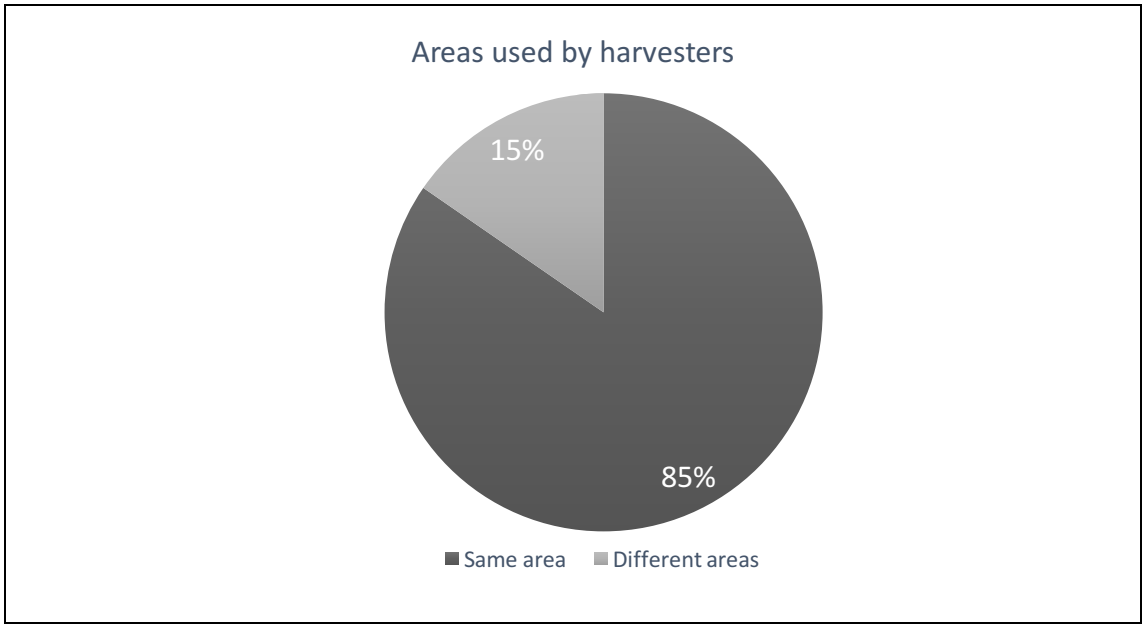

Figure 16 A graph showing whether harvesters utilise the same or multiple harvesting areas in different seasons

Harvesters often utilise different harvesting areas in order to buffer uncertainties such as interseasonal outbreak variability. In cases where outbreaks have been poor, alternative areas would be utilised. Fifteen percent of the respondents reported using multiple areas to harvest. The reasons for this occurrence are varied, they range from the decline in mopane trees driven by demand for firewood and land clearing for settlements; unfavourable climatic conditions such as

lower levels of rainfall; above average temperatures and high harvesting pressure due to the increase in number of harvesters. Therefore, in order to make up for the poor outbreak incidences, the harvesters opted to utilise multiple areas depending on the outbreak quality. Some of the respondents remarked:

> *"After the harvesting season then I wait for the following season, but if there are no worms where we harvest some people go to Masisi and Phalaborwa. I sometimes join them but in some seasons I don't"* VN334, Mphambo – 29 March 2016

Another respondent indicated that:

> *I can still harvest them but harvesting around here would require me to walk far otherwise I would take a taxi to Nkomo, Mtititi or Muyexe to harvest"* VN337, Mphambo – 23 March 2016

4.9. Conclusion

In summary, most of the respondents harvested from communal areas where access was found to be less restricted. However non-local harvesters were required to get permission from traditional leaders. On state and privately owned property, access was strictly regulated and permission was required for all harvesters. Mopane worm trading was found to be a lucrative trading commodity which created employment opportunities for rural people. Household consumption of mopane worms provided an important protein source which was readily available at no to very little cost. Indiscriminate harvesting, mopane tree cutting, vegetation change and changing climatic conditions were perceived by the respondents as the leading causes of poor mopane outbreak events. Low availability levels have altered the consumption patterns in the households and compensating for the low levels had negative financial implications for households. A discussion of the findings presented in this chapter will now be provided.

Chapter 5: Discussion

This discussion focuses on the significance of mopane worm harvesting and trade, environmental change and the impacts on rural households. The results of the study are discussed within the context of the literature reviewed in Chapter 2 and are synthesised within the sustainable livelihoods framework. The significance of mopane worm harvesting and trade as a livelihood strategy includes its contribution for food and income generation. This is important in poor households and has been part of their lives since childhood. Skills required and knowledge required for this activity have been passed down for generations. Lack of employment opportunities in rural areas make this livelihood activity an attractive occupation. However, the evidence suggests that mopane worm outbreaks are highly vulnerable to environmental change, and this could be exacerbated with future environmental change. Moreover, unsustainable harvesting practices are also putting a strain on mopane worm resources and could become significant if necessary resource management interventions are not made.

5.1. Contribution to Rural Livelihoods

i. Contribution to culture and food security

The importance of mopane worm as a natural resource and a source of protein and cash for rural households in poor communities has long been recognised (Madibela, *et al*., 2009). Historically, mopane worm harvesting and consumption has been practiced as part of the wider practice of entomophagy among many cultures across the world and has been well documented in literature (Teffo, *et al*., 2007; Ramos-Elorduy, 2009; Kinyuru, *et al*., 2010; Van Itterbeeck & van Huis, 2012; Dzerefos & Witkowski, 2014; Egan, *et al*., 2014). Mopane worms are highly nutritious and rich in protein, amino acids and fatty acids (Madibela, *et al*., 2009). The relative ease of access, affordability and popularity of mopane worm to rural people implies that this resource plays a critical role for nourishment in impoverished households which would otherwise struggle to afford protein sources such as beef and chicken products. This is an important livelihood activity for household provision. The value of the insects for consumption purposes is deeply appreciated by the consumers, and in some instances insects are preferred over meat products. Dzeferos *et al*., (2013) reported a statement made by a Muvenda harvester saying that "*If you have Thongolifha (edible stinkbug) you*

can leave the meat!". This is a demonstration of the significance of the resource as a food source and the valued placed on it by the harvesters and consumers.

However, the uptake of mopane worm consumption may not only be due to the nutritional value of the caterpillar. Traditional beliefs also contribute to its uptake. Some of the respondents in this study were harvesting and consuming mopane worm because they were perceived as a traditional food item and a form of cultural identity. Similar observations have been made for livelihood activities such as hunting, fishing and herb gathering wherein these activities are assimilated as tradition and thus form part of the cultural identity (Mutenje, *et al*., 2011). It is these notions that further strengthen the relationship between nature and culture. Some of the practices are driven by biocultural linkages (Cocks & Dold, 2004) and individuals believed that they had to engage in mopane worm consumption in order to keep their traditional customs in existence.

In the present study it was found that mopane worm harvesting and consumption has long been part of the household tradition among Vhavenda and Vatsonga people. Due to this, most of the respondents indicated that they were introduced to mopane worm harvesting and consumption from an early age and grew up with that knowledge being passed onto them by the elders. At least two thirds of the respondents consumed three different species of insects as part of their diet. This high level of entomophagy can be attributed to the widely held view that insects are a traditional food source of the local people and have been part of their diet for a long time. Similar findings were made in an earlier study by Dzerefos *et al*., (2013), who noted that entomophagy is a long-held tradition that is older than living memory in the north and north-eastern parts of South Africa. One of the tell-tale signs for this finding is the rich and extensive vocabulary used by Vhavenda people with regard to harvesting wild edible insects (Dzerefos, *et al*., 2013). As a result, the knowledge held by rural people about insect harvesting and consumption has been passed from generation to generation with children imitating the elders when on harvesting excursions as part of learning and knowledge transfer (Ramos-Elorduy, 2009; Dzerefos & Witkowski, 2014).

ii. Contribution to incomes

The current significance of mopane worm is both as a food source and trading commodity for goods exchange or monetary trade. Mopane worm outbreak seasons are in December/January and April. During this period temporary seasonal employment is created for those in rural areas who harvest to trade their stock for income generation and for household consumption. The importance of such employment is highlighted by the high level of unemployment which is 38,4% in the Limpopo

Province (StatsSA, 2016). In the present study, 20% of the respondents were harvesting mopane worms for income generation while a further 40% were harvesting for both consumption and trading. According to the respondents, the income generated from mopane worm trading was very important for paying tuition fees, household provisioning and purchasing costly household items which otherwise would not be affordable for unemployed people. Similar findings were made in previous studies on mopane worm trading in Thohoyandou (Makhado, *et al*., 2009b). This is an income which can rival any informal seasonal job within a rural context. The contribution of NTFPs to poverty alleviation in households can be either in direct-use or income generation. Such contributions may be for supplying basic needs, saving cash resources, safety-net functions and earning an income generation (Heubach, *et al*., 2011; Shackleton & Pandey, 2014). Some studies, however, have expressed caution about the use and dependence on NTFP trade as a way out of poverty. Firstly, because NTFPs do not generate enough regular incomes, but may generate income at certain times of the year but this is often seasonal and not enough to lift an individual out of poverty. Secondly, harvesting can lead to resource overexploitation and have biodiversity impacts with unintended impacts on biodiversity and rural households (Murali, *et al*., 1996; Shackleton, *et al*., 2005; Putzel & Cerutti, 2014).

5.2. Environmental Change and Mopane Worm Harvesting

One of the most significant findings of this study is the perceived change in mopane worm availability as a result of changes in rainfall and temperature. These environmental changes, according to the respondents, have been manifesting over the past decade. However, in the last three years, the lower-than-normal precipitation and higher-than-normal temperatures have been acute and have led to a noticeable decline of the mopane worms in the harvesting areas. Many harvesters believed that the reason for the decline in mopane worm outbreaks was due to the climatic conditions which prevailed. This finding was confirmed in a recently concluded drought impact assessment study conducted in the Mopane district of Limpopo Province over the period of 2015-2016, wherein 79% of the respondents held that the decline in precipitation and increase in temperature have resulted in environmental impacts such as ecosystem damage, dried-up streams, loss of livestock and crops (Manderson, *et al*., 2016). The close relationship that exists between climatic conditions and mopane worm outbreaks was observed in studies conducted in southern Zimbabwe and central Botswana which sought to understand impacts of climate change on rural livelihoods. It has been found in a number of studies that declines in rainfall and increased

temperatures resulted in impacts which ranged from significant reduction to complete disappearance of mopane worms (Dube & Phiri, 2013).

Similar findings were noted in a study conducted in Hwange, in western Zimbabwe, where rural households perceived changes in climatic conditions to be causing a decline in the natural resources on which their NTFP livelihoods were based. In addition, the study found that the perceptions of the respondents were comparable with empirical evidence on changes such as a decline in precipitation and increase in temperature in the Hwange region (Nhemachena, *et al*., 2014). This demonstrates the importance of traditional ecological knowledge in the detection of environmental changes and informing the development of strategies to combat and adapt to environmental changes such as climate variability (Vinyeta & Lynn, 2013).

While traditional ecological knowledge could be valuable in understanding climate change and its impacts on rural livelihoods (Byg & Salick, 2009; Salick & Ross, 2009), some degree of caution should be exercised when dealing with perceptions on the impacts of climate change, since the severity of the impact is a combination of other factors such as changes in land use, land cover and soil erosion which may be erroneously attributed to changes in rainfall (Mazvimavi, 2010).

In the present study, 42% of the respondents agreed that mopane tree density had decreased in their area of harvesting. The respondents further indicated that although mopane tree cutting had been banned by the traditional authorities in their villages, people still harvested the trees for a number of uses. Such uses have been shown to be of high importance to the wellbeing of rural households living near mopane woodlands (Makhado, *et al*., 2012; Tewari, 2012). From this observation, it could be argued that benefits and incentives derived from mopane tree uses and its products seem to outweigh the deterrent force of fines that are imposed on offenders who are caught harvesting mopane trees. In a review of the uses of mopane tree products, it was demonstrated that there are a wide range of products and uses which are utilised by rural households. The wood and non-wood uses included firewood, poles for construction of traditional structures and medicinal use. All these uses are inherently destructive and involve either cutting down the mopane trees and/or harvesting the bark, roots and leaves (Makhado, *et al*., 2014).

The decline in mopane tree density has been known to have an impact on the sustainability of mopane worm harvesting. In Namibia, traditional authorities have set up regulation by-laws which prohibit illegal cutting of mopane trees for fencing and building material and setting fires in the forest in order to protect mopane trees. This serves as way of curbing the destructive pressures on mopane worm populations to ensure sustainability of the resource (Thomas, 2013). Similarly, in Zimbabwe it was found that protection of the habitat, host tree and the mopane woodlands, was

important in order to ensure future availability of the mopane worm population (Gondo, *et al*., 2010).

Interestingly, 85% of the respondents confirmed that they are still utilizing the same areas for harvesting despite the continuing decline of the mopane worms. Factors such as close proximity, lack of regulatory hurdles and negligible costs to reach and access the harvesting areas were cited as the reasons for those choosing to utilise the same harvesting areas which they have historically used; in most cases these areas were in close proximity to their villages. Those who utilised different harvesting areas had to travel to distant areas to harvest. The deterring effect of transportation costs could be attributed to the observed low levels of traveling to harvest in distant areas. Baiyegunhi, *et al*., (2015) found that in NTFP harvesting transport played an important role in decision making about whether or not to harvest. It was also found that households were 85% less likely to harvest for every increase in distance of one kilometre to the harvesting area. Some of the contributing factors included the transactional and logistical costs of transporting mopane worms over long distances. In the present study it was found that the majority of the harvesters utilised areas in close proximity to their homes and in cases where transport was required, ease of access of transport influenced their decision.

NTFP harvesting has served as a vehicle for intergenerational traditional ecological knowledge transfer for rural people. Such important traditional ecological knowledge is entomophagy and habitat manipulation to increase woodland capacity to support higher yields (van Itterbeeck & van Huis, 2012). Habitat management to increase caterpillar yields is one form of environmental manipulation which is widely practiced in southern Africa. In the miombo woodlands of Zambia and the Democratic Republic of Congo (DRC), local communities practice tree thinning in order stimulate and rejuvenate coppicing to increase the capacity of the woodland to support the edible caterpillars. This form of environmental manipulation is practiced in a way that resembles the shifting cultivation in agriculture (Chidumayo & Mbata, 2002). Other environmental manipulation techniques include host tree planting in predetermined areas, correct application of fire to protect host trees, avoidance of destruction of moth eggs on foliage and the pupae underground and lastly, not cutting down host trees which preserves caterpillar breeding sites (Gade, 1985; Takeda, 1990; Chidumayo & Mbata, 2002; Van Itterbeeck & van Huis, 2012). To this end the insects are seen as cultural resources and their consumption serves as a reflection of the biological diversity of the region (Nonaka, 2009). In the face of declining mopane worm yields and erratic outbreak events, habitat manipulation techniques have the potential to improve yields in the study area. No findings were made in the present study which demonstrate the existence of similar habitat management and manipulation interventions. These methods have however been successfully practiced elsewhere for many

generations with success (van Itterbeeck & van Huis, 2012). The adoption of these methods is likely to have a positive impact on mopane worm yields and sustainability of the resource, although caution should be exercised due to the differences in species.

5.3. Socioeconomic Change and Household Vulnerability

It has been established that mopane worm harvesting is a livelihood strategy for harvesting households and the worms are important for household consumption and trading (Makhado, *et al*., 2009b; Makhado, *et al*., 2012; Thomas, 2013). In the present study, 67% of the respondents agreed that the worms are an important food source in their households, while 80% regarded the worms an important trading commodity for earning income. Lack of employment opportunities and limited income earning potential were cited by the respondents as some of the reasons to engage in mopane worm harvesting. To this end, it has been shown that rural households undertake NTFP harvesting and trading to safeguard against predictable periods of vulnerability, integration into the cash economy and unforeseen risk and shock (Paumgarten, 2005; Hunter, et al., 2007). Shackleton *et al*. (2008) argue that in addition to the function of a *safety net* for rural households to cope with shocks, the trade in natural products may perform a variety of functions such as allowing them to diversify or to specialise and accumulate. This is an important role of NTFP trade in poverty alleviation. In the present study it has been found that the harvesters and local traders operate on a scale that precludes accumulation and subsequent diversification. Harvesting and trading was done on a subsistence level and the profit earned from such activities would not be sufficient to invest elsewhere in a capital-intensive venture. Therefore the findings of this study do not demonstrate that mopane worm harvesting can be used as a standalone exit strategy out of poverty.

Shackleton *et al*., (2007) found that woodworkers earned a gross income of R48 769,50 while broom makers and traders earned R15 008,50 and R17 871,70 respectively, per annum. In the present study, a Zimbabwean mopane worm trader indicated that in a good trading month she earned a profit of between R25 000 and R30 000 trading at various markets in the town of Makhado. Most of this money was remitted back home to Zimbabwe for household expenses and university tuition fees (see Section 4.64). At the time of data collection, one of her children had already completed university studies with the support of income earned from mopane worm trading which was her main source of income. However, due to the unfavourable economic climate in Zimbabwe and socioeconomic conditions, she too had to participate in NTFP trade for income as a result of lack of employment opportunities in their country. Similar profits as reported in the present study had been

reported in separate study on the medicinal plant trade in the rural areas adjacent to Kruger National Park (Botha, 2001). Such investments of NTFP income in family education is one of the best known and important forest contributions to rural households (Shackleton, 2005).

The significance of NTFP income may be more evident in households where no one holds a formal job and NTFP trading serve as the main income source due to the inability to participate in waged labour. Shackleton *et al*., (2007) emphasise that structural impediments such as poor skills, education, lack of infrastructure, remoteness and limited access to real employment opportunities make NTFP livelihoods an important income source when compared to alternatives such as local wage labour. In a separate study in the Limpopo Lowveld, it was found that selling beer made from marula fruit (*Sclerocarya birrea* subsp. *caffra*) was more profitable than the available paid farm labour in the area (Mander , *et al*., 2002).

The majority of the harvesters were unemployed, originated from female-headed households, had no post-secondary education, and depended on social security grants and informal seasonal jobs to earn income. The high level of reliance on mopane worm harvesting and the increasingly unpredictable climatic conditions could increase the vulnerability of the households to food insecurity. To reduce such household vulnerability and level of dependence on NTFPs requires a multipronged approach.

While it is widely accepted that many rural households depend on NTFP-based livelihoods (Shackleton, 2005; Quang & Anh, 2006; Makhado, *et al*., 2014; Kar & Jacobson, 2012), this may also be a source of household vulnerability. Factors such as climate change, loss of biodiversity and changing socioeconomic factors may impact on the households' ability and capacity to secure sustainable NTFP-based livelihoods (Bele, *et al*., 2015). Mitigation of these contributing factors is necessary in order to reduce household vulnerability to unforeseen sudden shocks and/or prolonged changes (Boon & Ahenkan, 2012; Ofoegbu, *et al*., 2016). High levels of depedence on mopane worm have been reported in the present study with 67% and 80% of the respondents agreeing that the resource is important for food and trade. Given such high levels of dependence and resource use, any unforseen sudden shock or prolonged changes in availability may have significant impact on the households.

Given that women play a key role in the NTFP sector, intervention strategies to reduce household vulnerabilty need to focus more attention on women for greater household impact (Shackleton, *et al*., 2011). Baiyegunhi *et al*., (2015) suggest that intervention strategies should focus on increasing education levels of rural people, especially women, in order to improve their access to better job opportunities to increase their productivity and income. They further argue that rural women should

be empowered to encourage a shift to urban wage employment, and stress the importance of developing more profitable livelihood strategies for women and providing sustainable harvesting training to the harvesters. In the present study, it was found that more females and women-headed households are involved in NTFP-based livelihoods than male-headed ones. Various studies on the role of women in the NTFPs sector and household livelihoods have revealed that females play a far greater role and in the NTFP value chain, although the significance of that role is often undervalued (Osemeobo, 2005; Kalu & Egharevba, 2006; Awono, *et al*., 2010; Shackleton, *et al*., 2011). In Cameroon, it was found that more than 70% of women in rural areas utilise NTFPs to improve the livelihoods of their families (Awono, *et al*., 2010). Therefore, women's empowerment is more likely to have significant contribution to the reduction of household vulnerability.

The empowerment of rural women could be achieved with interventions that are tailored to support women's needs in terms of independent legal status, technology, organisation, and managerial capacity (Shackleton, *et al*., 2011). In Cameroon, a capacity builiding programme was rolled out to train female NTFP traders in aspects including market trends, product specialisation, storage strategies, availability of raw materials and better organisation among traders. The programmes resulted in increased income for the traders, which was used for basic household expenses and investments in home improvements (Awono, *et al*., 2010).

5.4. Access, Harvesting and Resource Management

Mopane worm harvesting takes place in different areas under different management regimes which result from different forms of ownership which include communal, state and private. Access, control and management of these areas are therefore different and reflect the underlying objectives of the respective owners. In the present study, the majority of respondents indicated that they were harvesting in communally owned lands which were governed by the tribal authority and the chief who are seen as the custodians of these common pool resources. The majority of the local harvesters indicated the existence of an open access regime on harvesting with the only control and regulation in place largely aimed at non-locals.

In Tanzania, traditional institutions have been credited with promoting traditional practices such as beliefs in sacredness of tree species; beliefs in sacred forests; respect for cultural forests; protection of plants at burial sites; collection of only deadwood for firewood, and use of energy-saving traditional stoves (Msuya & Kideghesho, 2009). In the present study local harvesters expressed concern about a perceived decline in control as it allowed non-local harvesters to access the

resource without preconditions, where non-locals were free to do as they please. This was seen as theft and was cited as the underlying reason behind the plundering of the resource. The effect of weak local institutions in communal areas has been known to be a contributing factor to poor resource management and thus unsustainable utilisation practices (Thomas, 2013). By inference, this limited control of mopane worm harvesting could be an indication of relative decline in control by the tribal authority and traditional leaders, thus signifying weak traditional and local institutions.

On the other hand, the open access approach to NTFPs could be a result of the confusion with regard to the custodianship of NTFPs in the woodlands in rural areas across South Africa in the post-1994 period (Kirkland, et al., 2007). According to Makhado *et al*., (2012) the effective management of woodland resources in rural areas has been undermined by a lack of clarity on the responsible entity for management of such resources between traditional leaders, local government and local communities. As a result of this management vacuum, woodland resource management problems such as flouting of traditional conservation norms, overexploitation of woodland resources, irresponsibility in the management of natural resources among local people, municipalities and traditional authorities, and increasingly open systems of woodland resource use in rural areas has continued unabated (Makhado, *et al*., 2012; Thomas, 2013). In the present study, it was found that traditional leaders are cooperating with the provincial government to enforce control mechanisms and management of mopane worm harvesting. In Nkomo village field rangers from LEDET undertake coordinated patrols with tribal police to monitor and enforce resource harvesting restrictions. Similarly, in Ha Gumbu, rangers from the Limpopo Department of Agriculture who are responsible for monitoring wild animal movement for foot and mouth disease control, double as eyes and ears to detect any unauthorised harvesting. However, the cooperation is limited, as it is only taking place in very few villages and may not result in achieving the intended objectives. These findings suggest that partnerships in resource management may result in effective regulation and control of resource harvesting and management. In the present study, the waning power and influence of traditional leaders is evident. The lack of respect for traditional leaders is shown primarily by non-locals who frequent the villages during the harvesting seasons. However, among the locals there is still respect for the role of the chiefs and traditional leaders with regards to harvesting seasons and methods.

The results of this study have shown that historically, mopane worm harvesting has been an important livelihood and this practice has been passed down through the generations. This has been perpetuated by traditional beliefs and customs. Currently, trading is providing an important source of income for unemployed rural people from this age-old practice, while harvesting for consumption provides a protein source and contributes to food security. Forms of environmental change, namely, climate change and vegetation changes, are viewed as the leading causes of the decline in mopane

worm populations and erratic outbreak events. High levels of unemployment and poor prospects of employability in the rural areas are some of the reasons for harvesters taking up the livelihood. This also serves to supplement remittances to cover household expenses. Major cultural shifts in which traditional leaders' influence is waning is perceived to lead to unsustainable harvesting, especially by non-local harvesters.

5.5. Sustainable Livelihoods Framework: Synthesis

Household decisions on whether or not to participate in NTFP harvesting and trading depend on a number of socioecomic factors. A careful consideration of the opportunities, constraints and returns on such livelihood activities in comparision to wage labour may be neccesary prior to pursuing a given livelihood activity. Socioeconomic factors such as age and gender of the household head, household size, religion, income earning potential, education and social group affiliation are known to play a role in determining household participation in NTFP-based livelihoods. Asset ownership and regulatory frameworks also play an important role (Stack, *et al*., 2003; Makhado, *et al*., 2009a; Lucas, 2010; Baiyegunhi, *et al*., 2015). Mopane worm harvesting and trading provides an invaluable rural livelihood for rural people and has been undertaken widely in order to reduce household vulnerability and minimise the impact of poverty. In order to understand the contribution of mopane worms to rural livelihoods, a synthesis within the context of the sustainable livelihoods framework is provided below.

Vulnerability context

The vulnerability context represents the external environment in which people exist. Shocks, trends and seasonality, over which people have little or no control, are some of the factors which affect the availability of assets (capitals) and people's livelihoods (DFID, 1999; Allison & Ellis, 2001). In the present study it was found that drought and high temperatures, which were resulted from by the El Nino phenomenon, resulted in the sudden shock on mopane worm availability. In the period between late 2014-2016, there were very little to no mopane worm outbreaks. This shock resulted in widespread shortages of mopane worms in households and markets. It was expressed by the respondents that in the last two decades mopane worms have been on a declining trend due to vegetation change, a reduction in mopane trees and unsustainable harvesting techniques. Unlike shock, trends may be more benign and less noticeable in the short-term. However, over longer periods, their effect may be be more noticeable and have an influence on the rate of return to pursued livelihood strategies (DFID, 1999), thus resulting in negative and unfavourable livelihood

outcomes (Kollmair & St-Gamper, 2002). Seasonal shifts in employment oportunities, food availability, and mopane worm outbreaks are some of the factors which contribute to the complexities of mopane worm livelihoods. In the present study, respodents reported very low levels of formal employment and some depended on seasonal jobs on farms. The outbreaks of mopane worms are also highly seasonal therefore people took part in harvesting during the outbreaks. This provided short-term employment and important income. The rising food prices were cited by some respondents as the driving factor for households to pursue livelihood activities. People grew crops and raised livestock in order to limit their exposure to the volatile food prices and improve their food security. This is important in order to reduce the household vulnerability, given that the people had no control over issues affecting food prices. The vulnerability context of the harvesting and trading households changed significantly due to the weather and climatic conditions shocks.

Natural capital

Access to natural capital is an important factor in rural livelihoods because natural resources provide the 'capital stock' through NTFP collection. In this context mopane worms were the main form of natural capital. Most of the respondents harvested in the communal lands where different arrangements exists for access to mopane worms. Most respondents showed satisfaction with access arrangements. The majority of the respondents indicated that within such harvesting areas there are no restrictive conditions for access and harvesting. However, access and harvesting condition exists and are strictly applied on the private and state lands. The respondents also expressed concerns regarding the decline in mopane worm avaialbility. In the past two decades, mopane worms have been declining, however in the past two years a lack of rainfall and high temperature have resulted in the complete unavailability. Thus demonstrating that availbility of mopane worms is a central constraint to achieving a sustainble livelihood.

Financial capital

This refers to the financial or monetary resources which people require in order to pursue their livelihoods. This may also be used to refer to other goods which may be exchanged as an equivalent of cash (DFID, 1999). There was a marked shortage of financial resources and income-generating opportunities among the respondents. Harvesters and traders required financial resources in order to cover costs incurred when harvesting and as stocking capital when procuring from other traders. This served as a major limitation for the harvesters and traders alike. For the harvesters, harvesting areas which required sustantial financial inputs such as transport costs were largely avoided due to the lack of funds required. This resulted in people opting to harvest in areas that cost little to access and where the harvesting areas are within walking distance. This served as an important

consideration for harvesters in order to maximise the resturns to labour, which would otherwise be eroded by the somewhat prohibitive costs on travel, entrance fees and living expenses incurred when harvesting in areas far away. On the other hand, the lack of income-generating opportunities for the respondents served as a motivating factor to encourage harvesters to trade their stock to earn an income for their households. This, in some households, served as the primary source of income and played a key role in minimizing the impact of poverty and household vulnerability.

Human capital

Human capital encompasses the skills, knowledge, ability to labour and good health that are key for the households to pursue livelihood strategies (DFID, 1999). Respondents had very low level of education. The majority of the respondents reached secondary schooling and none reached tertiary level. The majority of the respondents were females and were from female-headed households. The low levels of education coincided with the poor employability levels in the rural areas. Nevertheless the respondents had a relatively high level of indigenous ecological knowledge of the natural resources which had been passed on from one generation to the next. The respondents were generally farmiliar with the outbreak seasons, role of rainfall and temperature on the outbreaks and the development stages of mopane worms. This knowledge is critical for biological resource direct and medicinal use (Lienert & Burger, 2015). Reasons for the lack of education are varied however we suggest that socioeconomic constraints may have contributed to the high level of school-dropouts. Human capital may be a constraint in mopane worm livelihoods as it confines the respondents to harvesting and may preclude participation in other aspects of the trade. However mopane worm harvesting and trading is usually undertaken by enitre family thus resulting high availability of labour.

Social capital

Social capital refers to the social resources which aid people in their pursuit of livelihood outcomes (DFID, 1999). There were no formal social groups or formations linked to mopane worms harvesting which respondents indicated they were part of. The respondents, however, indicated that horizontal connections and networks existed among the harvesters and traders alike. These are individuals with shared interest and therefore the existence of connections and networks is important for sharing information about outbreak areas and harvesting excursions. Given that mopane worm harvesting takes place in the woodlands, the need for personal safety encourages the harvesters to undertake the harvesting excursions in a group for mutual safety. The relationship among harvesters went beyond harvesting, however, with some respondents indicating that they cooperated on price setting too. While there were no formal social formations, harvesters in the villages also cooperated

on upholding the decrees of the traditional leaders which banned harvesting juveniles worms. This community-wide level of cooperation was expressed as important for the sustainability of the mopane worm populations. Due to the amount of labour and assistance that is required in processing mopane worms, family and friends provided important sources of social capital for the harvesters as most of the work was undertaken with contrubition from such circles of social capital. This formed a good basis for social capital supporting mopane worm trading and livelihoods.

Physical capital

Physical capital encompasses the infrastructure, resources and goods that are needed in order to support livelihoods (DFID, 1999). Affordable and efficient transport is essential for mopane worm livelihoods and a lack of affordable and efficient transport could be a constraint for the harvesters. Costly transportation has been expressed as a limitation since most harvesters may not have the money to pay to access far harvesting areas. Mopane worms must be processed on the same day of harvesting in order to maintain their integrity and avoid spoilage. This requires easy transportation from harvesting areas to homes, for the daily-commuting harvesters. For the harvesters who prefer to sleep-over at the harvesting areas, prior arrangements have to be made for shelter and accommodation purposes. These are usually made with extended family, friends and fellow harvesters. However, the visiting harvesters expressed that they would have to pay for such accommodation. The payment, in the form of mopane worms or cash, has been cited as a cost that some respondents could not afford as it either reduces one's harvest or required money which some may not have. The cleaning, processing and storage of mopane worms is done through basic labour-intensive techniques, which may increase the chances of contamination. Some of the harvesters lack the capabilities to access the markets to trade their stock to other traders or consumers, which would earn a higher returns. Availability of appropriate physical capital is important for maintainign a sustainable livelihood.

Transforming structures and processes

These are the institutions, organisations, policies and legislation that shape livelihoods and are in turn shaped by the livelihoods (DFID, 1999). Social relations, institutions and organisations are key for the purpose of access and ownership, terms of exchange between different types of capital and returns. Promotion of access to the assets is important determinant of the success of household livelihoods (Allison & Ellis, 2001). Equally influential in this regard are the issues of social relationships and power relations which form part of the institutional processes governing access (Scoones, 1998). In communal areas, the institution of traditional leadership plays an important role in mopane worm livelihoods. Regulation of access and terms of such access is determined the chiefs

and it directly affects the harvesters. In private and public lands, such powers are vested in land owners and state entities, respectively. The respondents indicated that these structures determine the commencement of the harvesting season, and institute harvesting bans where necessary in order to curb harvesting of juvenile mopane worms. It was found that field rangers from LEDET are assisting in enforcing the regulations on mopane worm and mopane tree harvesting imposed by the chiefs. The communal rights of the villagers to access the resources have been recognised and protected by the chiefs, wherein local harvesters have unconditional access, provided that the harvesting season has been declared 'open'. For nonlocal harvesters, in some harvesting areas, they are required to obtain permission while in other areas they do not need to obtain it. Traditional leaders and landowners are the key regulating actors in the mopane worm livelihood through access regulation and management.

The livelihoods framework as an analysis tool allows for the assessment of the capitals which form livelihood platform. Assessment of capitals requires an understanding that some capitals may contribute to the attainment of others. Nonetheless, an attainment of these capitals may not necessarily translate into attainment of sustainable livelihood. Livelihoods are usually pursued within a certain vulnerability context. This is a component in which households may have very little to no influence or control. The transforming structures and processes provides for the requirements for attaining, administration, access and trade of capitals and benefiting from their utilization. The output of the livelihood strategies lead to the realisation of the livelihood goals such as generation or improved income, food security, physical security and reduced vulnerability. Natural capital provided greater opportunities for the households in this study due to the relative ease of access and insignificant input costs associated with accessing mopane worms. Equally, social capital presented greater opportunity due to the high availbility of labour from family of the harvesters. Physical and financial capital provided the greatest threat to the attainment of sustainble livelihood. Obtaining the two capitals was difficult for households which are aready in poverty. This served as a hindrance for households and limited their income earning potential.

Chapter 6: Conclusion

This study investigated the contribution of mopane worm harvesting to rural livelihoods, and the effects of environmental change on mopane worm harvesting in rural households in order to understand how households attain sustainable livelihoods in communal areas in Limpopo Province, South Africa. The study intended to:

- determine the current significance and contribution of mopane worm harvesting and trading to rural livelihoods;
- gauge the perceptions of harvesters and traders on forms of environmental change which have affected mopane worm availability and how consumption and trade patterns have changed in the last 20 years;
- assess access and management of mopane resources under different tenure types; and,
- explore mopane worm use in the context of the sustainable livelihoods framework.

The significance of mopane worm in the study area is three-fold: it is an important source of food, it is a valuable trading commodity, and it is an intrinsic part of local culture/ cultural practices. Mopane worm harvesting, trade and consumption are activities undertaken for dietary supplementation and income-generating purposes. The findings of this study indicated that the historical value placed on mopane worms as a food source and trading commodity has been passed down for generations. This has been perpetuated by traditional and cultural beliefs which regard mopane worms as a food source superior to meat products. Bartering and exchange of mopane worms for household goods continues to be practised, but is on the decline. Most harvesters prefer money for trading as it allows for procurement of necessary household items. Trading serves as an important form of employment for rural people who have limited prospects of formal employment and has the potential to generate higher income levels than wage labour in rural contexts.

Environmental change is a worrying factor for the harvesters and has impacted their livelihoods. The decline in mopane tree density, vegetation change, lower-than-normal precipitation, and higher-than-normal temperatures are the leading forms of environmental change which have significantly affected mopane worm availability and outbreak events. According to the respondents, changes in vegetation and mopane tree density have been continuing for over a decade. However, the sudden shock of the dry conditions resulting from the El Niño Southern Oscillation (ENSO) resulted in significant shortages of mopane worms and their complete disappearance in some areas in the period between 2015-2016. Given that mopane worm harvesting is an important livelihood activity for harvesters and traders, such unforeseen large-scale shortages have far-reaching socioeconomic

and nutritional consequences. The threats imposed by changing climatic conditions are likely to have long-term implications for harvesters and traders who depend on mopane worms for income to cover expenses such as education fees and household improvements. If this income stream is diminished, rural households will be adversely impacted with downstream socioeconomic impacts.

Sudden and unforeseen changes in mopane worm availability has the potential to alter household consumption and trade patterns. Mopane worms generally have a long shelf-life and this allows for storage in households between the two harvesting seasons in December and April, and for continued availability of mopane worms for the rest of the year in the markets. However, household consumption and procurement patterns are greatly altered when outbreaks are erratic and availability levels are low. In households where mopane worms formed a large part of the diet, alternative food sources were leafy vegetables or meat products. However, the latter required purchasing which presented challenges for poor households with very limited income. Usually during periods of poor outbreaks, mopane worm prices increases. Households adapt to this development by changing their consumption patterns such as reducing serving portions and changing purchasing patterns to coincide with paydays for the employed and social grant pay-out days for state grant recipients. To supplement their diets, households resorted to gardening and raising livestock. The changes in trading patterns have been to the detriment of traders who sell locally sourced stock. The decline in availability, however, creates a market for importation of mopane worms from Botswana, Zambia and Zimbabwe. The imported mopane worms are sold at higher prices due to transportation costs and custom duty at the border. This pushes some of the local traders out of business and encourages Zimbabwean bulk traders to sell directly to the consumers.

Findings made in this study show that land tenure type is the primary determinant of resource management and access regimes in the harvesting areas. On the communal land, the communal resources are governed under the regulation of traditional leaders or tribal councils. These determine access conditions and management regimes. Access and management regimes within the communal areas are not uniform. In areas where the traditional leaders still maintain and enjoy tight control over resources, it was found that there was greater respect of decrees and commands by the harvesters. In such areas there is typically strict control on access and management of mopane worm resource. Other communal areas revealed less respect for traditional leaders and any regulatory measures that they may impose. In such areas harvesters access harvesting areas without complying with any decree or customary practice. In private and public lands, management and access were strictly regulated by the land owners and authorities. On private land, harvesters were

only able to secure access by paying an access fee and obtaining a permit. While on public land harvesters were required to apply to obtain permission, however no payment was necessary.

The sustainable livelihoods framework offers an opportunity to investigate and get insights into the capitals which households make use of in pursuit of their livelihoods strategies and potential livelihood outcomes. Given that the combinations of resources in a given vulnerability context may enable or impede attainment of sustainable livelihoods, this approach offers a holistic view on combination of natural, physical, social, human and financial capitals and the resulting constraints and opportunities thereof. The limited availability of natural capital, mopane worm, as a result of environmental shocks presented a key constraint for the households and traders. The high availability of labour from family of the harvesters offered strong human capital to pursue the livelihood. Furthermore, the strong social links and networks which resulted from family-level and community-wide participation strengthened the social capital opportunities. Physical and financial capital were found to have greatest threat to the attainment of sustainable livelihood. Households suffer poverty and are not easily able to access financial resources. This served as a hindrance for households and limited their income earning potential.

In respect of these findings, the following recommendations are made:

1. Further empirical investigations should be undertaken to determine the status of mopane worm populations. This is required in order to validate the perceptions of the harvesters and to unravel linkages between mopane worm populations and environmental change. If mopane worm populations are declining, there is a need to fully understand the underlying causes in order to appropriately tailor conservation interventions and secure rural livelihoods.
2. Improved cooperation between traditional leaders, harvesters and local government is suggested as an option for management of mopane worm resources in the communal harvesting areas. Traditional leaders still maintain control of natural resource utilisation in communal areas and hold influence over the communities they lead. It is suggested that this relationship be enhanced with input on sustainable harvesting practices from conservation authorities. This should also include harvesters and traders as key players in this sector. This should instil a sense of ownership and responsible harvesting of the resources to promote sustainability of mopane worms and addressing the harvesters and traders' needs.
3. The interplay between access, land tenure and harvesting requires further research. Mopane worm harvesting takes place across multiple tenure types and therefore there is the opportunity to understand tenure, governance and access in the context of mopane worm livelihoods.

Research in this area would inform an appropriate management regime in harvesting areas for conservation and sustainability goals.

4. The influence of the growing adoption of western-oriented lifestyles on mopane worm harvesting and consumption requires further research. A high proportion of the Limpopo Province population comprises of young people. This section of the population does not typically adhere to a traditional lifestyle and its related practices, as their older peers do. It is therefore suggested that the importance of mopane worms as an NTFP to the younger population be explored in future research in order to understand how this will shape future long-term management frameworks.

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Appendices

Appendix 1: Trader and Harvester Questionnaire

University of Cape Town

George Sekonya Masters Project Data Collection

Project title: The contribution of mopane worms to sustainable rural livelihoods and the effect of environmental change on mopane worm harvesting and trading in Limpopo Province, South Africa

For the respondents who used to harvest and may have also traded or are currently trading mopane worms

Date:……

Questionnaire number:…….

Location:……

GPS coordinates:……..

Has the informed consent form been signed by the participant? Yes/No.

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1. Age
2. Gender
3. Level of education
4. Are you the head of the household? If yes, what is the household size?
5. Employment status [ ] unemployed [ ] self-employed [ ] pensioner [ ] formal job
6. How long have your household been living in this area?

Harvesting

7. What mode of transportation would you use to access the area where you harvest? [ ] By foot [ ] Public transport [ ] Our car [ ] Other
8. From what age did you start getting involved in mopane worm harvesting? How did you or your household become involved in mopane worm harvesting?
9. What role did your parents or elders play in influencing your involvement in the harvesting?
10. Was your harvest intended for household consumption only or trading?

11. How much time per day would you spend working on harvesting and processing the worms during the harvesting season in the camps?
12. Are you still involved in harvesting? If yes why? If not, why not?
13. What is the importance of mopane worms in your household? Please elaborate.

Very important	Fairly important	Not very well important	Not at all important	I don't know

Trade

14. Were you trading mopane worms for money or goods that you needed? What kind of items would you trade your mopane worms for?
15. How significant was the trading or exchange of mopane worms for other goods in your households?
16. How did you become involved in the mopane worm trade
17. Are there any members of your family or household who are involved in the trade too? What are their roles?
18. Do you specialise in trading only mopane worms? If yes, why? If no, what else do you trade?
19. From who do you buy your stock? What are the stocking prices? Do they depend on the place of origin of the stock?
20. Does the income earned from trading mopane worms serve as the primary household income or supplementary income? What are the quantity prices that you use?
21. How would you rate the importance of income earned from mopane worms trade for your household?

Very important	Fairly important	Not very well important	Not at all important	I don't know

22. What is your estimated profit from trading mopane worms? (per year, per season) and how does the seasonal fluctuations in availability affect your trade?

23. There has been a lack of rain in the past few months in Limpopo Province and other SADC countries, has this affected mopane worm availability? How does lack of rain affect mopane worm availability?
24. Does the lack of mopane worm availability affect your microbusiness? Please elaborate in terms of stocking capital, selling prices, profit margin etc.

Food security

25. When you were growing up what was the importance of mopane worms as a food source in your household?
26. Did you have alternative sources of protein to mopane worms?
27. Would you say your household depended on mopane worms as a protein source or it is only a delicacy?
28. Besides mopane worms, are there any other insects and small organisms which you harvest or catch in the wild?

Questions addressing the forms of environmental change which have affected mopane worm availability patterns

29. Does mopane worms still occur in areas where you used to harvest at when you were growing up? Does the breakout still occur at the similar time of the year? If this has changed what do you think has contributed to this?
30. How would you regard vegetation changes in the areas where you used to harvest? (Such as general vegetation clearing or targeted cutting of mopane tree, marula tree etc.) please elaborate.

Very major	Fairly major	Not very well major	Not at all major	I don't know

31. What is your perception on whether the density of mopane tree increased or decreased in the area?

Increased	Don't know	Decreased

32. How would you rate the spread of settlements or villages into the areas where harvesting used to take place?

Very major	Fairly major	Not very well major	Not at all major	I don't know

33. Has there been any noticeable changes in the rainfall in the area in terms of seasonality or intensity in the area?
34. Do you think the heat waves experienced since last year have affected mopane worm outbreak? If yes, how?
35. Do you think the harvesting practices may have affected mopane worm outbreak patterns? How?
36. Do the current harvesting practices differ from the old methods? If yes, how do they differ?
37. What do you understand about climate change, deforestation and urbanisation? Do you think any of these phenomena may have affected mopane worm outbreak and availability patterns?

Questions on how environmental change has altered mopane worm harvest, consumption and trade patterns of rural households

38. Are you still able to harvest mopane worms as it was when you were growing up? If not, what is the reason for this occurrence? If you are unable to harvest enough mopane worms, from where would you obtain your supply?
39. How often do you buy and what are the quantities and the prices? Are the prices affordable?

Very often	Fairly often	Not very well often	Not at all often	I don't know

40. Has this led to a change in the consumption patterns in your household? Please elaborate.
41. Does it affect the household from meeting their dietary requirements?
42. Have you explored other alternative sources to compensate for the changes in mopane worm outbreaks?

43. Do you inquire about the place of origin of the mopane worms when you purchase? Are there any differences between the locally sourced mopane worms and the imported worms from outside south Africa? Does this information contribute to your decision to buy or not to buy?
44. Are there any efforts by the community members or leaders to regulate mopane worm harvesting? If yes, what are the initiatives? Is there any regulation from the government to control mopane worm harvesting?
45. What do you think needs to be done to curb deforestation and urbanisation which are reducing the habitat for mopane worms?

Appendix 2: Key Informant Questionnaire

University of Cape Town

George Sekonya Masters Project Data Collection

Project title: The contribution of mopane worms to sustainable rural livelihoods and the effect of environmental change on mopane worm harvesting and trading in Limpopo Province, South Africa

Date:……

Questionnaire number:…….

Location:……

Has the informed consent form been signed by the participant? Yes/No.

The area of expertise:……..

Questions addressing the historical significance of mopane worm consumption and trade as a livelihood strategy

Within this region, what is the importance of mopane worm as a food source and trading commodity?

Historically what has been the significance of mopane worms to the communities in this region?

How would you characterise the dependency of the households on mopane worms?

What is the importance of mopane worm as a tradable commodity and as a food source?

Questions addressing the forms of environmental change which have affected mopane worm availability patterns

In the past few months Southern Africa has been experiencing heat waves and lack of rainfall, to what extent has this affected mopane worm outbreaks and availability in this region?

Has the geographical distribution of mopane worm outbreak areas remained the same in this region?

Has there been a marked shift in seasonality of the outbreaks?

Does deforestation play a role in altering the outbreaks and availability? Please elaborate.

Has there been any significant changes in the vegetation in this region which affects mopane worm availability?

Does the expansion of villages and towns in this region lead to loss of habitat for mopane worms? Please elaborate.

Is there evidence of mopane worm habitat loss in this area?

Does the other mopane tree uses such as firewood lead to a decline in the mopane tree density? How does this affect the availability of mopane worms?

Does the current harvesting practices affect the future potential outbreaks?

Do you think that the combination of climate change, urbanisation and deforestation put pressure on mopane worm outbreaks and availability? How?

Questions on how environmental change has altered mopane worm consumption and trade patterns of rural households

Many households consume mopane worms as a key food source, how does the decline in outbreak events affect such households in meeting their dietary requirements?

Recently mopane worms have been imported from as far as Zambia, how do you think this affect households who trade mopane worms for income? Does it

Does importing the worms affect the price at which they are sold? How does this affect the affordability of mopane worms?

Besides mopane worms, what other insects are harvested for by households in this region? Are those insects also traded?

What do you think needs to be done to ensure sustainable harvesting of mopane worms?