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FUELWOOD CONSUMPTION PATTERNS BY INFORMAL RESTAURANTS IN BINDURA URBAN, ZIMBABWE

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APPROVAL FORM

A dissertation titled “,Fuelwood consumption patterns by informal restaurants in Bindura urban, Zimbabwe”, has been recommended for approval by the signatories who attest to having read it, submitted by B212463B in partial fulfillment of the requirements for the University’s Bachelor of Science (Honours) Degree in Natural Resources Management.

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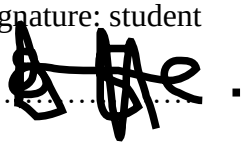

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DEDICATION

This dissertation is dedicated to the National Sports Academy, for providing me with the knowledge, guidance and opportunities that have contributed significantly to my academic and personal development throughout my journey towards obtaining this degree.

I also dedicate this work to my family, friends and colleagues, whose unwaring love support, patience and encouragements have been a constant source of strength. Their belief in me inspired me to persevere through challenges and remain committed to achieving my goals.

Above all, this dedication is a reflection of my gratitude to everyone who believed in me and contributed in one way or another to the successful completion of this degree. This achievement is not mine alone, it is a testament to the support and encouragement i received along the way.

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ABSTRACT

Fuelwood is an important source of energy for cooking. In urban areas of developing countries, informal restaurant operators heavily depend on fuelwood to run their enterprises. The purpose of this study was to investigate the patterns of fuelwood consumption by informal restaurant in Bindura Urban. A semi-qualitative study was carried out in 18 randomly selected informal restaurants of Bindura urban using an interview guide to collect data. A stratified random sampling research design was employed, grouping the population into three strata, namely High density residential area, Low density residential area and Light industrial area. Interviews were used to collect data on species preference, volume of fuelwood was measured using the cord system and GPS was used to obtain the coordinates for mapping the sources of fuelwood. Results showed that the most preferred tree species was *Brachystegia spiciformis* (28%), followed by *Brachystegia boehmii* (26%), *Julbernardia globiflora* (23%), *Combretum molle* (10%), *Terminalia sericea* (8%) and the least preferred wood species was *Pericopsis angolensis* (5%). The mean fuelwood volume consumed per day by informal restaurants of Low density residential area (0.22 m^3) was significantly higher than those of High density residential area and those of Light industrial area (0.12 m^3). The major sources of firewood were resettlement farms namely Chagside, Moneyquin, Foothill, Sydenham, Selwood, Chipadze and Wiseacre. Informal restaurant operators are selective in their fuelwood use, they prefer mainly indigenous species whilst their consumption rate vary across areas they operate in. There is need to establish local woodlots for firewood in areas surrounding Bindura urban to reduce pressure on indigenous woodlands. There is also need for researching on seasonal patterns of fuelwood consumption by informal restaurants in Bindura Urban.

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LIST OF ACRONYMS

BUSE	Bindura University of Science Education
CBD	Central Business District
EMA	Environmental Management Agency
ZEGU	Zimbabwe Ezekiel Guti University
ZOU	Zimbabwe Open University
ZRP	Zimbabwe Republic Police

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Fuelwood has remained the major source of energy for over half of the world's population (Makinde, 2018). In Africa, it is the major energy source for both rural and urban dwellers. Fuelwood is the most common good that people obtain from trees, followed by construction material such as poles (Agea and Waiswa, 2010; Abdel and Kobbail, 2011; Zembe *et al.,* 2014).

It is alleged that the consumers' dependence on fuelwood is driven by slow modernisation, poverty and scarcity of modern heat energy sources (Makinde, 2018). Although fuelwood is a renewable natural resource, rate of consumption has for years exceeded the rate of vegetation regeneration.

Unsustainable harvesting of fuelwood remains a problem in Zimbabwe due to poor enforcement of prohibitive regulations (Millennium Development Goals, 2012). Indigenous trees are the ones that are preferred for their favourable heating and burning properties, yet most of them are protected species (Dube *et al.,* 2014). Tree species that are commonly harvested for fuelwood in Zimbabwe include: Musasa (*Brachystegia spiciformis*), Munhondo (*Julbernardia globiflora*), Mupfuti (*Brachystegia boehmii*), Muunze (*Brachystegia glauscens*) and Mutara (*Gardenia volkensii*) (Mapira and Munthali, 2011). Wood properties are considered most when choosing tree species for fuelwood (Brock and Hill, 2004; Mmolotsi and Kejekgabo, 2013; Saravanan *et al.,* 2013; Cuvilas *et al.,* 2014; Mate, 2016). However, Mapira and Munthali, (2011) argued that distance also affected fuelwood preference, consumers tend to resort to species with undesirable properties such as Muunga (*Vachellia karroo*), Muora (*Albizia amara*), Muchecheni (*Ziziphus muchronata*) and Mususu (*Terminalia stenostachya*) if they are locally available, causing land degradation and other environmental problems on the peri-urban areas. Unsustainable fuelwood harvesting in urban areas is a very serious environmental problem because wood poachers do not give time to urban forests to regenerate, consequently, grasslands replace woodlands, biodiversity disappear, soil erosion is exacerbated and migration of fauna species increases due to habitat destruction (Mapira and Munthali, 2011; Zembe *et al.,* 2014).

In urban areas of African countries, informal restaurants are among top consumers that depend entirely on fuelwood as a source of energy to run their enterprises. They prefer firewood to other energy sources (gas, electricity and paraffin) because it is cheap, locally available sometimes and it produces ember that keep their foods warm for a while as compared to gas and electricity. Benhura *et al.,* (2012) in their study observed that foods are normally held hot to maintain wholesomeness, food quality and hygiene to attract customers and to reduce chances of food poisoning. Heat energy shortages lead to serving of food at lower temperatures, reducing flavour and aroma that are to some extent responsible for attracting customers (Benhura *et al.*, 2012). Currently, researchers have focused on consumption by households and a few on consumption by different types of institutions in the wake of electricity power cuts. There is need for studying patterns of fuelwood consumption by informal restaurants of urban areas since they rely on fuelwood regardless of electricity availability. They use fuelwood on daily basis and in bulky, thereby causing depletion of peri-urban vegetation. Fuelwood contributes the largest percentage to heating energy for informal restaurants. This study therefore aimed at investigating the patterns and rates of fuelwood consumption by informal restaurants specifically in Bindura urban. Patterns to be investigated include; species preference, alternatives to fuelwood, the rate at which fuelwood is being consumed by informal restaurants across the whole of Bindura urban and the fuelwood hotspots to be identified.

1.2 PROBLEM STATEMENT

Continuous reliance on fuelwood by informal restaurants operators in Bindura urban has allegedly resulted in a serious threat to threatened tree species. These restaurant operators rely on fuelwood because they do not afford other sources of heat energy such as electricity and gas. Little is known about the most affected tree species, consumption patterns and the rate at which these woody species are being consumed by informal restaurants. At the same time, a switch to alternative heat energy sources is limited. Type and quantity of food cooked sometimes determines the type of energy.

1.3 JUSTIFICATION

The study will enhance conservation and domestication of threatened tree species (indigenous woodlots) through provision of information to conservationists, research institutions and institutions that govern forest resources about tree species consumed by informal restaurants in Bindura, as well as the patterns and rates at which these tree species are being consumed. The study will also enhance formulation of policies (by-laws) by local authorities that prohibits illegal harvesting of threatened species basing on the consumption patterns. It will also bring necessity for legislation enforcement by institutions that govern the utilisation forest resources (Forestry commission, RDCs, EMA and ZIMPWA). The study will also provide baseline data in this area of specialisation for future researches.

1.4 AIM

To investigate the patterns and rates of fuelwood consumption by informal restaurants in Bindura urban.

1.5 OBJECTIVES

1.5.1 To identify the preferred tree species used for fuelwood by informal restaurants operators from different residential areas.

1.5.2 To determine variation in daily fuelwood consumption rate across different residential areas.

1.5.3 To map distribution of different sources of fuelwood supply for Bindura urban restaurants.

1.6 RESEARCH QUESTIONS

1.6.1 Which tree species are preferred for fuelwood by informal restaurant operators in Bindura Urban?

1.6.2 What is the consumption rate of fuelwood per day per restaurant in Bindura urban?

1.6.3 What is the source of fuelwood for Bindura urban restaurants?

CHAPTER 2

LITERATURE REVIEW

2.1 FUELWOOD CONSUMPTION AT GLOBAL LEVEL

Globally, 1.4 billion people have limited access to electricity and 2.7 billion (40% of global population) people rely on biomass fuel, mostly in rural areas (International Energy Agency). However currently even major cities of less economically developed countries are also depending on biomass fuel. In Africa, nations such as Burundi and Rwanda wood fuel accounts to over 90% of total wood consumption our projections suggest that the problem will persist and even deepen in the longer (IEA, 2010). Projections by the International Energy Agency, (2010) suggest that 1.2 billion people in 2030 will still depend on fuelwood, 87% of them living in rural areas of Sub-Saharan Africa, Asia and India. The Eastern Himalayan region depend excessively on forest resources for energy and 90% population of the region uses biomass as an important source of energy (Bhatt *et al.,* 2016).

2.2 FUELWOOD CONSUMPTION IN AFRICA

In Africa, firewood contribute to over 90 percent of total African wood consumption (IEA, 2010). Firewood is the most consumed source of energy in Sub-Saharan Africa, around 81% of households depend solely on it, which is the biggest percentage as compared to other regions in the world (Millennium Development Goals, 2012). Wood consumption as fuel has been linked to massive deforestation in many less economically developed countries (Bhatt *et al.,*

2016). Poverty is the major driver of heavy reliance of Africans on fuelwood (Kituyi *et al*, 2001). Dependence on fuelwood is largely driven by slow modernisation, poverty and scarcity of modern heat energy sources (Makinde, 2018).

2.3 FUELWOOD CONSUMPTION PATTERNS IN ZIMBABWE

Fuelwood is the most important source of heat energy for cooking, in Zimbabwe, about 6 million tons of fuelwood are burnt every year, especially by rural and urban low-income households (Jingura, Musademba and Kamusoko, 2013). Fuelwood contribute 51% to Zimbabwe's total household and industrial energy (Zembe *et al.*, 2014). In 2012, the provinces of Zimbabwe (exclusive of Harare and Bulawayo) had high proportions of households, almost 70 percent and over, using fuelwood for cooking (Zimbabwe National Statistics Agency, 2012). Zimbabwe National Statistics Agency (2012), stated that the highest percentage (84.6%) of fuelwood utilisation for cooking was recorded in Mashonaland central. The dependence of urban dwellers on fuelwood is determined by availability of alternatives, like electricity and gas for users (Dube *et al*, 2014; She, 2014). According to Dube *et al.*, (2014), urbanisation and increase in urban populations are the reasons behind growth of proportion of urban institutions without access to electricity. Fuelwood is the major alternative in urban areas of Zimbabwe because it is accessible and it is cheap at the market. Volume of wood consumed however depend on type of wood species, hardwoods or those with bigger portion of heartwood last longer (Manyanhaire and Kurangwa, 2014).

Some harvest firewood on their own from local woodlands and others buy from firewood dealers at the at the markets (Dube *et al*, 2014). With close proximity to both the fuelwood and markets or towns, landless and the poor gather and sell wood for heat energy (Arnold and Persson, 2003). Much of the firewood utilized in urban areas is harvested in farms, large numbers of farmers clear land on the pretext of crop production but an actual desire of selling fuelwood (Arnold and Persson, 2003). Some restaurant owners who owns trucks collect pouch in these farms also.

2.4 FACTORS THAT AFFECT CHOICE OF ENERGY SOURCE

High fuel prices for alternative fuels have exacerbated high dependence on fuelwood for heat energy. Alternative fuel prices make it difficult to move toward cleaner and environmentally friendly fuels and discourage people from adopting the use of cleaner fuels (Mislimshoeva *et al.*, 2014). Electric cooking appliances also consume a high amount of electricity which is economically unsustainable for small scale cooking restaurants, consequently users are restricted to fuelwood use. Level of education determine the rate at which people adopt

cleaner fuels, highly educated people are likely to adopt other fuels easily (Nlom and Karimov, 2015).

Income also affect users' switch to alternative heat energy sources, those with better income afford cleaner fuels such as gas and electricity (Bhandari, 2018). Age also play affect is also a critical factor, older people are resistant change from fuelwood to other heat energy sources than their younger counterparts (Nlom and Karimov, 2015).

2.5 WOOD PREFERENCES

On the basis of wood properties, consumers prefer fuelwood with high density, low moisture content, less ash content, high calorific value, natural durability, heating value and other chemicals factors because of their performance (Treacy and Evertsen, no date; Shanavas and Kumar, 2003; Brock and Hill, 2004; Ali, 2011; Saravanan *et al.*, 2013; Cuvilas *et al.*, 2014; Chavan *et al.*, 2016; Nabi *et al.*, 2017). *Brachystegia spiciformis* is very important as a source of firewood and charcoal, being among the preferred species for fuelwood throughout southern Africa (Louppe, 2016). *J. globiflora* (69%) and *B. spiciformis* (23%) had high tree stumps, indicating that they were the most preferred (Muboko *et al.*, 2014). In Zimbabwe, consumers prefer indigenous species for fuelwood because of their desirable burning qualities (Dube *et al*, 2014).

2.6 FACTORS THAT AFFECT WOOD PREFERENCE

2.6.1 Wood properties

Density

Wood density refers the volume a mass of wood occupies, dense wood the occupy less space (Brock and Hill, 2004). The density varies from location to location and with different forest types, at a given location, variation can be among different species and can be variation within a single individual due to the varying needs of trees for structural support under different circumstances (Brock and Hill, 2004). As trees get mature and transform from sapwood to heartwood, wood density and heating value also increases (Mmolotsi and Kejekgabo, 2013; Saravanan *et al.*, 2013). Wood density determine the supply and utilization of the fuel (Cuvilas *et al*, 2014). The higher density woody species produce fuelwood which provide longer lasting embers, which were much valued. *Brachystegia spiciformis,*

Pterocarpus angolensis and *Julbernardia globiflora* are suitable for producing good fuelwood (Mgumia *et al.*, 2017).

Moisture and Ash Content

Dry fuelwood burn very well, a low moisture content level of around 20% is much desirable (Brock and Hill, 2004; Alakangas and Erkkilä, 2008). Hardwoods naturally contain less moisture and they require less time to air dry as compared to softwoods (Louppe, 2016). Moisture content of fuelwood also varies with seasons, during rainy season wood contain more moisture as compared to dry seasons (Nabi *et al.*, 2017). According to Brock and Hill (2004) moisture hinders performance of fuelwood because much of the heat energy is consumed by the evaporation process of moisture contained in wood. For best performance, fuelwood should split and exposed to dry conditions for six or more months (Brock and Hill, 2004).

Firewood with higher moisture content is undesirable to different users as it causes an accumulation of tar in the roof, it burns efficiently and increases smoke pollution (Cuvilas *et al.,* 2014). Low density wood generally has high pore spaces that will absorb more moisture, consequently wood with low density allow moisture movement, hence contain more moisture as compared to high density wood (Mmolotsi and Kejekgabo, 2013).

Fuelwood with low ash content is desirable to users as it burn for a long time and low ash content promote air circulation within the fire that increases heat and flame (Cuvilas *et al*, 2014). Wood which produce a lot of ash is less desirable for fuel, as it is poorly-combustible, produce less ember and reduces the heat of combustion (Nabi *et al.*, 2017).

Calorific value

Calorific value refers to the quantity of heat emitted by a given weight of wood during the combustion process (Bhatt *et al.*, 2016). The standard calorific value use to categorize species as best fuelwood ranges from 4000-5000 Kcal g-1 (Bhatt and Sarkar, 2017). Calorific value is an important wood property to consider when choosing fuelwood, biochemical component in wood determine its calorific value (Bhatt and Sarkar, 2017). Effective calorific value of fuelwood also depends on the moisture content, wood density and ash content (Nabi *et al.*, 2017). Species that are less dense and moist cannot be recommended for firewood as these

two properties reduce calorific value and efficiency in the wood (Bhatt *et al.*, 2016). Saravanan et al. (2013) observed that Calorific value of fuelwood increases with age a tree.

Heating value and ignition

The heating value is an important combustion property for determining the efficiency and suitability of a wood as fuel (Brock and Hill, 2004; Bhatt *et al.*, 2016; Bhatt and Sarkar, 2017). It indicates the quantity of fuel required to generate a specific amount of energy in order to meet the needs of a consumer (Bhatt and Sarkar, 2017). Hardwoods produce more energy than softwoods because they are denser, however to some extent the volatile oils in some softwoods can increase the heating value of these species (Brock and Hill, 2004).

Ignition is a measure of how easy the firewood can be lit (Nabi *et al.*, 2017). Low density wood and those with high moisture levels are easier to light. Woods that contain a lot of volatile chemicals, such as conifers, ignite and burn easier than those with low volatile chemicals (Shanavas and Kumar, 2003).

CHAPTER 3

METHODOLOGY

3.1 DESCRIPTION OF THE STUDY AREA

The study was done in Bindura Town (Figure 3.1), which is the administrative capital of Mashonaland central province in Zimbabwe. Bindura town has a total population of 46 826, which was projected from the 2012 census population and two universities (Bindura University of Science Education and Zimbabwe Ezekiel Guti University) with enrolment of 5 316 and 420 respectively (Zimbabwe National Statistics Agency, 2017). The town has low density suburbs, high density suburbs, Institutions, industries and an active CBD with banks, food courts and shops. It is located in the Mazowe Valley about 88 kilometres northeast of Harare. Rainfall ranges from 750 to 1000 mm per year with an average of 25°C. Under the natural region ii b climate classification, Bindura has a Savanna middle veld climate. Bindura is dominated by mambo woodlands, mainly Musasa (*Brachystegia spiciformis*) and Munhondo (*Julbernardia globiflora*) species. These species are found in association with *Vachellia* species. Mining and farming are the major human activities in Bindura.

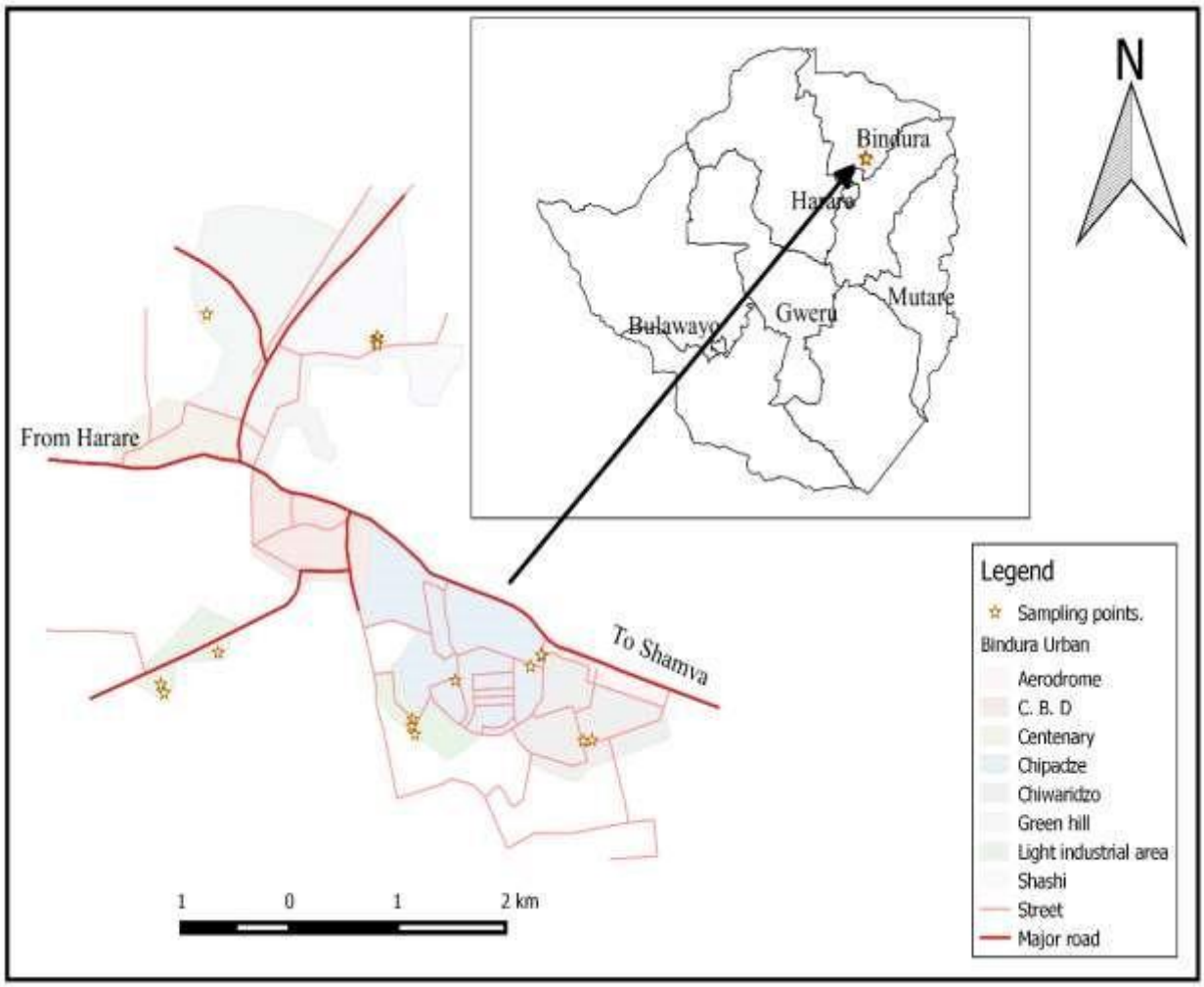

Figure 3.1: A map of Zimbabwe showing location of Bindura and the study area

3.2 RESEARCH DESIGN

A survey was carried out in seven business centres of Bindura Urban's residential areas (High density residential area and low density residential area) and industrial area (Light industries). A stratified random sampling design was employed for this study. The population was grouped on the basis of their location and perceived living standards of the customers, so it was grouped into high density, low density suburbs and light industries. Informal restaurants were selected at random from business centres of high density suburbs (Chipadze, Chiwaridzo and Aerodrome), low density suburbs (Shashi, Greenhill and Centenary) and Light industries. These restaurants were classified as informal because they are not registered to the local authority (Bindura Municipality). Six restaurants were drawn from each stratum. The targeted population in this study were informal restaurant operators who utilise fuelwood as either main or alternative source of heat energy.

3.4 DATA COLLECTION PROCEDURES

3.4.1 Species preference

Using an interview guide (Appendix 1), interviews were conducted to gather qualitative data on species preference, tree species harvested, firewood sources and firewood quantities consumed per day per restaurant. Eighteen restaurant operators were interviewed.

3.4.2 Daily fuelwood consumption rate per restaurant

The volume of firewood consumed per day per restaurant was measured using the cord system. First of all, the width, length and height were measured in metres. Then total volume of the timber stack was calculated by multiplying the stack length, width and height. This gave the stack volume in m^3. Since the stack volume includes air spaces, it was multiplied by the standard stacking factor (0.7) in order to obtain the actual volume of firewood. A commonly used factor is 0.7 although this can vary between 0.6 and 0.75 (Meyen and Connell, 2012; Knyaz and Maksimov, 2014). Restaurant operators were instructed to set aside the fuelwood that would remain after cooking for that day so that its volume could be measured and subtracted from the initial volume in order to come up with the actual volume consumed per day.

3.4.3 Mapping

In order to come up with sources of firewood to be mapped, key informant interviews were conducted. Firewood sellers, firewood transporters, the District Forester of Forestry Commission Bindura and the EMA provincial officer were interviewed. A GPS receiver was used to record the coordinates of each fuelwood source.

3.5 DATA ANALYSIS

Statistical Package for Social Sciences version 21 (SPSS)'s One way Analysis of Variance was used to analyse data and test variation in daily fuelwood consumption rate according to different residential areas over time at $p<0.05$. Descriptive methods were used to analyse data on species preference and spatial data were presented in form of a map.

CHAPTER 4

RESULTS

4.1 SPECIES PREFERENCE

Out of 18 restaurant operators, majority (72%) of them prefer certain tree species for fuelwood for their daily cooking business while only 28% do not prefer certain tree species, they use any tree species available at the market. Six tree species (*B. spiciformis, B. boehmii, J. globiflora, C. molle, P. angolensis* and *T. cericea*) from five genera (*Brachystegia, Julbernardia, Combretum, Pericopsis* and *Terminalia*) were preferred by different restaurant operators (Figure 4.1). The respondents preferred different woody species for fuelwood. The most preferred tree species was *Brachystesgia spiciformis* (28%), followed by *Brachystegia boehmii* (26%), *Julbernardia globiflora* (23%), *Combretum molle* (10%), *Terminalia sericea* (8%) and the least preferred wood species was *Pericopsis angolensis* (5%) (Figure 4.1)

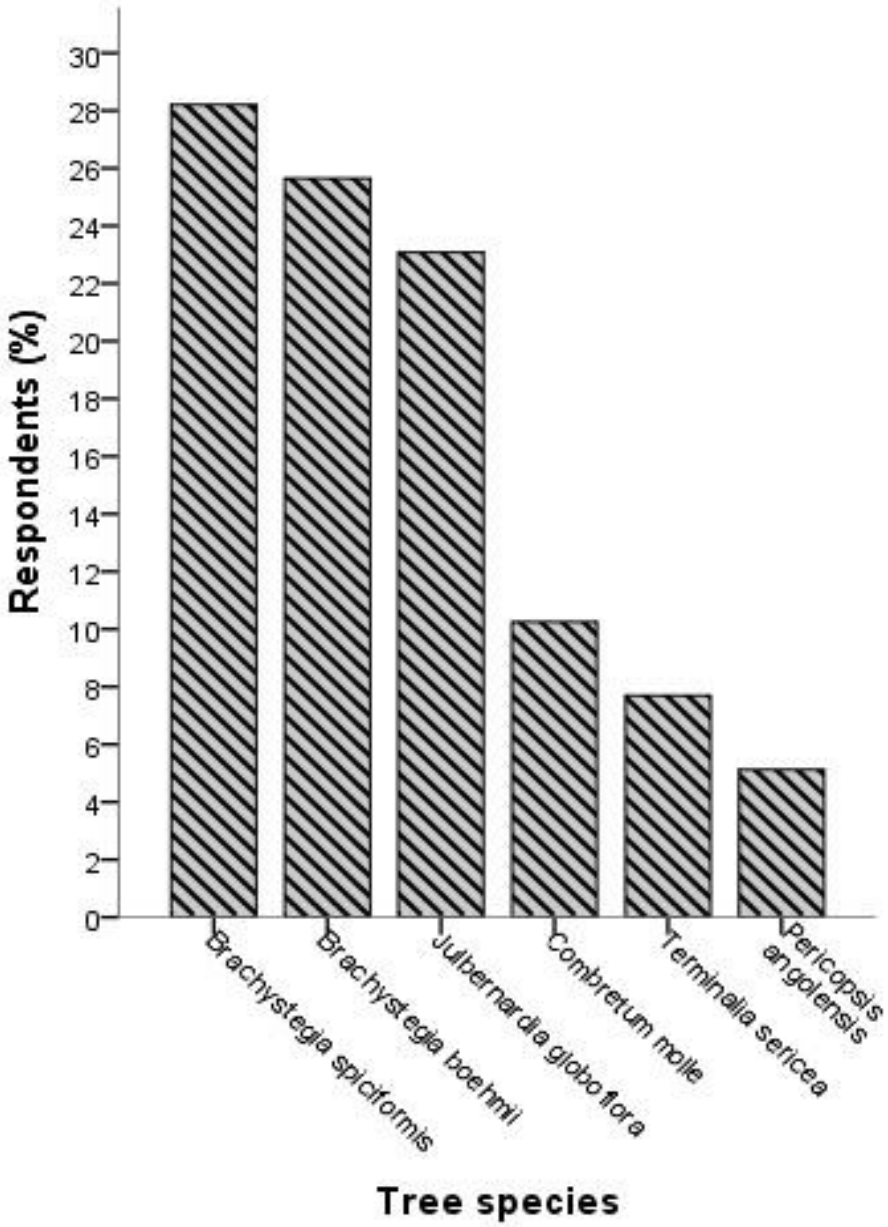

Figure 4.1: Woody tree species for fuelwood in their order of preference by informal restaurant operators in Bindura

Although informal restaurant operators prefer certain woody tree species, 10 species namely,

B. boehmii (21%), J. globiflora (17%), V. karroo (16%), B. spiciformis (16%), C. molle (11%), P. angolensis (4%), B. tamarindoides (4%), T sericea (6%) D. condylocarpon (3%) and D. cinerea (2%) (Figure 4.2) were used for fuelwood. Undesirable tree species such as *V. karroo, D. cinerea and T sericea* were also used for fuelwood (Figure 4.2).

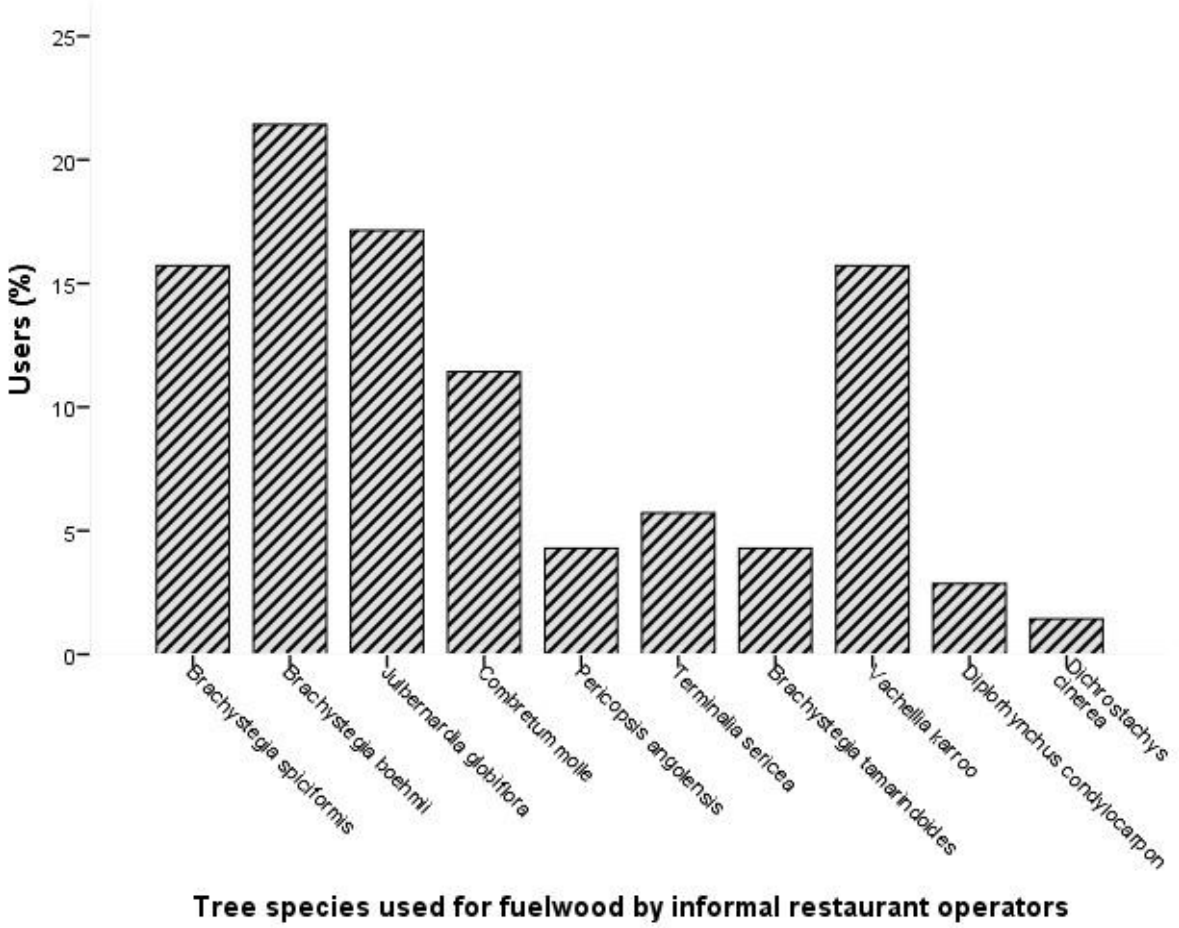

Figure 4.2: Tree species used for fuelwood by informal restaurants

4.2 VARIATION IN DAILY FUELWOOD CONSUMPTION ACROSS DIFFERENT RESIDENTIAL AREAS

The mean fuelwood volume (0.22 $m^{3)}$ consumed daily by informal restaurants of Low density residential area was significantly higher than that of High density residential area (0.12 $m^{3)}$ and Light industrial area (0.15m^3). The mean volume of fuelwood (0.15 $m^{3)}$ consumed by informal restaurants in High density residential area was not significantly different from the mean volume (0.12 $m^{3)}$ consumed by restaurants in Light industrial area.

4.3 DISTRIBUTION OF FUELWOOD SOURCES

Fuelwood that was sold to the informal restaurant operators was being harvested outside Bindura urban (Figure 4.3). The major sources of firewood were farms in resettlement areas of Bindura district namely: Benridge (38km), Chagside (40km), Moneyquin (35km), Foothill (16km), Sydenham (21km), Selwood (20km), Chipadze and Wiseacre farm. All the sources of fuelwood were within Bindura district.

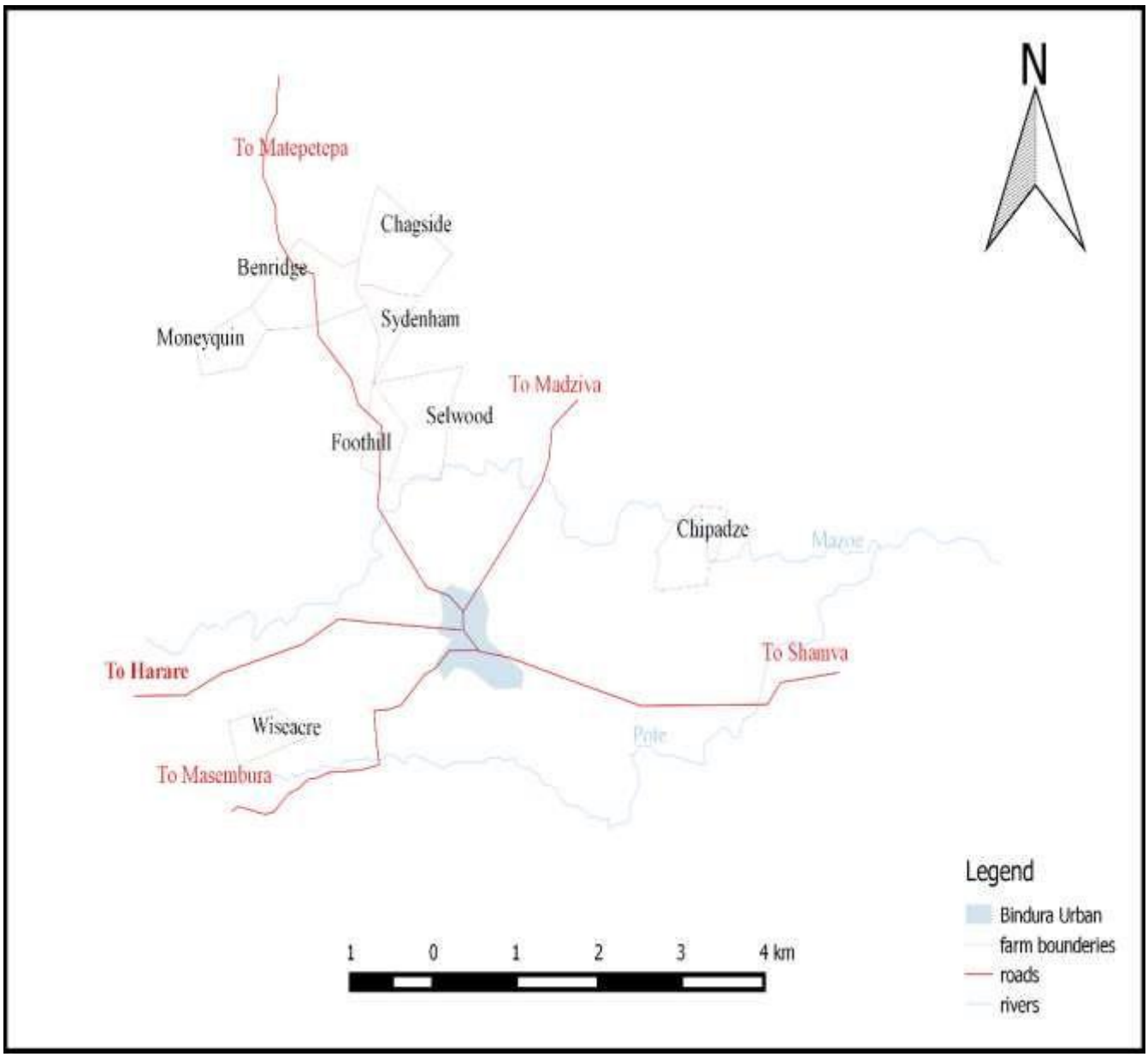

Figure 4.3: A map of Bindura showing sources of fuelwood

CHAPTER 5

DISCUSSION

5.1 SPECIES PREFERENCES

Results showed that informal restaurant operators preferred six indigenous tree species for fuelwood. This shows that indigenous trees are more desirable for fuelwood as compared to exotic ones. These findings are in line with what was observed by Dube *et al.,* (2014) who showed that consumers preferred indigenous woody species to exotic species, as evidenced by the excessive use of *C. mopane*, *Acacia* species and *Z. mucronata*.

Results also revealed that *Brachystegia spiciformis*, *Brachystegia boehmii* and *Julbernardia globiflora* were the most preferred species (Figure 4.1). This could be because of their desirable heating properties, therefore they are the most threatened species. Miombo woodlands are threatened by human activities such as wood poaching because of their hardwood type which is suitable for fuelwood (Pote *et al.*, 2006). These species were preferred because they produce long lasting embers that keep food warm for a long time, produce good flame, produce less smoke and ashes. Bhatt *et al.* (2016) supported that good fuelwood species should have high calorific value, and low ash and moisture content. *Terminalia sericea, Pericopsis angolensis*, and *Dichrostachys cinerea* were least preferred whilst *Vachellia* species and exotic trees were not preferred because they are not durable and produce a lot of smoke and ashes that can be harmful to food handlers. However, in this study no exotic tree species were used as fuelwood by informal restaurant operators, which might be because of the absence of woodlots in Bindura urban. There is need for local authorities to initiate afforestation programmes in surrounding communal areas so that they will generate income from their woodlots instead of harvesting wood from indigenous forests.

However, there was excessive use of tree species with undesirable burning properties such as Muunga (*Vachellia Karroo*) (Figure 4.3). The use of undesirable species could be an indicator of scarcity of desirable species in the vicinity. This is in line with Mapira and Munthali,

(2011)'s claim that distance affects fuelwood preference, consumers tend to resort to available species with undesirable properties. Dube *et al.,* (2014) supported that consumption of tree species of poor quality as firewood clearly indicates that firewood is becoming scarce

as demand is increasing. Depletion of desirable species such as *B. spiciformis* and *J globiflora* in local woodlands results in non-selective harvesting of firewood. Mapira and Munthali, (2011) claimed that non-selective harvesting of fuelwood occurs near to urban areas due to scarcity of fuelwood and competition among fuelwood traders.

5.2 VARIATION IN DAILY FUELWOOD CONSUMPTION ACROSS DIFFERENT RESIDENTIAL AREAS

There was variation in daily fuelwood consumption across different residential areas. Daily fuelwood consumption rate by informal restaurants of Low density residential area was significantly higher than that of informal restaurants of High density residential area and Light industrial area because of their close proximity to big institutions such as Bindura University of Science Education (BUSE), Shashi hospital, Bindura provincial hospital, Prison, ZRP, Zimbabwe Open University (ZOU), Bindura Primary and other institutions. BUSE students and Employees from these highly paying institutions buy food from restaurants at business centres in Low density residential areas. Residents of Low density residential area are generally richer than their high density counterparts so demand for food is higher than in high density where most of the inhabitants cook their own food at home.

The difference in fuelwood consumption rate between Low density and Light industrial restaurants may be attributed to stove type, in Low density they used braai stands (Appendix 3) which accommodates both braai and cooking whilst in Light industrial area they use an unshielded four legged metal grate stove (Appendix 2) which accommodates cooking only. Stove type determines the amount of fuelwood consumed (Musademba *et al.*, 2012; Jingura *et al.*, 2013). Braai stands burn the whole piece of firewood, which is not sustainable. There is also a lot of braai activities mostly weekends and month ends when workers are off-work and when it is their pay days respectively. In light industrial area it is only cooking, there is no braai activities, which might be a possible reason for low fuelwood consumption rate. Restaurant operators should use conservative stoves such as the unshielded four legged metal grate (Appendix 2) that do not burn the whole log of wood.

High fuelwood consumption rate by informal restaurants in Low density area can also be attributed to cooking on open space, their braai stands are on open space. Cooking on open space is wasteful because air carries away useful energy, hence resulting in consumption of more firewood (Musademba *et al.*, 2012). Unlike restaurant operators in Low density, those in High density and Light industrial area do not cook on open space but indoors, reducing

wasting of heat energy. Restaurant operators should therefore build enclosures so as to avoid blowing of energy by wind.

5.3 DISTRIBUTION OF DIFFERENT SOURCES OF FUEL WOOD IN BINDURA

The major sources of fuelwood are farms in resettlement areas of Bindura district (Figure 4.3). Travelling long distances to farms and poaching of fuelwood from these private lands could indicate depletion of fuelwood in Bindura urban and communal lands. Mapira and Munthali (2011) stated that due to scarcity of fuelwood, dealers sneak into the surrounding farms to collect fuelwood using motorised vehicles from distances over 40 km. Wood dealers poach wood from these farms and sometimes farmers sell willingly to them after land clearing. Much of the firewood utilized in urban areas is harvested in farms, majority of farmers clear land for crop production (Arnold and Persson, 2003). Results showed that fuelwood dealers who supply Bindura urban restaurants performed selective harvesting, and are supported by Mapira and Munthali (2011) who showed that selective harvesting occurred far away from the market or urban areas, usually beyond 2 km. Selective harvesting could extend deforestation levels and worsen threat to miombo woodlands. Rights over properties such as farms should be enforceable to avoid poaching of fuelwood.

CHAPTER 6

6.1 CONCLUSIONS

Results showed that informal restaurant operators in Bindura Urban prefer *Brachystegia spiciformis, Julbernardia globiflora* and *Brachystegia boehmii* firewood. Daily fuelwood consumption by informal restaurants varies across residential areas with informal restaurants in Low density residential area consuming more fuelwood than High density residential area and Light Industrial area restaurants.

6.2 RECOMMENDATIONS

Further research should be conducted on seasonal patterns of fuelwood consumption by informal restaurants in Bindura urban.

Commercial woodlots should be established in areas around Bindura urban such as resettlement farms in order to reduce pressure on indigenous woodlands.

The Ministry of Energy should initiate Improved Cooking Stoves Programmes to introduce efficient stoves such as Chingwa stove to these restaurants.

Restaurant operators should construct enclosures as a way of avoiding blowing of energy by wind, which waste fuelwood.

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APPENDICES

APPENDIX 1: Interview guide

SECTION A DEMOGRAPHIC INFORMATION

Instruction: Fill in correctly or circle the corresponding response

Restaurant name

Period of operation

Residential area **1**. **2**. **3**. **4.** **5**.

Respondent's name

Cell phone number

Q1. Sex **[1]**. Male **[2]**. Female

Q2. Age group (years) [**1**]. 18 - 25 [**2**]. 26 -35 [**3**]. 36 - 45 **[4]**. > 45

Q3. Position of interviewee in the enterprise

[1]. Food handler **[2].** Restaurant owner

SECTION B SOURCE OF HEAT ENERGY

Q1. What is your main source of heat energy for cooking?

[1]. firewood **[2].** Electricity **[3].** Gas

[4]. Charcoal

If other, specify …….

Q2. Do you collect firewood for yourself? **[1]. Yes** **[2]. No**

Q3. Where do you buy/collect firewood?

1. **2**.

3. **4**.

Q4. Approximately, how far is the firewood source from Bindura town?

[1]. < 10 km **[2].** 10 – 20 km **[3]**. 20 – 30 km **[4]**. > 30 km

Q5.Do you prefer certain tree species for firewood? **[1] Yes** **[2] No**

Please give reason(s)

…….....

.....

.....

.....

Q6.Which tree species do you prefer?

[1] Musasa, **[2]** Munhondo, **[3]** Mupfuti, **[4]** Mususu,

[**5]** Mugodo, **[6]** Muunze,

If *other specify*……

Q7. Which tree species do you use on daily basis?

[1]……. **[2]**…… **[3]**…….

[4]…….. **[5]**…… **[6]**……

[7]…… **[8]**……

APPENDIX 2: Unshielded four legged metal grate stove used by restaurants in light industrial area



APPENDIX 3: An enclosed cooking place in High density residential area and a braai stand used for cooking



APPENDIX 4: Braai stands on open space in Low density residential area

