Investigating the implications of the use of charcoal to process manganese on forest revenue collection: A case of Serenje District in Zambia

BY

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A thesis submitted to the University of Zambia in partial fulfilment of the requirement for the award of the Master of Science Degree in Sustainable Mineral Resources Development.

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DECLARATION

I, **Mercy Mupeta Kandulu** declares that this thesis represents my work, and that it has not been previously submitted for a Postgraduate Diploma or Degree at this or any other University or college. Other sources of data and information are fully acknowledged and referenced.

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CERTIFICATE OF APPROVAL

This is to certify that the thesis by ***Mercy Mupeta Kandulu*** is approved as partially fulfilling the requirements for the award of the degree of Master of Science in Sustainable Minerals Resources Development by the University of Zambia.

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DEDICATION

To Peter Bwalya Hateba the ever helpful son for his unconditional support during this academic journey.

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ABSTRACT

This study investigated the implications of using charcoal to process manganese on the amounts of forest revenue that the Forestry Department (FD) had collected from selling charcoal in Serenje District of Zambia from 2012 to 2017. Manganese processing plants commenced operations in the district in 2012 after they were issued with the Mineral Processing Licence by the Ministry of Mines and Minerals Development (MMMD). Manganese processing operations demanded huge quantities of charcoal which the FD authorised by issuing production and conveyance licences to charcoal traders. Increased charcoal demand encouraged uncontrollable harvesting of trees which caused forest degradation, affected livelihoods and threatened the existence of some rivers in the district. Government and the traditional rulers raised concerns over the negative environmental impacts and a ban on the use of charcoal to process manganese was effect in 2017.

Literature from research studies, annual reports from the FD and mineral production returns from the MMMD were reviewed in order to collect information and data on forest revenues and mineral production. Fifteen (15) questionnaires were distributed to eight institutions and twelve (12) Key Informants responded by providing information and data. Data was analysed using excel. Two (2) Focus Group Discussions were conducted in communities living close to the mineral processing plants in order to obtain the general perception of the people on the subject matter. Actors along the charcoal value chain were mapped and their roles specified.

Results showed that annual average revenue collected from charcoal by the FD increased from K10,600.23 (2008-2011) before the mines were introduced to K54,375.88 (2012-2016) when the mineral processing companies were authorised to use charcoal in their operations. Despite manganese processing continuing, forest revenue from charcoal reduced from K56,578.50 recorded in 2016 to K16,713 after the ban was effected in 2017. Though the revenue reduced, production of charcoal continued thereby indicating a continuation of the illegal trade.

The study concluded that the use of charcoal to process manganese has potential to increase forest revenue when user industries adhere to local rules and regulations. However, failure to enforce forest laws on industrial charcoal demand promotes the informal charcoal trade to elusive markets that evade payment of government fees and contribute to forest degradation.

Key Words: Forest revenue, manganese, mineral processing, Serenje District

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LIST OF ABBREVIATION AND ACRONYMS

ABBREVIATION	DESCRIPTION
CBD	Central Business District
CSO	Central Statistics Office
DFO	District Forest Office
PFO	Provincial Forest Office
FD	Forestry Department
FeMn	Ferro Manganese
FeSi	Ferro Silicon
FGD	Focus Group Discussion
FSM	Ferro Silicon Manganese
GNR	Great North Road
GDP	Gross Domestic Product
GFRA	Global Forestry Resource Assessment
GPS	Global Positioning System
GRZ	Government of the Republic of Zambia
IS	Information Sheet
KI	Key Informant
KII	Key Informant Interview
MSRD	Master of Science Degree in Sustainable Mineral Resources Development
MMMD	Ministry of Mines and Minerals Development
ND	No data
SI	Statutory Instrument
SiMn	Silicon Manganese
SSA	Sub-Sahara Africa
USA	United States of America
WW II	World War II
ZEMA	Zambia Environmental Management Agency

CHAPTER ONE

INTRODUCTION

1.0 Overview

Chapter one begins with the description of the study area and continues with a brief description of the biophysical and socio-economic information about Serenje District. This is followed by the rationale which is narrowed to the problem statement, the objectives of the study and the methodologies used to conduct the study. The chapter ends with key questions and a summary.

1.1 Description of the study area

The study was conducted in Serenje District in Zambia where a case study was undertaken to investigate the extent to which the use of charcoal to process manganese had affected the amount of forest revenue that was collected by the FD from 2012 to 2017. Serenje District lies about 408 km north east of Lusaka and 369.7 km from the Kabwe Central Business District (CBD) in the Central Province of Zambia. The study area lies about 70 km north east of Serenje CBD. The area was most preferred for the study because it presented a unique scenario characterized by massive production, trade and utilization of charcoal for mineral processing during the study period. The district was also rich in manganese, gold, iron, copper, coal, quartz, dolomite and graphite. Among these, manganese, iron, quartz, tourmaline, dolomite and aquamarine were mined during the study period. There were two (2) Mineral Processing Plants who were using charcoal to process manganese. These two (2) were located along the Great North Road (GNR) at Mukando in Chief Kabamba and Kanona in Chief Mailo's area. The district had an estimated population of 166,741 and 6,557 of the people lived in Kanona while another 7,533 lived in Mukando, (CSO, 2014). Of the people in Kanona and Mukando, 0.49% lived in areas surrounding the mineral processing plants. The major sources of livelihood for the people include; small scale farming, charcoal production, gathering of wild forest products and piece work.

There are five (5) Forest Reserves in the district and two (2) of these lie in the study area. These protected areas comprise miombo woodlands that are dominated by *Brachystegia*, *Pterocarpus angolensis* and *Julbernardia paniculata* tree species that are very good for charcoal production. Major rivers include the Luombwa, Mulembo and Munte flowing from the central watershed, and the Lukusashi and Lusiwasi flowing to the south. The geographical location of Serenje District and the study area are shown in Figure 1.1.

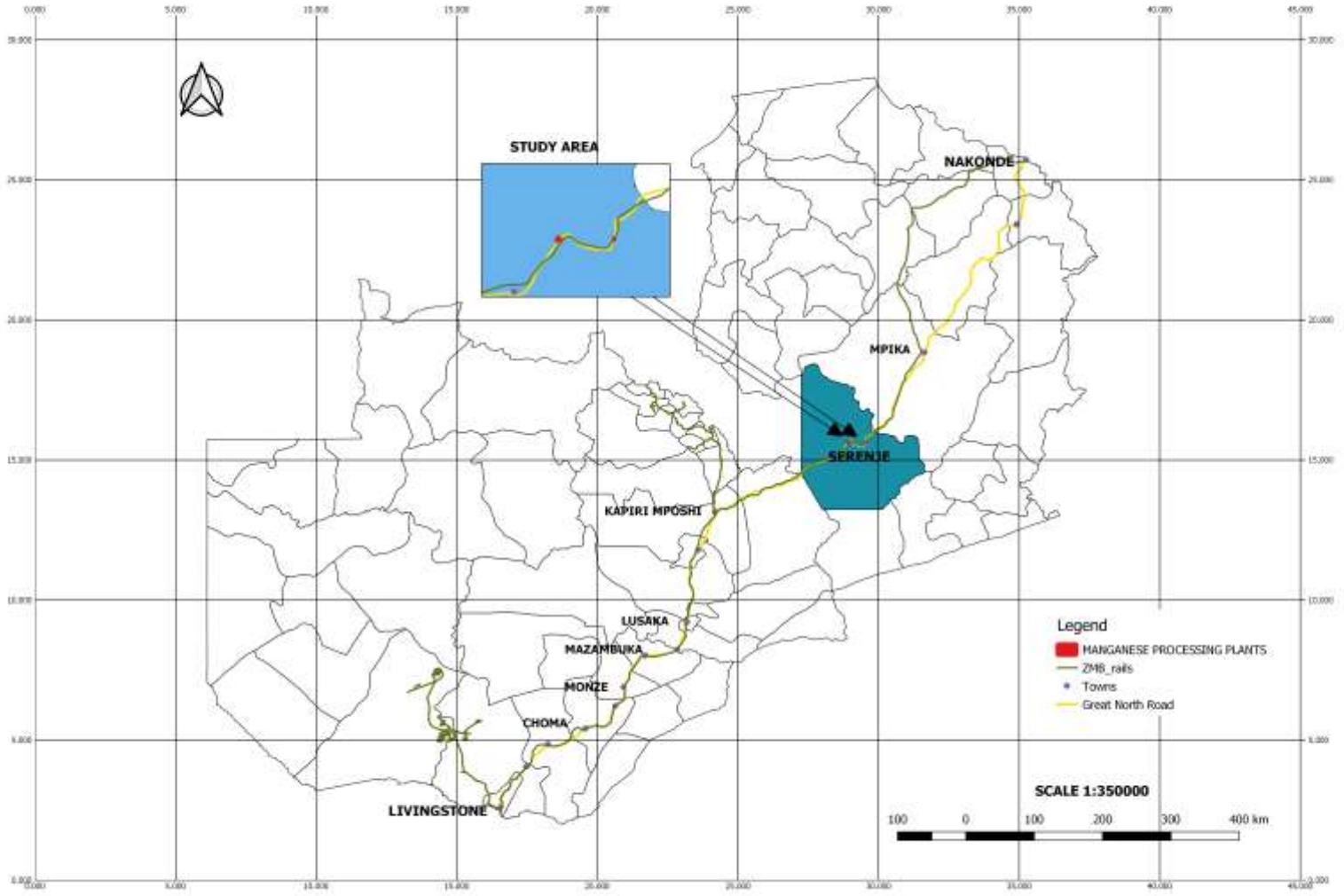

Figure 1.1: Map of Zambia showing the location of Serenje District and the study area. (Source: Location of mines generated from GPS coordinates obtained during field work)

The bio-physical and socio-economic information about Serenje District are summarized in Table 1.1.

Table 1.1: Bio physical and socioeconomic information about Serenje District

ATTRIBUTE	**INFORMATION**			
Province	Central			
District	Serenje			
Location	13'' 15' 35 S; 30'' 14' 0 E			
Area covered	23,351 km^2 ; 2,335,400 ha			
Constituency with mines	2		Kanona	Mailo
Agro ecological zone	3		III	II
Population	166,741		6,557	7,533
Number of households	29,011		1,108	1.286
Soils	Sandy clay			
Annual average temperatures	21.73^0C			
Annual average rainfall	1,141mm			
Vegetation	Miombo, dominated by *Brachystegia, Pterocarpus angolensis* and *Julbernardia paniculata spp*			
Rivers	Luombwaand Munte flowing from central watershed, Lukusashi, and Lusiwasi flowing to the south.			
Mining licences	Mineral Processing Licence		Small Scale Mining Licence	Artisanal Mining Licences
	2		7	14
Mineral occurrence	Manganese, Gold, Iron, Copper, Coal, quartz & Graphite ores			
Minerals being mined	Manganese, Iron, Quartz, Tourmaline and Aquamarine			
Manganese ore production	Manganese structure at 2.5 km with low grade horizons at 10-15 % Manganese, ore ungraded through beneficiation 36-40% Manganese, medium Carbon Ferro Manganese.			
Livelihood sources	Urban	Formal/informal employment (piece work) and trading		
	Rural	Farming, charcoal production, mining and small-scale trading, gathering of forest products		

1.2 Rationale

During the study period, the FD in Serenje District conducted licencing and collected non-tax revenue from the sale of forest product. Collected revenue was receipted and banked into the central treasury. The total forest revenue collected from all revenue collection centres in the country constituted part of the forestry sector contribution to the Gross Domestic Product (GDP) at national level. Compared to other districts in Central Province, Serenje District collected the third highest forest revenue in 2012 and the highest revenue in 2013, 2014 and 2016 as indicated in Table 1.2.

Table 1.2: Revenue collected in Central Province from 2012 to 2017 (ZMK and ZMW)

District	2012 (ZMK)	2013 (ZMW)	2014 (ZMW)	2015 (ZMW)	2016 (ZMW)	2017 (ZMW)
Provincial office	ND	ND	35,000	15,450.00	ND	ND
Chibombo	48,755,300	61,229.32	63,864.70	84,339.10	83,555.50	6,335.00
Kabwe	112,192,400	118,729.05	250,354.70	267,723.4	82,195.00	115,790.50
Kapiri-mposhi	81,805,400	82,934.04	69,430.50	62,384.0	52,898.00	191,529.00
Mkushi	43,551,200	72,182.30	82,506.40	646,267.7	453,996.00	185,960.50
Mumbwa	148,027,600	216,894.80	251,186.70	371,976.0	285,428.00	309,013.50
Serenje	89,795,529	707,209.88	1,697,407.48	266,797.2	1,458,763.00	240,801.00
Itezhi-tezhi	New District	26,191.19	174,519.30	83,155.5	251,561.00	111,299.00
Chisamba	New District	4,157.80	52,332.20	500,904.0	977,515.80	126,803.50
Chitambo	New District	ND	ND	ND	44,366.00	4,860.00
Luano	New District	ND	ND	10,530.0	98,284.00	117,241.00
N'gabwe	New District	ND	ND	ND	ND	ND
Total	**524,127,421.0**	**1,289,528.38**	**2,676,606.0**	**2,009,527.90**	**3,788,562.30**	**1,409,113.0**

Note: ND means No Data (Source: Central Province, FD Annual Reports (2012-2017))

The major forest product sold was wood fuel that include timber, charcoal, firewood, cordwood and poles. The FD authorised the wood fuel trade by issuing two (2) types of licences namely; the production license that authorized the cutting of trees that were used to manufacture wood fuel; and the conveyance license that authorized transportation of the wood fuel to the market. Wood fuel obtained through this process was considered to be legal and could be traded on the domestic market for commercial or industrial use.

In 2012, the need for the FD to conduct licensing in Serenje District became even more necessary after the MMMD issued two (2) mineral processing licenses authorizing the companies to commence processing of manganese and the Zambia Environmental Management Agency (ZEMA) issued a decision letter for the mineral processing companies to ensure that the mineral processing operations conform to prescribed conditions. The operations required huge quantities of charcoal which the companies sourced from charcoal producers who lived in the surrounding villages. The increased demand for charcoal encouraged uncontrolled harvesting of trees which resulted in forest loss that threatened the continuous flow of water in some rivers, land productivity and ultimately livelihoods of the people. To protect the forests from further losses, stakeholders called for a ban on the use of charcoal for manganese processing and this was effected in 2017.

In response to the ban, the mines refrained from using charcoal and opted for alternative energy sources like electricity, coal and coke. Coal was sourced from Maamba in Southern Province and coke from Huange in Zimbabwe. However communities continued producing charcoal though at a lower rate but the market to which they sold remained elusive as few producers reported at the District Forestry Office (DFO) to buy licences. The FD on the other hand could not effectively enforce the ban due to lack of transport to visit the scattered charcoal producers and the mines. This made the linkages between the FD on the regulatory side, the charcoal producers on the supply side and the mining companies on the demand side relatively weak while the amounts of revenue collected by the FD from charcoal fluctuated with time. Despite the observations made, no study was conducted with the view to collect quantitative data on revenues collected from charcoal so that the losses and gains made could be determined for decision making and policy advice. It is against this background that this study was commenced.

1.3 Problem statement

Lack of research aimed at collating consistent and reliable statistical data and information limits the extent to which the FD could provide evidence based advice to justify claims that the revenue collected from charcoal in Serenje District from 2012 to 2017 could have been higher than reported had the FD captured inventory data from industrial charcoal that the people in Serenje District sold to the mines for use in the manganese processing operations.

1.4 Hypothesis

Planning, reporting and collection of forest revenue from charcoal can be tremendously improved and well projected to inform the fiscal policy if quantities of charcoal required for mining operations were accounted for and charges collected for traded volumes of the commodity in Serenje District from 2012 to 2016.

1.5 Aim of the study

The study aimed at evaluating the extent to which the use of charcoal to process manganese had affected the amounts of forest revenue that was collected by the FD and the management of the forestry resources in Serenje District from 2012 to 2017.

1.6 Objectives of the study

The objectives of the study were as follows;

- To identify the licences that were issued by the MMMD in Serenje from 2012 to 2017, the types of manganese by-products that they produced and raw material used in production;
- To identify the sources of charcoal, actors involved in the production of charcoal that was supplied to the mineral processing plants and their roles along the charcoal value chain; and
- Determine the amounts of revenue that was collected by the FD from the sale of charcoal from 2012 to 2017 and establish how the revenue trends varied over the years that the mines used charcoal to process manganese.

1.7 Methodology

Methods used to collect data and information required for each specific objective are briefly described in this section. Method used to analyse data are also described.

1.7.1 Identify the licences that were issued in Serenje District from 2012 to 2017, the products produced and the raw material used in production

A search was conducted on the mining cadaster portal at the MMMD in order to generate information on the mineral processing licences that were issued in Serenje District from 2012 to 2017. Key Informants (KI) within the MMMD and the manganese processing companies were then identified and interviewed in order to generate further information on the types and volumes of manganese by-products that were produced by the two (2) mineral processing companies during the study period. The KI further facilitated educational tours of the smelters in order to obtain good understanding of operations, materials used in production of products and appreciate the challenges faced by the companies when accessing charcoal for manganese processing. Data and information collected was used to derive trends in mineral production during the study period.

1.7.2 Identify the sources of charcoal, actors involved in the production of charcoal that was supplied to the mineral processing plants and their roles along the charcoal value chain

Key institutions that played a role along the charcoal value chains were identified and KI in the institutions interviewed in order to obtain information regarding the roles that their

institutions performed in the charcoal industry. In addition, Focus Group Discussions (FGDs) were conducted in two (2) communities in order to derive information about the general perception of the community about the areas where charcoal production was conducted and charcoal trade related issues. Information obtained was then used to develop the charcoal value chain depicting the relationships between the identified actors.

1.7.3 Determining the amounts of forest revenue collected by the FD from 2008 to 2017

FD annual reports from 2012b to 2017 were reviewed and a table compiled to show the amounts of revenue that was collected from each source annually. Revenue data was analysed using excel and graphical presentation developed to show trends in revenue from different revenue sources before and after the mineral processing companies commenced operations.

1.8 Justification for the study

This study generates results that contribute to the body of knowledge on the revenue collection systems in the forestry sector in Zambia. It generates quantitative data on revenue collected in Serenje from 2012 to 2017 and provides a baseline for decision support. It identifies the interactions between the actors along the charcoal value chain and the FD; the gaps in the revenue collection systems used during the study period; the challenges faced by the FD when collecting forest revenue and how this impacted on the amounts of revenues that were collected; and recommends options useful for sustainable management of forests in Serenje District. If well implemented, the recommendations made in this study can help the FD to develop effective revenue collection systems that would increase the amounts of forest revenue that the institution can collect, enhance forest management practices in the district; and design better information packages useful for policy advice on charcoal demands for mining operations.

1.9 Key questions

- Where were the two mineral processing companies that were licence in Serenje District from 2012 to 2017 located and what products did they produce?
- Who were the actors involved in the production, transportation and trade of charcoal in Serenje District from 2012 to 2017? What roles did they play?
- How much revenue did the FD collect before and after the mines commenced operations in Serenje? How much of the revenue was collected from charcoal?

1.10 Thesis layout

This thesis presents outcomes of a case study conducted to assess the extent to which the use of charcoal to process FSM had impacted on the amounts of revenue collected by the FD in Serenje District from 2012 to 2017. The thesis is presented in seven (7) Chapters outlines as follows;

Chapter one (1) begins with the description of the study area in Serenje District of Central Province of Zambia and highlights the bio physical and economical information. The biophysical information includes major features in the form of forest types and cover, rivers, soil types and the mineral resource base found in the district while social economic information are in the form of livelihoods and populations. The chapter further identifies charcoal production among major sources of livelihood that has had anthropogenic impacts on both people's livelihoods and the environment. The chapter further identifies the mineral processing companies as major drivers for the increased industrial charcoal production in Serenje District and the local community as major players in the informal charcoal industry that supplied the mines. The thesis is presented in seven (7) chapter outlined as follows;

Chapter two (2) reviews literature from previous studies in order to bring out information on the findings made, learn lessons, and identify gaps and opportunities to enrich the current study.

Chapter three (3) presents the methodology and variables used to collect information and data.

Chapter Four (4) discusses data collection and analyses

Chapter five (5) presents and discusses the results.

Chapter six (6) presents the conclusions and recommendations of actions to be taken.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This sections reviews literature from various studies that were conducted on the mining and the wood fuel industries at global, regional and national levels. This was done with the view to get a deeper understanding of the findings made at that time, identify the gaps in information that needed to be addressed and explore the opportunities created on the subject matter.

2.1 Studies on the historical use of wood fuel in mining operations

Historically, mines are known for their high demand for wood fuel utilisation in their operations. The huge quantities of wood fuel supplied to the mines impacts on livelihoods, the environment and national economies, (Robert et al. 1985; Mwitwa et al. 2012; Puustjarvy et al. 2005; Ngandwe et al. 2012). Studies conducted across the globe have also identified wood fuel as a major source of energy among households.

2.1.1 Survey of the wood demand for coal mining in the United States of America

The United States of America (USA) are among countries that have used wood fuel for mining operations. According to Robert et al. (1985), the USA Department of Agriculture and Forest Services conducted a survey of 220 coal mines in order to estimate the lumber and mine timber requirements for coal mining in the USA in 1970. This followed the observation that when oil prices were low, the amount of wood fuel that was used for coal mining had declined from 49,271,319m^3 in 1923 to 9,061,393m^3 in 1970 and 6,760,440m^3 in 1976. After the oil crisis of 1978, oil prices increased and coal was found to be the best alternative energy to oil. However, mining of coal required the use of wood fuel. As a result, quantities of wood used for coal mining then increased from 6,760,440m^3 in 1976 to 15,007,930.5m^3 in 1979, (Robert et al. 1985).

Findings from the survey showed that underground coal mining could not be done without using wood to support the roof and often sides of the shaft. The largest share of wood amounting to 42% of cross bars and 25% of round props were used to support mine roofs. The other types of wood were required for use as split props for wheel choking, lagging used

for shoring sides of the mine entrance and haulage ways, sawn props, crib blocks and ties for larger bearing surfaces in the mines. Hardwood timber was found to be forty times stronger than soft wood and therefore most preferred for structural use where it was abundance. Though useful to this research, this study was confined to the USA and focused on establishing the volumes of wood used in coal mining. The study did not consider the amount of revenue that could have been raised by the USA Department of Forest Service from the sale of the timber to the mines.

2.1.2 Studies on the use of wood fuel in the early mining operations in the Southern African Region

Another study conducted by Sikamo et al. (2015) revealed that the arrival of early commercial businessmen and white settlers in the Southern African region contributed to the transformation of the traditional subsistence mining once associated with small scale smelting of metals for making tools, weapons and objects to big commercial business entities, (Sikamo et al. 2015; Phillipson, 1974). Two major impacts were observed to have contributed to the commercialisation of wood fuel demand in the region. Firstly, the early businessmen obtained mineral rights to mining concessions from local Chiefs and used Northern Rhodesia as a source of labour for Southern Rhodesia. This led to commercialisation of the mining industry in Northern Rhodesia in 1908 and formation of multinational companies that took control of the mining industries, (Sikamo et al., (2015); 2015US congress, (1988). In 1989, Northern Rhodesia was put under the British protectorate and there after extensive exploration activities were observed in neighbouring countries like the Malawi, Zimbabwe and the Democratic Republic of Congo among others, (Ndulo, 1986).

Secondly, the discovery of copper deposits on the Copperbelt contributed to the development of the rail way lines linking Livingstone to the towns on the Copperbelt and extension of the rail lines from Livingstone to Mulobezi in the Western Province of Southern Rhodesia, (Zimba, 2007). The Mulobezi-Livingstone rail line was used to facilitate transportation of timber from the concession areas in Western Province to the Copperbelt while the copperbelt – Livingstone rail line was used to transport copper from the Copperbelt to South Africa for onward export, (*Ibid*). like in the USA, strong hard wood timbers of the teak (*Guibourtia coloespermum*) and rosewood (*Baikiael plurijuga*) tree species were most preferred for use as pit props, rail sleepers and platforms in the mines,(Ngandwe, 2012). These projects contributed to the foundation for the development of the mining industry in Zambia.

These studies discussed the role that the private sector played in the development of the mining industry in Nothern Rhodesia. They identified industrialisation and infrastructure development among the major projects undertaken. They linked the commercial mining operations to wood fuel demands and identified the source of hard wood timber from the concessions. They however never considered estimating the amount of revenues that could have been generated by the FD from the sale of wood fuel used in the mines at that time.

2.1.3 Studies on the World War II and the wood fuel demand in Zambia

Others studies identified the occurrence of the World War II (WW II) as having contributed to further development of the mining industry in Northern Rhodesia. According to Zimba, (2007), the WW II (1939-945) presented opportunities for increased trade in copper from Northern Rhodesia and three (3) major impacts were observed in the wood fuel industry.

Firstly, the (WW II) caused an increase in oil prices which triggered demand for coal as an alternative energy source and caused a coal deficit in Northern Rhodesia, (Zimba, 2007). Secondly, the devastating effects of WW II caused an increase in the demand for copper, (Zimba, 2007; Sikamo et al. 2015). Because of its good conductivity, copper was required for use in the reconstruction of the damaged infrastructure in more than 30 countries that were involved in the WW II. Among the applications were wiring of every piece of rolling, floating or flying equipment that went to war, production of electrical equipment like radios that were put to use, production of shell casing that contained coper and jackets to prevent bullets from failing the gun barrels when they are fired. The increased demand for copper caused the Northern Rhodesian government to increase copper production by utilising wood fuel as the major source of energy for smelting, (*Ibid*). By the year 1969, Zambia reached its peak of 769,000 tonnes of copper production, (Sikamo et al.2015), Table 2.1.

Table 2.1: Wood fuel consumption and copper production in Zambia

Year	Quantity of wood fuel (m)	Quantity of copper produced (Metric tonnes)
1965	283,000	603,000
1969	unknown	769,000
2000	200,000	360,000
2010	360,000	767,000

Source: Sikamo et, al 2015; Ngandwe et, al. 2012

Thirdly, growth in the mining industry led to growth in other sectors like schools, hospitals, recreation facilities and roads. In 1972, the number of people employed in the mines had increased to 62,000, (Sikamo et al. 2015). The increased population was mainly concentrated in the mining towns were charcoal was extensively used at household level. After independence, the new government of the Republic of Zambia embarked on increasing wood fuel supplies by planting 55,000 ha of plantations in order to reduce the chances of over exploitation of indigenous forests for mining purposes, (Zimba, 2007)

The historical accounts given in the studies focused on the major impacts of the WW II on the demand for copper, coal and wood fuel in Northern Rhodesia. They highlight the measures taken by government to reduce the increased exploitation and depletion of indigenous forests in Southern Rhodesia by establishing exotic plantations. However, these studies could not estimate the amounts of revenue that could have been derived from either the indigenous or the exotic plantation wood fuel that was used in the mining industry. For now, the recommendations made through these studies have become insufficient because; most of the exotic plantations have been harvested and delays in replacing the growing stock has caused a deficit in the exotic timber stocks on the Zambian market. The demand for exotic timber for construction purposes has also increased thereby rendering plantation timber stocks insufficient for mining operations. In addition, the number of mining companies has increased and this has caused some mines to continue using indigenous wood fuel for mineral processing operations.

2.2 Studies on wood fuel, forest revenue and the Gross Domestic Product

A review of studies revealed that wood fuel has contributed to government revenue and the GDP of some countries in Sub Sahara Africa (SSA). According to Chidumayo and Gumbo, (2013), existing natural resource policies and legal frameworks in Zambia, Tanzania and Mozambique provides for payment of fees for removal and transportation of forest produce. This enables governments through their agencies to collect money from the fees paid for forest products. The money collected constitutes forest revenue which is generally defined by the Global Forestry Resources Assessment (GFRA) to include taxes, fees, charges and royalties collected specifically from domestic production and trade of forest products but excluding general taxes collected from the sale of the economy (e.g. economic tax and sales tax), (Ngandwe, 2012). Forest products include wood and wood products (wood-based products, manufactured and remanufactured).

Like other countries in the region, Zambia has a long history of forest revenue collection dating back from colonial times through independence and post-independence time. Before Zambia's independence, government in Northern Rhodesia collected forest revenue through the Barotse Native Government and in 1947, the responsibility was handed over to the FD under the colonial government, (Zimba, 2007). During the study period, the Forest Act No.4 of 2015 mandated the FD to collect forest revenue from the sale of forest products, (GRZ 2015; Gumbo et. al. 2013) and the sum total of all forest revenues constituted the forestry sector contribution to the GDP. At national level, the forestry sector contribution was accounted for under the agriculture were it was grouped together with agriculture and fisheries.

At group level, the forestry sector contribution to the GDP in Zambia increased from 0.9% in 2001 to 3.7 % in 2004 at the time when the agriculture sector contributed 7.2% and fisheries 2.6% to the GDP, (Chileshe 2001; Puustjarvi, et al., (2005). Within the forestry sector, the largest share of revenue was attributed to charcoal which accounted for 2.2%, followed by firewood at 0.8% and timber at 0.3%, (Puustjarvi, et al., (2005). The peak contribution was observed in 2005 and 2006 when the forestry sector contribution was 6.3% and 6.1%, (Ngandwe, 2012). From 2007 to 2010, the forestry sector contribution reduced from 5.9% to 5.7% respectively, (Ngandwe, 2012), Table 2.2.

Table 2.2: Industry shares of GDP by kind of economic activity at constant 1994 prices

	2005	**2006**	**2007**	**2008**	**2009**	**2010**
Forestry	5.2	5.0	4.9	4.8	4.7	4.5
Wood and wood products	0.8	0.8	0.8	0.8	0.8	0.8
Paper and paper products	0.3	0.3	0.3	0.3	0.3	0.4
Total GDP at market price	6.3	6.1	5.9	5.9	5.8	5.7
Total forestry sector	100	100	100	100	100	100

Source: CSO 2010; Ngandwe et.al 2012 Estimates of Central Statistics Office

Despite the observed increase in the sector contribution to the GDP, some studies have revealed that the forestry sector contribution to the GDP is considered to be generally low and understated, (Chileshe 2001; Mwitwa, 2012; 2004; Matakala et al. 2015; CSO, 2015). This was mainly attributed to very few statistics on the forestry-based informal and formal sector activities (Chileshe,2001), lack of reliable statistics and information on revenues collected and the failure by the FD to capture inventory statistics on commercial wood fuel

supplies for industrial purposes (CSO, 2015). In addition, other studies have shown that failure to capture revenue was largely due to the ways in which charges or fees were collected by the FD. According to Whiteman, (1999), the revenue collection systems used by the FD were costly to the producers who rarely paid for production charges, economically inefficient to support Sustainable Forest Management (SFM) and discouraged maximization of sustainable yield. Supporting these findings, Chidumayo and Gumbo (2013) and Ellegard et al. (2001) also observed that enforcement of the law on removal fees have not been effectively implemented and that this to a larger extent showed weaknesses in the revenue collection systems used at the time.

These studies estimated the forestry sector contribution to the GDP and considered this to be generally low and understated. They identified wood fuel (firewood, Charcoal, timber and poles) among the major sources of forest revenue but could not estimate how much of the wood fuel was used as industrial wood in the mines and the amount of forest revenue that the FD could have collected from the sale of industrial wood to the mines. The studies recommended fiscal measures and law enforcements as best options for increasing the amounts of revenues that can be collected by the FD but could not recommend the best means of collecting forest revenue from industrial wood fuel supplied to the mines.

2.3 Studies on wood fuel, the energy sector, the environment and livelihoods

Belward et al. (2011), identified households among the major consumers of wood fuel in SSA countries where wood fuel accounts for over 80% of the total national energy demand. In Zambia, wood fuel accounts for over 70% of household energy demand, (CSO, 2015). Electricity, petroleum, coal and others accounts for 14%, and 12%, 2% and 2% of the national energy demand respectively, (CSO 2015), Table 2.3.

Table 2.3: Proportion of types of energy used by sectors in Zambia

Type of energy source	Agriculture (%)	GRZ (%)	Households (%)	Mining (%)	Transport (%)	Commerce & industry
Wood fuel	Unknown	Unknown	70	Unknown	0	Unknown
Petroleum	Unknown	4	6	27	53	10
Electricity	2	7	19	68	0	4
Coal	Unknown	9	0	54	0	37
Others	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown

Source: CSO, 2015: Sooka and Sikaundi, 2007; Baruya and Kesselss, 2013

In their investigation, Belward et al. (2011); Chidumayo and gumbo (2013); Ellegard et al. (2005) further identified the high population growth, limited access to affordable alternative energy sources in urban areas and mining among the drivers of the high demand for wood fuel in SSA. They observed that the high demand for charcoal had created opportunities for income generation by the majority of the rural and urban population who were involved in charcoal production and trade for their livelihood in Zambia, Mozambique, Tanzania, and Nigeria, (Ellegard et al. 2001; Chidumayo and Gumbo 2013; Saadu, 2019); Gumbo et al. (2013; Jumbe et al. (2008).

Further review of the study by Chidumayo and Gumbo (2013) revealed that the increased demand for wood fuel impacted negatively on the forests and the environment. They observed that the increased demand for wood fuel at household and industry level contributed to the increased harvesting of trees, deforestation and forest degradation in some cases. They however argued that the occurrence of deforestation or forest degradation depended on the scale of production and the method used to harvest trees. In justifying their observations, Chidumayo and Gumbo (2013) argued that forest degradation may occur when a small piece of land is cleared off trees to lower than 10% of forest cover and the use of the land is changed. They also observed that at large scale, selectively cutting of preferred trees species and sizes for charcoal production may most likely cause forest degradation. This is because the depletion of preferred tree species may change forest composition and biological productivity. They further cautioned that deforestation may ultimately occur if the regeneration is continuously harvested such that forest cover is reduced to less than 10%. Based on that understanding, Zambia, Mozambique and Tanzania have been identified among countries where mining, settlements and charcoal production has contributed to deforestation and forest degradation.

These studies identified the major sources of energy in SSA and Zambia. They identified the factors that contributed to the demand for wood fuel and the impacts of wood fuel harvesting on forest cover and the environment. The studies further estimated the proportion of electricity, coal and petroleum in the mining, transports, agriculture, commerce and industry, services and households. They also estimated the proportion of wood fuel used at household level but failed to estimate either the proportion of wood fuel used for mining or the estimated revenue that the FD could have generated from the sale of wood fuel to the mining industry in Zambia.

2.4 Studies on the mining sector contribution to the Gross Domestic Product

Unlike the forestry sector, studies in the mining sector have generally indicated the positive contribution the industry to the fiscal policy through presentation of reliable data on production volumes, revenue generated and employment creation, (Mayondi, 2014); Mwitwa *et al*., (2012; Simutanyi, 2008), Table2.4.

Table 2.4: The contribution of the mining industry to the national economy 1970-2006

Year	GDP (%)	Government revenue (%)	Exports (%)	Employment (No)	Production (Metric Tonnes)
1969	-	-	-	-	769,000
1970	36	58	97	-	750,000
1972	-	-	-	52,000	-
1973	-	-	93	-	-
1974	-	-	-		
1975	13	13	94	66,000	-
1976	17	3	94	66,000	-
1977	11	-	94	-	-
1978	12	-	94	-	-
1979	18	-	96	-	-
1980	17	6	80	-	550,000
1986	-	-	-	51,000	-
1991	-	-	-	56,000	400,000
2000	6.2	-	-	22,280	200,000
2004	-	-	-	31,440	398,000
2005	11.8	-	-	-	467,000
2006	-	-	-	31,199	492,016

Source of production records; Simutanyi compilation from the Bank of Zambia Quarterly Reports, various Issues, 1975-2007

Source of employment figures: Simutanyi (2007) compilation from the various issues of the monthly digest that is published by the Central Statistics Office in Lusaka

Source of the GDP, Foreign Exchange and government revenue contribution 1970-1980; Simutanyi (2007) citing Burdett.

2.5 Summary

Chapter two (2) reviewed twenty two (22) articles of studies that were undertaken on wood fuel, mining, livelihoods, forest revenue and the environment. It begins with the review of studies that were undertaken on the use of wood fuel in the mining industry at international, regional and national levels. The chapter identifies the mining industry among the major users of indigenous wood fuel and highlights the impacts of the mining industry development on infrastructure development, wood fuel demand and population growth in Northern and Southern Rhodesia. It goes on to discuss the occurrence of the WWII and its impacts on the development of the copper industry in Zambia.

The chapter continues by reviewing articles on the wood fuel demand which strongly associates charcoal to household consumption while the huge volumes used in mining operations remains largely unaccounted for. It brings out observations made on weaknesses in the revenue collection systems used by the FD in Zambia and which to a larger extent had contributed to high revenue leakages.

Despite all these findings, the chapter observed that none of the studies reviewed had gone further to collect revenue related data with the view to establish the industrial wood fuel demand and recommend workable wood fuel allocations to meet industrial demand at prescribed fees that can be collected as revenue by the FD. This study will look at the gaps identified in the literature and attempt to provide reliable consistent data and information to prove that if captured well, information on industrial traded charcoal can cause the FD to contribute significantly to government revenue and the GDP. Chapter 3 outlines with the methodology that was used to collect the required data and information.

CHAPTER THREE

MATERIALS AND METHODS

3.0 Introduction

Chapter three explains the research design that was used, types of data and information that was collected in the study and the sources from which they were obtained. It identifies the variables used and states the reasons why they were preferred for collection of the necessary data including the information. It also presents the methods that were used to obtain and analyse the data that was collected during the study.

3.1 Research design

The case study design was used in conducting this research because despite forest revenue having been collected by the FD countrywide, the study only focused on Serenje District where stakeholders where able to participate in providing the required information for the study and eventually would benefit from the outcomes. The targeted stakeholders were also knowledgeable of the topic at hand and played a key role in finding solutions to the investigations.

3.2 Sample determination

Purposeful sampling was conducted in order generate data and information required in the study. Fifteen (15) questionnaires were distributed and twelve (12) responded to the study as indicated in Table 3.1.

Table 3.1: Institutions targeted for interviews and number of respondents to the study

Institution	Questionnaires distributed	Number of respondents
MMMD	1	1
Mineral processing plants	2	2
Provincial Forestry Office	2	1
District Forestry Office	2	1
ZEMA	1	1
Traditional Rules (Chiefs)	1	1
Community members	4	4
Local authority	2	1
Totals	15	12

Five manganese processing plants were operational at the time of the research and only two (2) that existed from 2012 to 2017 were sampled. One (1) Chief, one (1) officer from the MMMD, one (1) Licencing officer and one (1) officer responsible for compilation of revenue at district and provincial levels of the FD, the officer responsible for the environmental section of the Local Authority and four (4) community members involved in charcoal production and trade responded to the questionnaires.

3.3 Criteria for selection of the study area

The selection of the study area was based on the availability of manganese processing plants that used charcoal in smelting operations, charcoal manufacturers that supplied the mines with charcoal and the regulatory agency responsible for licencing of wood fuel including charcoal in Serenje District.

3.3.1 The availability of mineral processing companies that used charcoal in mining operations

The first priority for selection of the study area was the existence of the mining area that hosted two (2) mineral processing plants that had used charcoal in their mineral processing operations. The preferred study area was found to be more appropriate because it hosted two (2) mineral processing companies that had fully installed manganese processing plants that were operational during the study period, Figure 3.1.

Figure 3.1: Manganese processing plant with smelting facilities (Field photos)

The two (2) companies were involved in the processing of Manganese base metal to produce FSM and other by-products. Manganese ore was sourced from small scale and artisanal mines located in Serenje, Luapula and other districts in Central Province. The process involved the beneficiation where manganese ore was mixed with other mineral ores and charcoal in a blast furnace to produce FSM and other by-products with approximately 30% to 80% manganese content. For purposes of consistency and in line with terminologies used in this study the definitions given in the Mining and Minerals Development Act No. 11 of 2015 will be applied as follows;

A mining area is defined as "*a place or working in or on or by means of which any operation connected with mining is carried on, together with all the works, machinery, plant, buildings premises, erections and appliances whether above or below the ground, that are used in connection with the operation or for the extraction, treatment or preparation of any mineral or for the purpose of dressing minerals";*

Mineral Processing Operations are defined as "*any operation carried out under a mineral processing licence that is granted for processing, cutting, polishing and manufacturing jewellery under part III of the Minerals Development Act No. 11 of 2015*";

Mineral processing is defined as "*the practice of beneficiating or liberating valuable minerals from their ore which may combine a number of units operations such as crushing, grinding, sizing, screening, classification, washing, froth, floating, gravity concentration, electrostatic separation, refining, calcining, and gasification or any other process";*

Manganese is defined "*as a metal with a chemical element symbol Mn, atomic number 25 and naturally found as a base metal occurring in combination with iron*";

The Small Scale Mine is defined as "*a mine over an area covering a minimum of 3 cadastre units and not exceeding 120 cadaster units. A cadaster Unit being a quadrilateral formed by the intersection of meridians and paralles and with a distance equal to 6 sex gesinal seconds, and that covered an average plan metric surface of three points in three four zero zero hectares*" and Mining which is defined as "the *extraction of minerals whether solid, liquid or gaseous from the land or from beneath the surface of the earth in order to win minerals and includes any operations directly or indirectly necessary or incidentally hereto."*

Minerals being "*any material substance whether liquid, solid or gaseous from that occurs naturally or in beneath the surface of the earth but does not include water, petroleum or any substance or thing prescribed by the minister by regulation*".

3.3.2 Availability of charcoal producers supplying the mining industry

The second priority for selection of the study area was the availability of people that were involved in the production of charcoal in Serenje District during the study period. These were the primary source of either the legally or illegally produced charcoal that contributed to the informal trade that supplied the mines. To produce charcoal, the farmers had to harvest the indigenous trees, cross cut and pile the logs, cover the kiln with earth and fire the kiln to burn the wood slowly in the absence of air as shown in Figure 3.2.

Figure 3.2: Traditional charcoal kiln covered with earth (Field photos)

A tree felling permit and a conveyance licence were required for these operations to be legitimised. The legal framework provided for any person wishing to harvest trees for purposes of producing charcoal for sale to obtain a felling permit from the FD prior to making charcoal. The permit indicates the area where the trees would be harvested and the charcoal produced. In 2015, the government set the price for cordwood at ZMW270/cord (i.e. $3m^3$ of cord wood), (Statutory Instrument (SI) No. 117 of 2013 of the Forest Act No. 39 of 1973). In addition, any person intending to transport charcoal from the production site to the market or storage was required to obtain a conveyance licence from the FD at ZMW135 per 10 x 50kg standard bags. Conveyance fees for each standard bag was ZMW13.50. The duration period for the permits and the licence was fourteen (14) days.

3.3.3 Availability of the regulatory agency in the Forestry Department that collects forest revenue from charcoal

The last priority for selection of the study area was the presence of the FD who are the regulatory government institution responsible for managing forestry resources and enforcing the provisions of the forest law in the country. Based on the mandate derived from the Forest Act No. 4 of 2015, the department had a DFO with a Licensing Officer who was responsible for issuing permits for the rights to harvest, manufacture and transport forest products including charcoal during the study period.

According to the Forest Act, a licence is treated as a control mechanism for allocation of forest areas where charcoal can be sustainably produced in areas that are monitored and well managed for continued supply of the commodity. To this effect, only those that obtain tree felling harvesting permits for charcoal production and conveyance licences authorising transportation of the charcoal are permitted to do so. Even with a paid for licence, it is a requirement that one adheres to predetermined licence conditions when harvesting or transporting or trading in charcoal. For purposes of consistency and in line with terminologies used in this study, the following definitions will be applied.

Government revenue is defined as moneys accruing to the public by way of taxes, licences, import fees, fines levies ad charges, sale of government property and shares, loans, grants, donations and grants raised within or outside Zambia or any other income due to the public, (SI No. 111 of 2004).

Forest revenue is defined as government revenue collected from the sale of forest products and services by the Forestry Department in Zambia, (Whiteman, 1999). As a regulatory agency, the FD issues permits for the rights to harvest, transport, manufacture forest products including charcoal or access forest services from forest areas owned by the state or held by the state on behalf of the people, (*Ibid).* Prices of the various forest products are prefixed in the SI that is issued by government to guide the sale of produce. Money collected is banked in the central treasury to constitute non-tax revenue that is an important tool of the fiscal policy of the government.

The revenue collection system is defined as the methods used to set, assess and collected the government revenue, (Whiteman, 1999). In this study revenue collected from charcoal is of interest.

Charcoal is generally defined as a black solid consisting of an amorphous form of carbon obtained as a residue when carboneous materials is heated in the absence of air, and a forest product imbedded in fuel wood as "*any forest produce in form of boards, branch wood, chips, coppice, fuel wood, planks, poles, sawdust, slabs, timber, thinnings and wood splits*", (Forest Act No. 4 of 2015). Fuel wood is defined as wood sourced for energy and includes charcoal and firewood. For purposes of this study, only charcoal derived from indigenous wood is considered.

3.4 Types of data and information collected for the study

Mixed methods that are both qualitative and quantitative were used in collecting the required information from primary and secondary sources.

Qualitative information include information obtained from actors involved in charcoal production and manganese processing. Others include information on forest cover resource base, biophysical and socio economic status of the district.

Quantitative data include data on amounts of revenue collected by the FD, quantities of charcoal licenced annually by the FD, the estimated annual production of manganese by-products, including the forestry and mining sector contributions to the GDP.

Trends in revenues collected by the FD were examined at three (3) levels as follow;

- From 2008 to 2011 before the mines commenced operations and charcoal manufacturers were authorised to get licences for charcoal production and conveyance as per provision of the Forest Act no 39 of 1973;
- From 2012 to 2016 when the mines were fully operational and authorised to legally produced charcoal for use in their operations;
- From 2016 to 2017 when government issued a policy directive to ban the mines in Serenje District from using charcoal to process manganese.

3.4.1 Primary data and information sources

Primary data and information were obtained from the mining companies and KI identified at national, provincial, district and local levels. This was done at the commencement of the data collection exercise. Purposeful sampling method was used to identify KI who were

interviewed. These include officers from government institutions, the mineral processing plants, the local authority, the community and traditional leaders (Chiefs).

3.4.2 Secondary data and information sources

Secondary data and information was gathered from existing reports that include;

- Annual reports for the DFO in Serenje District;
- Published articles;
- Environmental Impact Assessments and Environmental Impact Briefs;
- Forest resources assessment reports to give indication on the natural resource endowment in Serenje District;
- Socio economic reports for the Serenje District;
- Topographic maps;
- Company websites ; and
- Unpublished materials on the subject matter.

3.5 Method used to collect data and information

Methods used to collect data and information required in this study are presented in the section below.

3.5.1 Desk research/ literature review

To get a deeper understanding of what has been studied on the research topic and related articles, literature relevant to the study was reviewed from published articles, annual reports and other documents listed in the sources of secondary data at National, provincial and district level.

3.5.2 Primary data collection tools

Instruments and tools used to collect data and information include the Global Positioning System (GPS), semi structured questionnaires and information sheets. Collection of data and information was guided by the 5 objectives and for each objective, the tools used to collect, analyse information and data, and derive expected outputs are outlined as follows;

(a) Information sheets

Information Sheets (IS) were developed and used to guide collection of data as well as information from each of the identified institutions and communities. The IS contained questions that the institutions were required to answer in order to provide the required data and information. Generally, the IS were sent in advance to institutions and followed up with an individual interview with the assigned (KI) who provided information on institutional roles and responsibilities, challenges faced in performing their core functions, and proposed recommendations for improvement of sector performance.

For the FD, the IS was used together with the questionnaire to guided collection of data and information regarding revenues collected from 2008 to 2017 and factors that may have contributed to revenue leakages during the study period;

For the MMMD, the IS was used to collect information on manganese production statistics from 2012 to 2017.

For the mining companies the IS was used to obtain information on the volumes of production, institutional preferences for energy sources for manganese processing and how this was affected by the ban on the use of charcoal for mineral. The IS were used obtain suggestions on options available for improving fuel wood supplies to the mining industries.

For the communities, the IS was used to guide a Focus Group Discussion (FGD) in 1 community in order to collect information regarding the general perception of the people on issues regarding the forest cover changes in the area and their participation in the charcoal industry and how this was affected by the ministerial ban on the use of charcoal in the local mining companies during the study period.

(b) Questionnaires

A questionnaire was prepared and administered to KIs in the Forestry Department. Using a questionnaire, individual interviews were conducted in order to collect information on the institutional roles, revenues collected, challenges faced and recommendations for improvement of revenue collection systems and forest management. Additional information was also provided on the actors involved along the charcoal industry value chain.

(c) Global Positioning system

The Global Positioning System (GPS) was used to obtain coordinates for locations of mines, charcoal trade points and settlements in the study area.

3.5.3 Primary data and information collection methods

Two methods were used to obtain the required data and information as follows;

(a) Key Informant Interviews

KII were conducted with KI who were identified from institutions and communities based on their responsibilities and knowledge of the subject matter. In government institution, the KI were assigned by supervisors while in the communities they were identified by the group of people who regarded them as being either active in forestry activities, the charcoal value chain or doing business with the mines. The interviews were guided by the questions specified in the questionnaires for the institutions in order to obtain additional information and data specifically required from each institution as follows;

For the FD, three (3) KII were conducted in order to obtain data and information specific to the revenues collected from 2008 to 2017, sources of revenue, revenue collection systems used and the general trends observed in revenue collected from the sale of charcoal before and after the mines commenced manganese processing operations in Serenje District.

For the mining companies, KII were used to collect data and information regarding the types of manganese by-products that were produced by the mines, monthly manganese raw material mix for processing cycles and the quantities of charcoal required.

(b) Focus Group Discussions

Two (2) FGDs) were held in Chief Mailo and Chief Kabamba ’s areas in order to obtain the general perception of the people on the actors involved in charcoal production; their location in the study area and their roles in the charcoal value chain; the trends in the charcoal manufacturing and trade business in the catchment area; observed changes in forest cover; the causes of the observed forest cover changes; anticipated threats to the forest resource in the charcoal hot spots; and how best charcoal production areas can be managed to ensure sustainability of the charcoal industry. Information obtained was used to develop a charcoal value chain depicting the actors and their levels of interaction with the FD.

(c) Conducted tour of the manganese processing plant

A tour of the mineral processing plants at the two (2) Mineral Processing Plants for purposes of familiarising to the processes and the production systems. Information obtained was used to explain the materials flow in facility and types of products produced by the company.

3.6 Data analysis methods

(a) Excel

Excel spread sheets were used for entering and analysing the quantitative revenue data in order to make graphs and tables to depict relationships of trends in forest revenue and manganese by- products production during the study period.

(b) ArcGIS

Arc GIS program was used to map the location of the Mineral processing plants in the study area.

CHAPTER FOUR

RESULTS OF THE STUDY

4.0 Introduction

In chapter four quantitative data and qualitative information collected during the research are presented. These results are aligned to the three (3) specific objectives focusing on;

- Identifying the licences issued by the MMMD in Serenje from 2012 to 2017, the types of by-products that they produced and raw materials used in production;
- Identifying the sources of charcoal, actors involved in the production of charcoal that was supplied to the mineral processing plants and their roles along the charcoal value chain; and
- Determining the amounts of revenue that was collected by the FD from the sale of charcoal from 2012 to 2017 and establish how the revenue trends varied over the years that the mines used charcoal to process manganese.

4.1 Objective 1: Identify the licences issued in Serenje from 2012 to 2017 and products produced and raw materials used in production

This section presents the findings on the location of the mineral processing licenced plants that existed in Serenje District and the type of manganese by-products that they produced during the study period.

4.1.1 The licences issued in Serenje District from 2012 to 2017

Examination of record on the mining cadaster portal revealed that sixty-four (64) licenses were issued by the MMMD in Serenje District from 2012 to 2017. Of the sixty-four (64) licenses, two (2) were issued for mineral processing (Manganese), twenty-three (23) were conducting explorations for minerals, one (1) was prospecting for minerals and thirty-eight (38) were mining. Of the 38 mining licenses 8 were only mining Manganese, three (3) mined Manganese and Iron (Fe) and twenty-six (26) were involved in mining of Manganese with iron, quartz, tourmaline as well as aquamarine. This study focused on the two (2) mineral processing licences issued in 2012 and 2016, and located at Mukando in Chief Kabamba and Kanona in Chief Mailo respectively. Of the two (2) companies only one (1) operated from the inception while the other only commenced operations in 2016, Table 4.1.

Table 4.1: Types of mining licences in Serenje District during the study period

S/N	Type of license	Licenses issued by 2012	Licenses issued by 2017	Licenses expiring by 2019
1	Artisanal Mining Rights		14	27
2	Large Scale Exploration License		16	43
3	Prospecting License		1	1
4	Small Scale Exploration License		23	45
5	Small Scale Mining License		7	7
6	Large Scale Mining License		1	1
7	Mineral Processing License	1	2	5
	Totals	1	64	129

Source: MMMD Cadastre Portal 2019

4.1.2 The types and quantities of manganese by-products processed from 2013 to 2017

Examination of production returns at the MMMD four types of high carbon manganese by-products namely Ferro Silicon Manganese (FSM), Silicon Manganese (SiMn), Ferro Manganese (FeMn) and Ferro Silicon (FeSi) were produced during the study period. Though production commenced in 2012, records of production returns were only available The total national Manganese by-products production volumes was estimated at 72,969 metric tonnes out of which 41,450 metric tonnes was produced in Serenje District. Records for 2012 statistics were not available at the MMMD and therefore could not be included in the data presented in Table 4.2.

Table 4.2: Types and quantities of products produced from 2013 to 2017

S/N	Year	Annual Manganese products production records							
		Total national annual production (Metric tonnes)				Share from Serenje (Metric tonnes)			
		FSM	SiMn	FeMn	FeSi	FSM	SiMn	FeMn	FeSi
1	2013	ND	ND	ND	ND	ND	ND	ND	ND
2	2014	7,965	7,923	12	ND	7,965	7,223	12	ND
3	2015	ND	ND	ND	1,676	ND	ND	ND	385
4	2016	8,150	ND	2,866	3,844	ND	ND	2,866	3,844
5	2017	ND	8,250	6,638	25,645	ND	8,250	6,638	5,265
	Totals	**16,115**	**16,173**	**9,516**	**31,165**	**7,965**	**15,475**	**8,516**	**9,494**

Source: MMMD

From the KII, it was further learnt that all the by-products produced in Serenje were alloys of more than two (2) elements and that data for production of FSM was only available in 2014. Processing of FSM required use of carbon that was obtained from charcoal. It was further leant that either Mn ore (40) % or FeMn ore were used as base metals in the production process while silica or dolomite were added as the flux that would bond with undesirable

impurities found in the molten base metals in order to be removed from the alloys. The huge quantities of charcoal required for production of FSM triggered the massive harvesting of trees for charcoal production and caused the subsequent ban on the use of charcoal for manganese processing. Production of SiMn, FeSi and FeMn required use of the same but charcoal was replaced with coal and coke as major sources of carbon while maintain minimal quantities of charcoal. Table 4.3 shows the raw material mix for each of the products.

Table 4.3: Manganese by-products, their contents and applications

Type of product	Grade	Content (%)							
		Mn	Fe	Si	C	S	P	Ca	Al
Ferro Silicon Manganese		√	√	√					
	Use	Used as a deoxidiser and alloy in manufacturing of steel components.							
		Mn		Si	C	S	P	$CaMg(CO_3)_2$	Al
Silicon Manganese		√		√	√			√	
	Use	For steel making and foundry activities. In steel making SiMn enhances the natural strength and durability by giving increased strength function as well as aesthetic appeal to the products. It is also used for metallurgical applications in batteries and chemicals.							
		Mn	Fe	Si	C	S	P	$CaMg(CO_3)_2$	Al
Ferro silicon			√	√	√			√	
	Used	Used to manufacture silicon corrosion resistant and high temperature resistant ferrous Silicon alloys, and silicon steel for electrolysis and transformer cores. Also used in the manufacturing of cast iron and inoculation of iron to accelerate graphitisation.in manufacturing of corrosion resistant and high temperature ferrous silicon alloys.							
		Mn	Fe	Si	C	S	P	Ca	Al
Ferro manganese		√	√		√				
	Use	Deoxidiser and alloy element in steel production. Used to counteract the bad effect of sulphur by combining with sulphur thereby giving the hot working properties of the product.							

Source: Field records

4.1.3 The raw material feed stock source and requirements for processing of manganese

From the KII and the conducted tour at the processing plants, it was learnt that the two (2) companies obtained manganese ore from either within Serenje District or from Mansa in Luapula Province. Records from the MMMD further revealed that the total annual

manganese ore produced in Zambia during the study period was 560,235 metric tonnes and 0.2% of this amounting to 1,150 metric tonnes was produced in Serenje District, Table 4.4.

Table 4.4: National Manganese ore production for 2013 to 2017

S/N	Year	Manganese ore	
		Total national annual production (Metric tonnes)	Share from Serenje (Metric tonnes)
1	2013	59,659	Unknown
2	2014	137,769	1,150
3	2015	107,034	Unknown
4	2016	137,769	Unknown
5	2017	118,004	Unknown
	Totals	560,235	Unknown

Source: MMMD

4.1.4 Manganese processing

From KII it was learnt that though manganese was the main base ore required for processing the needed by-products, the manganese processing companies required a specific raw material mix to produce the desired alloys of by-products. In order to produce FSM, Manganese ore base metals were conveyed to the crusher where they were cut into smaller pieces in order to increase the surface areas and later conveyed over a washer that separated the ore from the waste. Crushed ore was then conveyed to the blast furnace and exposed to high temperature of over $1,200^0$C in order to enable a reactions that liberated the elements from the ores and stimulated the molten alloy formation. During this smelting process, crushed dolomite was added to molten manganese ore as a flux that would bond with undesirable impurities that were later removed. Charcoal was added as a source of carbon and used as a reducing agent in the smelting process, Figure 4.1.

Figure 4.1: The Manganese processing crusher and furnace (Field Photos)

Once the manganese is smelted, the molten ore was then released to a cooling tray where it was settled and cooled for hardening while the slag was released for disposal. The hardened alloy was then later offloaded onto the concrete floor and broken to smaller pieces that were graded, weighed, and packed in bags that were labelled in readiness for export as shown in Figure 4.2

Figure 4.2: The Finished and packaged product ready for export (Field Photos)

4.2 Identification of source of charcoal, the actors involved and their roles along the charcoal value chain

This section presents findings regarding the actors who were involved in the manufacturing of charcoal that was supplied to the mines for processing manganese. Their roles along the charcoal value chain are also discussed.

4.2.1 Identification of the sources of charcoal

Examination of licensing records at the DFO in Serenje revealed that most of the permits and licences were issued for charcoal to be produced and conveyed from four (4) prominent Chiefdoms namely; Chieftanace Serenje; Chief Mailo; Chief Kabamba; and Chief Muchinka. However, the study focused on charcoal producers in the two chiefdoms namely; Chief Kabamba and Chief Mailo where the two (2) mineral processing plants were located and the people living closer to the processing plants were more actively involved in the commercial charcoal production which they supplied to the companies during the study period.

4.2.2 Identification of the actors involved in the charcoal industry and their roles

From the KII that were conducted in Chief Mailo and Chief Kabamba's areas, four (4) levels of the charcoal value chain were identified at production, transportation, trade and utilization. The actors involved at each level of the charcoal value chain and their roles are indicate in Table 4.5.

Table 4.5: Actors involved in the charcoal value chain

LEVEL	ACTOR	ROLES
Production	Traditional Rulers	Authorizing or delegating powers to allocate forests to the subjects for various uses
	Tree harvesters	Cutting down trees, cross cutting, pilling,
	Charcoal manufacturers	Firing the kiln, monitoring, harvesting charcoal and packaging
Transportation	Transporters	Transporting charcoal from production sites to the market within and outside the district. Transport were self-owned or hired.
	Loaders	Loading charcoal on to trucks or oxcarts. These were either family members or hired labour.
Trading	Road side traders	Buying charcoal at wholesale prices and selling by the road side.
	Long distance traders	Buying charcoal at wholesale prices and transporting to markets outside the district. Mainly to Lusaka.
	Middle men	Buying charcoal at wholesale price and retailing to long distance buyers.
	Traders	Buying and repackaging charcoal for re-selling
Consumption	Households	Buying charcoal in smaller quantities for domestic use.
	Restaurants	Buying charcoal in smaller quantities for commercial use
	Mines / institutions	Buying charcoal in bulk for industrial use

At production level, we had the traditional rulers, tree harvesters and charcoal producers. The traditional rulers presided over the land, forests and their subjects. Their main role was to authorize production of charcoal. They sometimes delegated this role to the village headmen. At the level of transportation, we had transporters who were either the local farmers themselves or outsiders who transported goods along the Great North Road. Their role was to move or convey charcoal from production areas to the market or holding place. At the

level of trading we had wholesalers and retailers. Wholesalers usually operated either at the production level or roadside markets. Their role was to buy charcoal in bulk and reselling the charcoal to available markets. At production level, the wholesalers would buy bulk quantities of charcoal from producers and resell to the nearby markets at a whole sale price. At the road side markets, wholesalers would resell their bulk charcoal to either the long distance truckers, middlemen or retailers. The role of middle men was to link buyers to producers or wholesalers and facilitate trade between producers, wholesalers and retailers. The role of retailers was to buy charcoal in smaller quantities, repackage it into smaller packages and resell the commodity locally within residential areas or at the local markets. At the level of utilization, we had the restaurants, government institutions, households and mines who bought the charcoal for consumption.

4.2.3 Challenges faced by actors along the charcoal vale chain

From the KII, it was learnt that the actors along the charcoal value chain faced challenges in the execution of their work.

(a) Challenges faced by the FD.

Major challenges faced by the FD at district level were as follows.

- Illegal production, transportation and trade of charcoal.
- Uncontrolled harvesting of trees for charcoal production.
- Limited dialogue between the FD and other government departments or stakeholders who had interest in the charcoal industry.
- Increased level of encroachment in the protected areas.
- Insufficient funds to support timely response to forestry management operations.
- Lack of appropriate modes of transport to support mobility of staff to conduct forestry operations made it difficult for Forest Officers to consistently closely monitor production, transportation and trade of charcoal at producer and consumer level. Even where officers managed to conduct inspections, they lacked the appropriate trucks for bulk hauling of confiscated produce and pickups to monitor production areas.
- Inadequate staffing levels at the district level affected the extent to which officers could travel and supervise charcoal production operations in the district and no Forest Guards to supervise production areas. The few officers could therefore not manage to supervise production in the scattered farms where charcoal production was taking place.

- The informality associated with the charcoal industry limited the capacity of the district staff to mobilise charcoal producers who cooperated as Individuals from different localities in their villages into formal entities that can be engaged to do formal business. The scattered nature of the actors in the industry at producer and trade levels of the value chain made it difficult for the FD to reach out to them and collect revenue especially at the point of production.

(b) Challenges faced by ZEMA

From the KII it was leant that the ZEMA were responsible for ensuring that the manganese processing operations conducted by the mineral processing companies did not destroy the environment through pollution, forest and environmental degradation. In doing their work the ZEMA faced challenges as follows;

- Low levels of compliance to the conditions set in the decision letter that was issued to the mines in the initial stages of the mineral processing operations;
- Inadequate representation of staff at district level; and
- Increased levels of deforestations that resulted from uncontrolled charcoal production.

(c) Challenges faced by the MMMD

From the KII it was learnt that the MMMD were responsible for issuing the MPL that authorized the mines to process manganese under given conditions that should have been monitored to ensure they were adhered to by the mineral processing companies. In performing their roles, the ministry experienced challenges as follows;

- Difficulties in monitoring artisanal mining licences who were in the majority and caused destruction in areas were manganese was being mined;
- Lack of representation at district level and dependence on the regional office in Mkushi to cover Serenje District
- Inconsistencies in capturing records of production from the mines some of whom could not voluntarily provide the figures to the ministry in the initial stages.

(d) Challenges faced by the charcoal producers, transporters and traders

From the FGD it was further learnt that the traditional leaders, charcoal producers, transporters and tree harvesters faced the challenges as follows:

- The long distance to the licensing offices increased transaction costs and the cost of doing the charcoal business. This discouraged those interested in getting permits and contributed to low levels of compliance to rules and regulations on charcoal.
- The high price of a standard bag of charcoal that was set by government at ZMW40.50 from 2015 to 2017 made it difficult for the producers to pay the necessary fees for production of charcoal when the farm gate price for the commodity was set at ZMW25 and the major market at the mineral processing plants were offering ZMW15.
- The preference by the companies to buy charcoal in bulk rather than in standard bags prescribed by the FD disadvantaged the charcoal traders who earned less from the business.

(e) Challenges faced by the manganese processing companies (mining)

At the level of consumption, only KI from the mineral processing companies that used charcoal were interviewed. From the KII it was learnt that the companies experienced the following challenges when accessing charcoal as follows;

- Charcoal was associated with deforestation and mineral processing as a major driver of the uncontrolled charcoal production and trade activities in the district;
- Lack of formal charcoal producer organizations that could supply industrial charcoal from well managed forests caused the companies to rely on individual charcoal traders who supplied charcoal from unverified sources that were not well managed.
- Lack of approved commercial suppliers engaged in large scale commercial production of wood pallets and other alternative sources that could substitute charcoal by making use of the abundant saw dust, wood waste from sawmills or carbonic waste for industrial use.
- Limited collaboration among regulatory agencies in the forestry, mining and environmental sectors. This caused delays in the delivery of collective decisions regarding failure by the mineral processing companies to comply to environmental conditions for commercial charcoal production in the area.
- Lack of coking coal in the Serenje District caused the company to travel long distances to purchase coal at Maamba in Southern Province and coke from Zimbabwe; and
- Insufficient supply of electricity which was also often interrupted and could therefore not guarantee continuous operations of the processing plant.

4.3 Determine the amounts of revenue collected by the FD from 2008-2017

Review of secondary data and information contained in the annual reports from 2008 to 2017 revealed that the FD in Serenje District collected forest revenue from ten (10). The major sources of forest revenue were wood fuel which comprised indigenous timber from forest concessions, charcoal, firewood, bush poles and cord wood. Other sources include exotic timber from plantations, tree seedlings, and fines for forest offenses. Total forest revenue collected in Serenje District in the ten (10) years was K3,855,892.00, Table 4.6 and Annex I.

Table 4.6: Forest revenue collected, sources and revenue collection systems in place from 2008 to 2017

S/N	SOURCE	REVENUE COLLECTED (ZMK)	REVENUE COLLECTION SYSTEM
1	Timber	1,844,819	Mandatory licencing through concession as per licence conditions, production areas specified with threshold set.
2	Charcoal	288,883	Voluntary licensing by client, un controlled areas of production. Open access and limited compliance to threshold set in the licence conditions.
3	Firewood	28,158	
4	Rentals/ royalties at loading bay	1,359	
5	Bush poles	4,090.60	
6	Forest soil	9,060	
7	Admission of guilty	15,204.0	Mandatory licensing through law enforcement guided by fees set in SI. Fees based on the offenses committed.
8	Exotic timber	50,798	Mandatory licencing guided by fees in the SI. Quantities /volumes measurable and predetermined before purchase, stocks easy to count and fixed prices.
9	Seedlings	2,427	
10	Way leave clearing of wood biomass from trees	1,611,092	Mandatory licensing guided by fees in SI. Areas for harvesting described and inventoried before clearing. Trees to be cleared valued and company charged. Revenue paid through bank transfer or cheque.
	TOTAL	3,855,892	

Source: FD Annual reports (2008-2017)

4.3.1 Regulatory framework guiding the pricing of forest produce and charcoal

According to information collected from the KII, the fees charged by the FD for permits to authorise either production or conveyance of charcoal were guided by the SI issued by government. Before the commencement of mineral processing operations SI. No. 121 of 2003 was in effect. When the mines commenced mineral processing operations, the fees for charcoal were increased twice through issuance of SI. No. 117 of 2013 and SI. No. 141 of 2015. The amounts of forest revenue that was collected by the FD before and after the commencement of mineral processing operations are shown in Table 4.7.

Table 4.7: The Legal framework for pricing of charcoal from 2003 to 2017

Year	Total annual revenue collected (ZMK)	Revenue from charcoal (ZMK)	SI. No	Remarks
2017	191,968.00	16,713	141 of 2015	Ban on use of charcoal to process FSM in Serenje District effected
2016	1,458,764	56,578.50		Mines continued to use charcoal to process FSM introduced in Serenje
2015	266,789	92,965		
2014	1,682,728	39,713.4	117 of 2013	
2013	43,584.60			
2012	88,468.2	28,246.65	121 of 2003	Mines started using charcoal to process FSM introduced in Serenje
2011	34,189.30	13,359.20		No mines processing FSM using charcoal in Serenje District

Note: Revenue figures for 2013 were not available at the district and provincial level
Source: FD annual reports (2011-2017); SI No.121 of 2003; SI No. 117of 2013; SI No. 141 of 2015

4.3.2 The statutory prices of forest produce and charcoal during the study period

Based on the three (3) SIs, the price of charcoal increased from K16.20 before the mineral processing plants commenced operations to K24.30 when operations commenced. During the study period, the price for charcoal increased from K24.30 in 2014 to K40.20 per 50kg standard bag. The amounts of revenue that was collected and the quantities of charcoal that was sold by the FD are shown in Table 4.8.

Table 4.8: Prices of charcoal as per SI in force

Year	Total annual revenue collected (ZMK)	Revenue from charcoal (ZMK)	Cost of production and conveyance per bag			Number of bags licensed
			Production /cord	Conveyance / bag	Unit cost per bag (K)	50kg standard bag
2017	191,968.00	16,713	270	13.50	40.20	416
2016	1,458,764	56,578.50	270	13.50	40.20	1,407
2015	266,789	92,965	270	13.50	40.20	2,312
2014	1,682,728	39,713.4	162	8.10	24.30	1,634
2013	43,584.60		162	8.10	24.30	
2012	88,468.2	28,246.65	108	5.40	16.20	1,743
2011	34,256.30	13,359.20	108	5.40	16.20	824

Source: FD annual reports (2011-2017)

CHAPTER FIVE

DISCUSSION OF RESULTS

5.0 Introduction

Results presented in chapter four (4) are analyzed in chapter five and relationships established to show trends in revenues collected before and after the mines were introduced in Serenje District. Information generated provide answers to the three (3) key questions in chapter one.

5.1 Identifying the location of the manganese processing licences, the raw material required for processing and the products produced

Results of the study showed that the two (2) mineral processing companies had established processing plants at Mukando and Kanona in Serenje District where they produced four (4) types of by-product namely FSM, SiMn, FeMn and FeSi from 2013 to 2017. The first company to commence operations produced SiMn in 2013 and added FSM and FeSi in 2014 and 2015 respectively. Though produced from the initial stage in 2012 production records for FSM were only available in 2014. In 2016 the second company was opened and FeMn was added to the product range thereby bringing the total number of products to four (4) SiMn, FeMn and FeMn in 2017. Trends of production are shown in Figure 5.1.

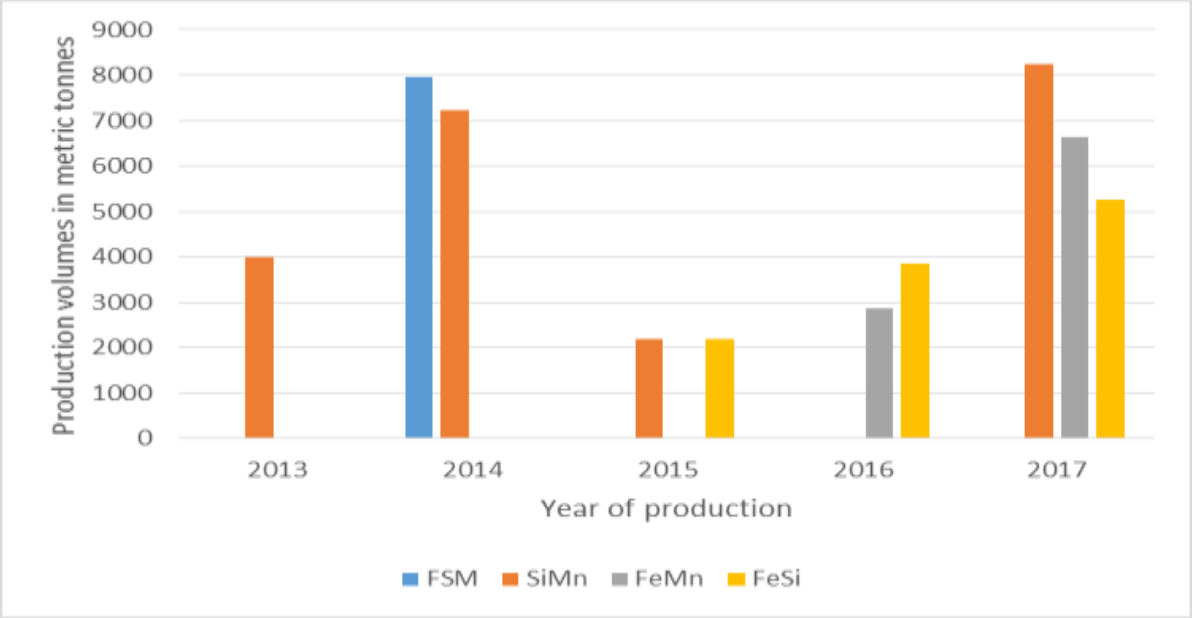

Figure 5.1: Manganese by-products production in Serenje District 2012 to 2017 (Source: MMMD)

As can be observed from Figure 5.1, FSM was produced during the initial stages of operations and that only reported in 2014. The companies stopped production of FSM and introduced a new range of products that required minimal quantities of charcoal to process. Fire 5.1 further shows that the total volumes of the new range by-products produced from 2015 to 2017 was much higher than that of FSM. It can therefore be deduced that though required in minimal quantities, the amounts of charcoal required for processing of the new product range from 2015 to 2017 were huge enough to influence both the amount of revenue that the FD could have collected and the quantity of charcoal that the department could have sold before the ban was effected in 2017

5.2 Identification of source of charcoal, the actors involved and their roles

Results from chapter four revealed that actors along the charcoal value chain operated at four (4) levels of production, transportation, trading and consumption. They performed specific roles in the charcoal industry and interacted with the FD. At production, the Chiefs performed an important role by authorizing or delegating powers to allocate forests to the subjects who were involved in charcoal production but rarely interacted with the FD. At the level of transportation, the FD randomly interacted with transporters who conveyed charcoal in small trucks or on bicycles and sold to households during patrols or when licensing and away from the production sites. At the level of trading, the FD interacted more with traders at the established markets or along the roads. At utilization level, the FD interacted more occasionally with the mines from 2012 to 2016. The actors, their roles and the interactions with the FD are shown in Figure 5.2.

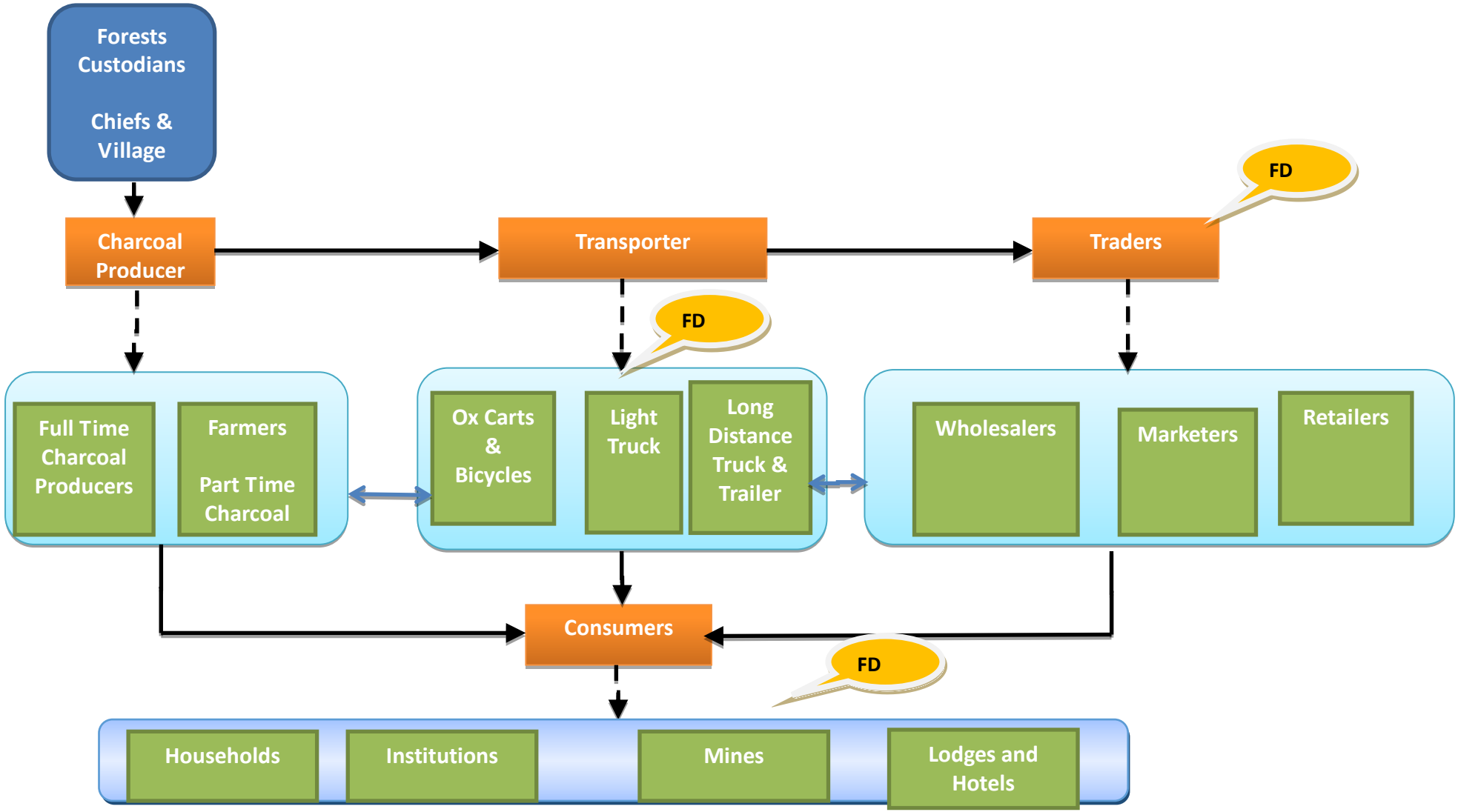

Figure 5.2: The actors involved and their interaction with the Forestry Department

From the presentation given in Figure 5.2, it can be deduced that the interaction between the FD and other actors identified at different levels of the charcoal value chain impacted on the amounts of revenue that could have been collected by the FD and delivery of technical services on SFM practices in harvested areas. The absence of the FD from production areas left charcoal producers unsupervised and caused the department not to collect revenue for tree harvesting from the producers. This though could have been avoided if challenges faced by the FD were addressed. According to information obtained from the KII, the failure by the FD to interact with charcoal produces were attributed to; lack of appropriate modes of transport to support mobility of staff who were required to travel to far flung charcoal production sites and haul bulk seized produce; inadequate staffing levels at district offices; lack of Forest Range Guards to supervise production areas; the informality associated with the charcoal producers who operated as individuals and made it difficult for the FD to provide technical advice on forest management; and insufficient funds to support timely response to forestry management operations. These challenges had contributed highly to the failure by the FD to capture most of the revenue from production sites.

5.3 Determine the Sources of forest revenue collected by the FD and trends associated with the revenue collected from charcoal from 2012 to 2017

From results in chapter four (4), it was learnt that the major source of forest revenue was wood fuel which comprised timber, charcoal, firewood, wood biomass and bush poles. Others were forest soil and tree seedlings. Highest forest revenue was collected from indigenous timber and this was followed by cord wood, charcoal and firewood respectively. Three (3) major pre-paid revenue collection systems were used. There were variations in the amounts of revenue that was collected from the identified revenue sources. For timber production, prior description and planning of areas to be harvested, issuance of licences and permits for prescribed monthly production volumes was used. For cord wood to be harvested in order to pave way for power line installations, prior description of areas for harvesting, inventorying of trees and valuation of trees to be harvested was used. In addition, one off payments were made by the companies involved. For cold wood to be harvested for charcoal production, issuance of licences for areas that were generalised was used. The variation in revenues was attributed to the revenue collection systems that was used to collect revenue, the market obligations for the product, internal consumer company policies and the presence of the FD. The percentages of forest revenue that was collected from each of the source are shown in Figure 5.3.

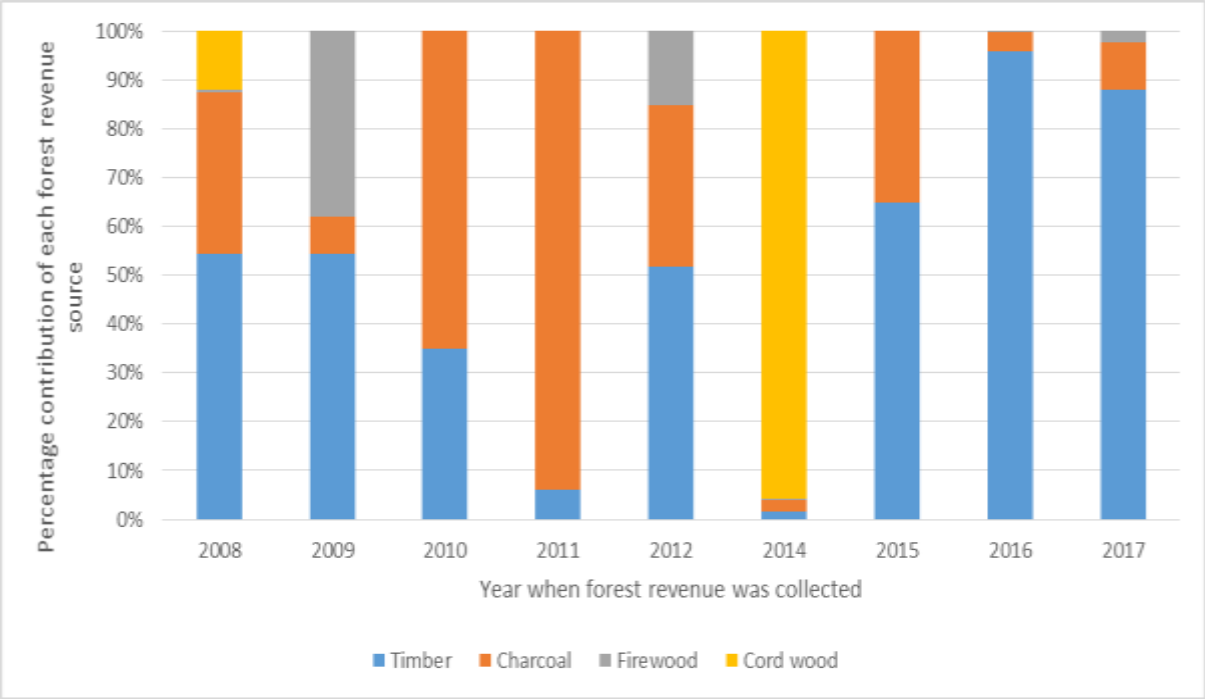

Figure 5.3: Forest revenue collected in Serenje District by sources 2008-2017 (Source: FD District Annual Report)

Highest revenue was collected from indigenous timber which accounted for 48% of the total revenue that was collected in the district during the study period. The high amounts of revenue was attributed to the high value of timber set by government at that time, the availability of the market for the indigenous timber, the trade obligations related to trade of timber on the domestic and export market, as well as the revenue collection system that was used by the FD. The *Pterocarpus chrysothrix* (Mukula) indigenous timber tree species was introduced on the market and concession licences were issued for citizen to harvest the timber in specific area assigned to them for a specific period of time. The concessionaires were required to pay their monthly quarters prior to harvesting. Failure to do so attracted penalties on their part and chargeable by the FD. The timber was mostly destined for export and because of the market availability, the producers endured to adhere to their obligations on paying for the timber prior to harvesting. In addition, export trade required that the seller of the valuable timber *Pterocarpus chrysothrix* timber provided all relevant documentation that would enable the exporters to facilitate trade out of the country. Because of this, the timber producers ensured that they obtained all relevant licenses, permits and receipts by obtaining permits from the FD. The buyers of the timber also ensured that they signed the necessary agreements for transfer of such legally obtained goods from the producers. Enforcement of laws was also enhanced in order to curb illegalities.

The second highest source of revenue was cord wood which accounted for 42% of the total revenue that was collected from all sources for the 10 years (2008 to 2017). Though only collected once during the study period (2012 to 2017), revenue from cord wood was significantly higher than even that collected from charcoal and timber. The high revenue was attributed to the pre-paid revenue collection system used and the internal policies which compelled the companies to diligently follow procedure in their installations. The one off payment for the trees to be harvested and the method of payment helped reduce challenges associated with cash transactions prior to cclearing of the designated area.

However, despite being the most frequently licenced and consumed products, revenue collected from charcoal was the third highest at 8% while that from firewood and exotic poles was the least at 1%. In the case of charcoal, the FD was required to issue the production licence to the charcoal producer prior to harvesting of trees that were to be used for charcoal production and a conveyance licence to the trader who transported the charcoal to the market. However, FD interacted more with the trader than the producer and this resulted in the trader taking up the two charges in order to fulfil the consumer obligation before the ban was effected.

From the above analysis it can be deduced that the amount of revenue that was collected by the FD from the wood fuel industry was highly influenced by the revenue collection system used. And from the comparison of revenue from timber, cord wood and charcoal, it was also clear that issuance of concession licences and inventorying of forest areas that are earmarked for timber or cord wood harvesting were the best ways of establishing the stocking levels of the forests and generating sound data that can be used to support the allocation of the forest resources for harvesting. Reasons are that concession licence holders are required to operate in specific areas where they would be obliged to adhere to forest licence condition by managing harvested areas and adhering to the prevailing legal obligations regarding production and trade of the forest products. It was further deduced that random licencing of charcoal that is produced in areas that are not supervised contributed to the uncontrolled harvesting of trees for charcoal production and the massive loss of forests that was experienced in the district during the study period.

5.3.1 Trends of the forest revenue from major sources before and after the manganese processing was commenced (2008 – 2017)

From the results in chapter four (4), it was observed that the amounts of forest revenue that was collected from the identified major sources in Figure 5.4 varied with time. Before the mines were introduced in the district and while maintaining the same sources, forest revenue collected by the FD was at its lowest from 2008 to 2011. In 2012, the mines commence manganese processing operations that required them to use charcoal and total general forest revenue increased drastically from K34,189.30 in 2011 to K88,468.22 in 2012 and reached the peak at K1,697,407.48 in 2014. During this period, cordwood accounted for 94.9% of the revenue followed by charcoal with 2.34%, indigenous timber with 1.67% and firewood with 0.12%. The least were bush poles and tree seedlings which collectively accounted for 0.97%. However, revenues reduced drastically from K1,458,763.50 recorded in 2016 to K191,968 after the ban in 2017. Trends in the general forest revenue flows before and after the mineral processing plants commenced operations are shown in Figure 5.4.

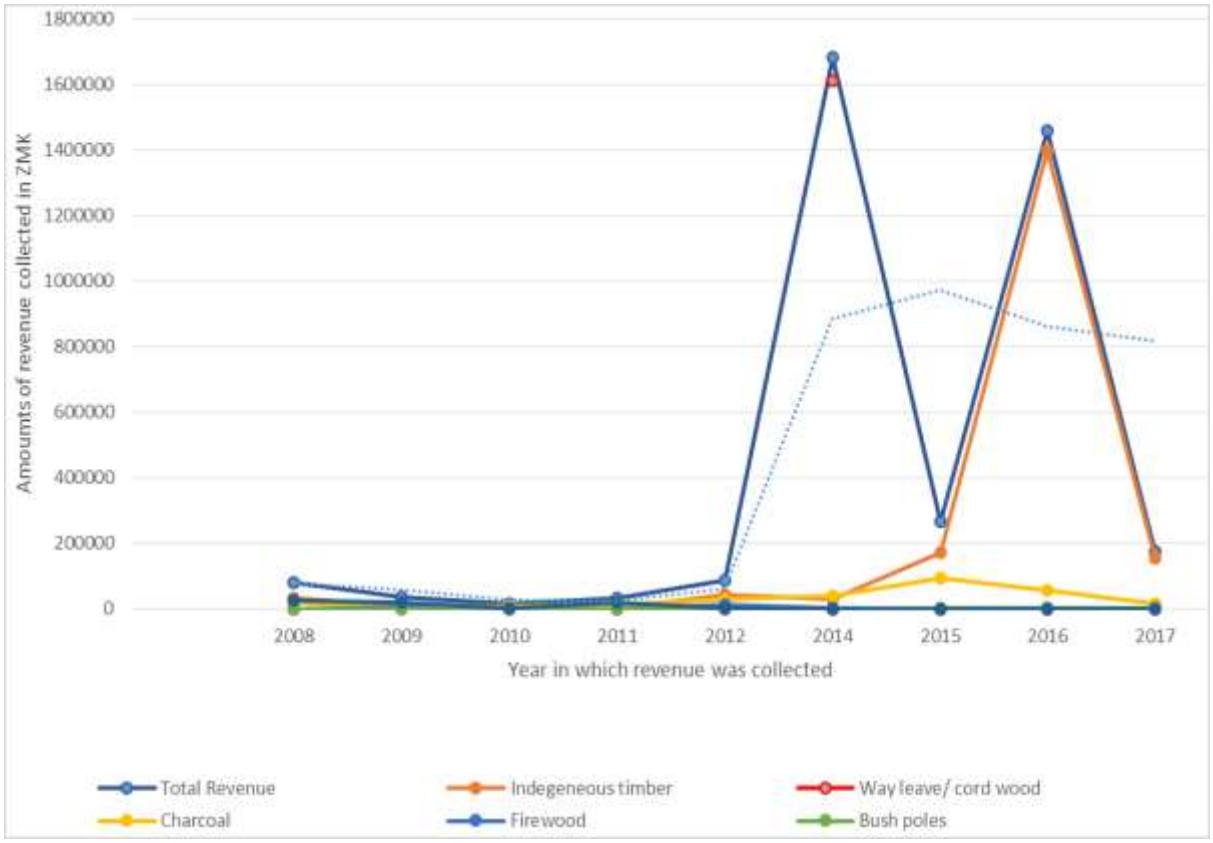

Figure 5.4: Trends of revenue collected from wood fuel 2008-2017 (Source: FD Annual Report (2008-2017))

5.3.2 Trends in revenue collected by the FD from charcoal

Analysis of the data in chapter four (4) further revealed that revenue collected from charcoal was at its lowest before the mines commenced operations in Serenje District. After the mineral processing operations commenced, forest revenue collected from charcoal increased drastically from ZMK13,359 in 2011 to ZMW28,246,649 in 2012 and reached its peak at ZMW92,965 in 2015. In 2016, concerns were raised by stakeholders on the rampant harvesting of trees for charcoal production and revenues from charcoal reduced to ZMW56,578.50. In 2017, government banned the mineral processing companies from using charcoal to process manganese and forest revenue from charcoal reduced further to ZMW16,913, Figure 5.5.

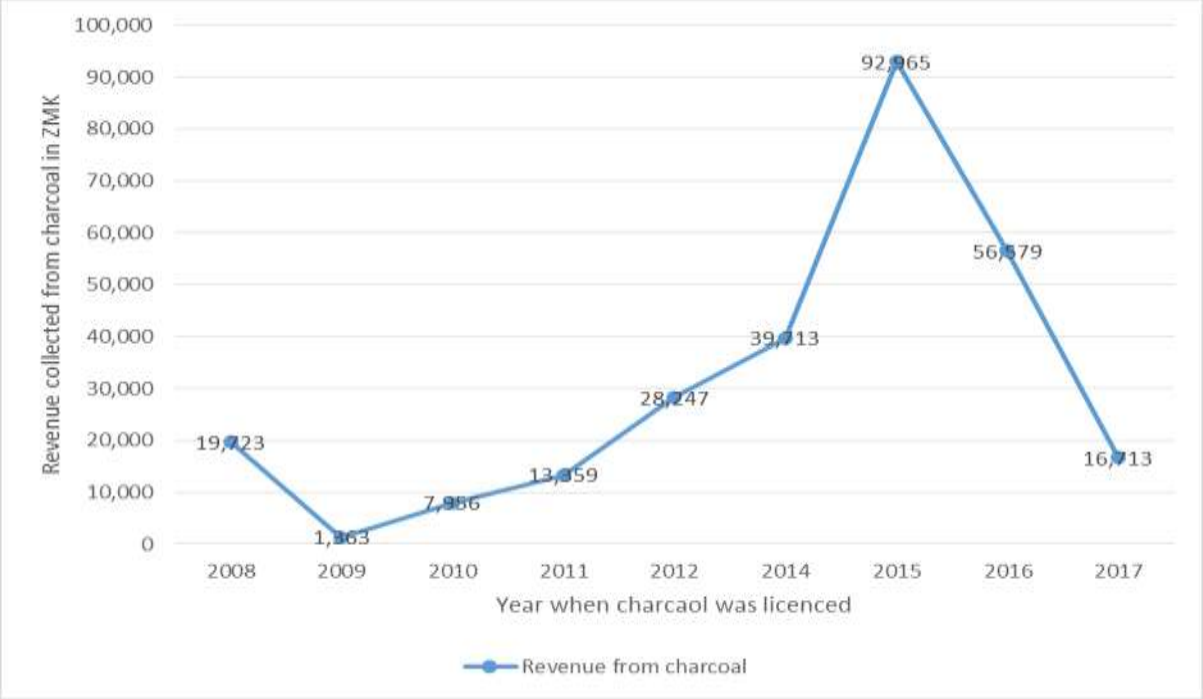

Figure 5.5: Trends of forest revenue collected from the sale of charcoal 2008 - 2017 (Source: FD Annual Report)

The increased revenue observed in Figure 5.5 was largely attributed to the willingness of the two (2) companies to adhere to the prevailing local rules and regulations by only purchasing charcoal from producers who obtained permits for production and conveyance from the FD. This way, the mineral processing companies were able to compel the charcoal traders to adhere to the available laws in order access the market for charcoal. It can therefore be deduced that the market obligation contributed to the high levels of adherence to the legal frameworks and the high revenues that the FD was able to generate.

5.3.3 Trends in the number of standard bags of charcoal traded by the FD from 2012 to 2017

Like in the case of revenue, analysis of inventory data on the quantities of charcoal that were sold by the FD from 2014 to 2017 revealed that more charcoal was licensed by the FD during the period when the mineral processing companies were authorized to use charcoal for processing manganese (2012-2016) and that the numbers of bags of charcoal sold drastically reduced after the ban was effected in 2017, Figure 5.6.

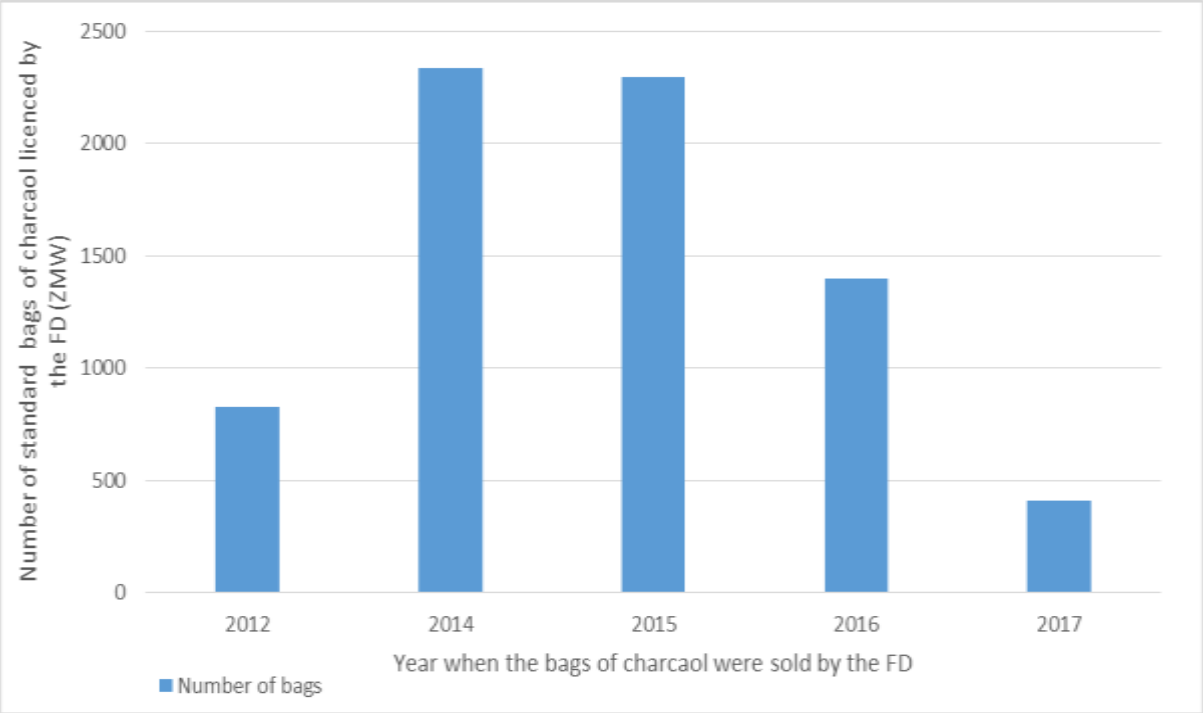

Figure 5.6: Number of standard bags of charcoal traded by the FD from 2014 to 2017 (Source: FD Annual reports (2014-2017)

The trend in the number of bags of charcoal that were sold by the FD in Figure 5.6 shows a positive correlation between the charcoal trade and the mineral processing operations in the district during the study period. Generally, the increase in the quantity of charcoal sold by the FD was attributed to the increased demand for commercial charcoal by the mineral processing companies. From the KII it was learnt that the companies provided reliable market for charcoal and this encouraged the local people to engage in charcoal production and trade.

It was further observed that the quantities of charcoal sold by the FD in 2017 had reduced. The reduction was attributed to the withdrawal by the major consumers of charcoal in the mineral processing companies from purchasing charcoal from suppliers who had legal

documents and this ultimately forced the mineral processing plants out of the wood fuel energy market but opened up to new markets that were ready to purchase charcoal from traders regardless of whether the charcoal was accompanied by legal documents from the FD or not.

The reduction was further attributed to the failure by the FD to trace and charge the majority of charcoal traders who could not voluntarily go to the offices to obtain permits. Compliance to regulations among charcoal traders reduced while the markets became elusive. Controlling this required more law enforcement efforts through patrols on highways, markets and in the charcoal production areas by the FD. This however, was not usually possible because the FD lacked appropriate transport and other logistical support that hindered the mobility of forestry staff to travel to distant places were charcoal was produced. As a result, the FD failed to capture revenue and inventory volumes from the elusive markets despite the increase in production of FeMn, FeSi and SiMn that required the minimum quantities of charcoal to process.

5.3.4 Trends in the number of bags of charcoal traded by the FD at different prices

A review of regulations for pricing of charcoal further revealed that the increase in the price of charcoal had little impact on the quantities of charcoal that was sold by the FD, Figure 5.6.

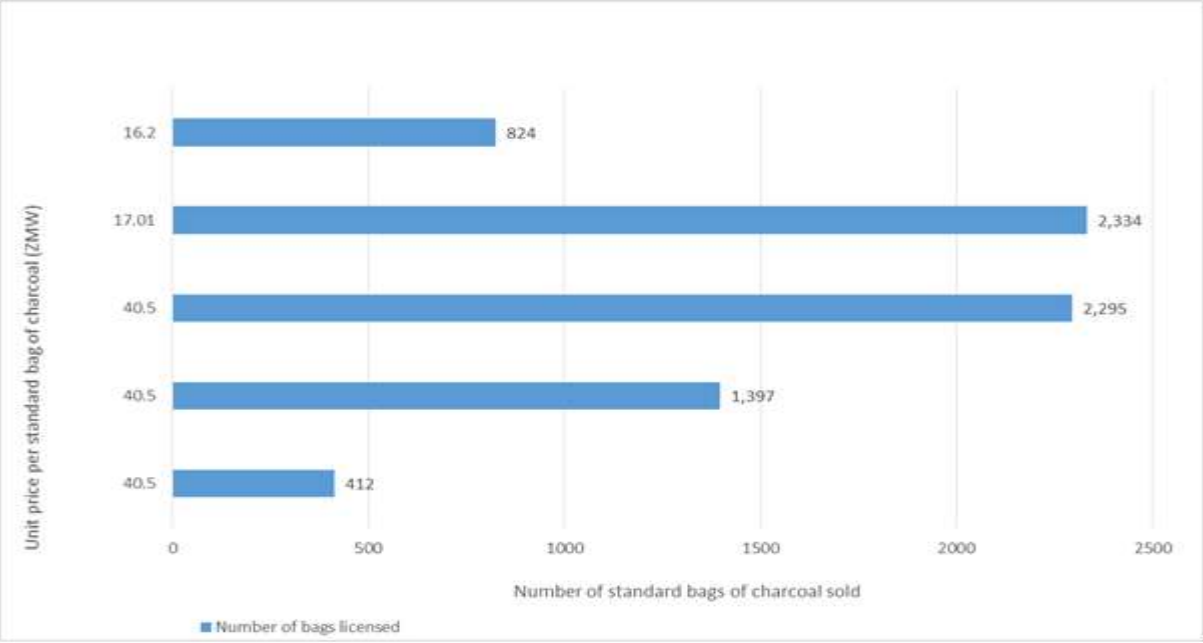

Figure 5.7: Number of bags of charcoal sold at different government prices (2008 -2017) (Source: FD annual reports (2011-2017); SI No.121 of 2003; SI No. 117of 2013; SI No. 141 of 2015)

The argument above was strengthened by the observation that the demand for charcoal continued to increase even when the price of the standard bag of charcoal was increased. Specifically, the price of a bag of charcoal had increased from ZMK16. 20 in 2012 to ZMW24.30 in 2013 and ZMW40.50 in 2015, Figure 5.6. Despite the increase in the price of charcoal, traders still turned up to obtain licences at the FD offices, hence the increase of the number of bags sold by the FD during the period when the companies were authorized to use charcoal for manganese processing.

It was further deduced that the ban on the use of charcoal to process manganese caused a reduction in the quantity of bags of charcoal that were sold by the FD because the current market for charcoal no longer obliged them to obtain permits from the department. In the absence of regular enforcement from the FD, the charcoal was traded illegally thereby eluding the FD. This caused the FD to fail to capture revenues and statistic of the quantities of charcoal traded to the elusive markets and contributed to the potential leakages of uncollected revenue experienced during the study period.

Apart from the observed positive impacts, the increased demand for charcoal from 2014 to 2016 contributed to the increased forest loss and environmental damage in charcoal production areas. These observations were also confirmed by information obtained from the FGD and the KII where the traditional leadership had observed a shift in lifestyle as some local people were reportedly observed to have migrated from their villages to areas closer to the mineral processing plants for purposes of engaging in charcoal production. This observed negative impacts prompted the government and traditional leaders to call for a ban on the use of charcoal for manganese processing. Various stakeholders welcomed the ban as an immediate solution to stop the rampant cutting of trees for charcoal production, allow communities to save the remaining forests and save the sources of livelihoods for the

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.0 Introduction

From the results and discussion in chapter five (5), conclusions were drawn and recommendations on each of the three objectives.

6.1 Conclusion

From the findings of this study, it was concluded that;

6.1.1 Objective 1: Identify the licences issued from 2012 to 2017, the products produced and raw materials used

- Opening of the mineral processing companies that used charcoal in their operations impacted positively on the amounts of revenue that were collected from charcoal by the FD from 2012 to 2017 in Serenje District. Four years (2008-2011) before the mineral processing plants were introduced, average annual revenue collected from charcoal was K10,600.23 and five years later (2012-2016) when the mineral processing plants were operational, annual average revenue from charcoal increased to K54,375.88.
- The mines provided a lucrative market for charcoal and this encouraged farmers to engage in charcoal production as a livelihood. But this caused massive harvesting of trees for charcoal production and migration of some charcoal producers to areas closer to the mineral processing plants for purposes of continuing with the charcoal business.
- The type of mineral products produced by the mineral processing plants determined the quantity of charcoal that may be required for processing. In all processes, huge quantities of charcoal were required and even the minimal quantities used must be determined and accounted for.
- Company obligations contributed greatly to the high levels of compliance on the part of the mineral processing companies who only accepted to buy legally produced charcoal accompanied by legal documents from the FD during the period when they were authorized to use charcoal in their operations. This to a larger extent helped the

FD to generate the revenue from the charcoal traders who were compelled to obtain permits for them to sell charcoal to the mineral processing companies.

- Limited access to expensive alternatives to charcoal contributed to the high preference for charcoal by the mineral processing plants. While electricity was expensive, coal and coke could only be accessed from far distances outside the district and sometimes out of the country. This increased the cost of doing business.
- The lack of harmonization of laws and regulations contributed to the conflicting actions taken by the different government regulatory agencies. The MMMD issued mining licences, FD continued to issue licences for charcoal while ZEMA issued a decision letter whose conditions were not in harmony with what the FD was doing.

6.1.2 Objective 2: Identify the actors involved, their roles and levels of interactions

- The levels of interaction between the actors along the value chain and the FD played a big role in enhancing the forest revenue collection system. The FD mainly interacted with charcoal traders at the point of sell and away from production areas.
- The absence of the FD at production level left most of the charcoal producers unsupervised.
- The informality associated with the actors in the charcoal industry disadvantaged both the mineral processing companies who could not sign contract with traders and the FD who could not reach all the producers at the point of production were they were also required to promote SFM practices. This made it difficult for the FD to keep track of the track of the charcoal supplies to the mineral processing plants and contributed to revenue leakages.
- Participation of the traditional rulers in enforcement of the forest law contributed greatly to the arresting of uncontrolled charcoal production and ensuring SFM forest management.
- Logistical challenges experienced by the FD due to lack of appropriate transport, under staffing, fuel and understaffing at the district contributed to the failure by the FD travel to monitor the charcoal producers in far flung areas and ensure SFM in harvested areas.

6.1.3 Objective 3: Determine the amounts of forest revenue that was collected from charcoal

- The amount of revenue collected from charcoal by the FD increased tremendously from K13,359.20 before the mines were introduced in 2011 to K28,246.65 in 2012

and all the way to K56,578.50 in 2016 before the ban on the use of charcoal for mineral processing was effected.

- The amounts of revenue that was collected by the FD from charcoal reduced from K56,578.50 in 2016 to K16,713 in 2017 when the ban on the use of charcoal for mineral processing was effected. This was attributed to failure by the charcoal producers to voluntarily report at the FD to obtain permits.
- The voluntary revenue collection system used by the FD to collect revenue from charcoal producers was not effective because it made the FD to rely on the charcoal producer to provide information on what they wanted to pay for. This created weaknesses in the determination of what actual quantities could be.
- Issuance of concessions for wood fuel harvesting in specified areas and with conditions for forest management worked better as more revenue was collected from cord wood than voluntary licensing of individual charcoal producers located in scattered areas.
- This though requires better revenue collection systems that promote planned tree harvesting regimes in areas suitable for charcoal production management under specified conditions.
- In the short term, the ban was most appropriate for controlling indiscriminate charcoal production because it temporally closed the market.
- In long term, the ban created room for the illegal charcoal trade to thrive among the charcoal producers who pursued lucrative elusive markets.

6.2 Recommendations

In view of the conclusions of the study and in order to improve revenue collection in the FD as well as ensure SFM in Serenje District it is recommended that;

6.2.1 Objective 1: Identify the licences issued from 2012 to 2017, the products produced and raw materials used

- The FD must consider conducting inventories of existing forest areas surrounding the mineral processing plants in order to establish the forest resources base and levels of forest loss and impacts of charcoal production
- The FD should consider developing the forest management plans for the two (2) forest reserves in order to enhance SFM in the district.

- Government should promote investment into production of coke within the country in order to lower the cost of the commodity which is currently being sourced from Zimbabwe and thereby increasing the cost of doing bustiness for the mineral processing plants.

- Government should consider increasing funding towards restoration of the harvested areas through natural regeneration in order to restore forests in degraded forests in harvested areas of Serenje.

- ZEMA must consider assessing the quality of gaseous emissions and waste water released from the processing plant in order to ensure they don't exceed allowable limits and advise were need arises.

- The FD should conduct pyrometallurgical analysis of the manganese products in order to establish the estimated quantity of charcoal required for production. This will help in projecting the volumes of wood fuel required for mining purposes.

6.2.2 Objective 2: Identify the actors involved, their roles and levels of interactions

- The FD should engage Chiefs in the study area to encourage their subjects to participate in the Community Forestry Management initiatives that provide incentives for costs and benefit sharing schemes. Under this arrangement, local rules and regulations will be strengthened and communities will be able to contribute towards the cost of managing the forests and benefit from the revenue that will be generated from the sale of forest produce harvested from the Community Forest Management Area.

- The local authority must take key interest in promoting integrated planning systems by developing harmonised work plans and budgets that would allow regulatory agencies in government to collectively monitor the mineral processing plants on regular basis and provide technical advice. This will help government departments to move out of silos and work towards strengthening the clusters approach that is promoted by the decentralisation policy.

- The MMMD and the Ministry of Commerce and Trade should consider promoting investments into off grid mini hydro power station that would utilise the natural water resources in the rivers closer to the mineral processing plants. This will sustain the

energy demands for mineral processing plants that have increased from two (2) in 2017 to four (4) in 2019, supplement wood fuel and reduce pressure on the forests.

6.2.3 Objective 3: Determine the amounts of forest revenue that was collected from charcoal

- The FD must consider allocation of concessions for wood fuel harvesting to be put under the coupe system management for charcoal production. This will enable the department to collect revenue before harvesting of trees and hold the concessionaire responsible for managing the harvested areas, presentation of monthly returns on the harvested and production volumes of charcoal.
- The FD must consider decentralising funding for forestry operations to the district level in order to enable the officers to implement delegated responsibilities and draw work plans that respond to the local needs.
- The FD must considers improving staffing levels and providing appropriate transport at the district level. This would enable officers to collect more revenue and travel to production sites where they will provide technical support that would promote SFM in harvested areas.
- The FD must strengthen the enforcement of forest laws in charcoal production areas in order to ensure that charcoal producers pay the ZMW270 of production fees required for each cubic meter of cord wood utilised for production of ten (10 x 50kg bags) standard bags of charcoal.
- Where enforcement becomes is a challenge, the FD should consider reviewing the ZMW40.50 of conveyance fees required to be paid for each bag of charcoal transported from the production site to the market and .
- Where the farm gate price of charcoal is lower than ZMW27 required for payment of both production fees, the FD should consider reviewing the licencing system by simply shifting the whole cost of production and conveyance to the trader who sells each bag of charcoal at not less than K50. This will enable the charcoal producers to break even when selling the charcoal at farm gate price pegged at K25 to K35 per standard bag farm gate price.

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Annex I: The amounts of revenue collected by the Forestry Department from the various sources from 2008 - 2017

Table 5: revenues collected by the FD during the study period (2008 to 2017)

Year	Total Revenue	Timber	Charcoal	Firewood	Bush poles	Admission of guilty	Rentals (loyalties at loading bay)	Exotic timber	seedlings	Way leaves /cord wood	Forest soil
2017	191,968.00	154,090	16,713	4,140	810	15,000	1,215	Nil	Nil	Nil	nil
2016	1,458,763.50	1,398,405	56,578.50	2,070	810	nil	nil	Nil	Nil	Nil	900
2015	266,789.20	172,252	92,965	Nil	972	nil	nil	Nil	600	Nil	nil
2014	1,697,407.48	28,431	39,713.4	2,010	129.60	nil	nil	Nil	759.30	1,611,084.88	600
2013	43,584.60**										
2012	88,468,221.00 *	44,405,172	28,246,649	12,960,000	680,400	54,000	72,000	110,0600	765,800	nil	1,836,000
2011	34,189,300*	850,800	13,359,200	Nil	415,000	150,000	nil	19,035,300	50,000	nil	396,000
2010	19,156,600*	4,266,000	7,956,200	Nil	273,600	nil	nil	3,462,200	54,000	nil	720,000
2009	20,718,236*	9,778,616	1,362,800	6,798,000	nil	nil	nil	628,500	198,000	nil	900,000
2008	82,767,700*	32,340,600	19,722,700	180,000	nil	nil	72,000	26,571,700	Nil	7,200	3,708,000

Note: * old currency before kwacha was rebased was used from 2008 to 2012; **Please note that data for 2013 is yet to be collected

Questionnaire

UNIVERSITY OF ZAMBIA – SCHOOL OF MINES

QUESTIONNAIRE FOR KEY INFORMANT INTERVIEW – DISTRICT FOREST OFFICE, SERENJE

MAY, 2019

I will introduce myself as a student coming from the University of Zambia and conducting research aimed at assessing the impact of the use of charcoal to process Ferro Silicon Manganese on the revenues collected and the management of the forests in charcoal production areas in Serenje District. I will also explain that before I could ask any questions, I will share with the informant the information contained in the information sheet and ask for their consent to participate in the interview and the research. If consent is granted based on the understanding of the information given, I will tell the respondent that questions to be asked will be based on their participation in the collection of forest revenue and management of the charcoal production areas in the district. I will ask them if I could take some of their time to go through the questionnaire with them and where necessary if I could take photographs.

DETAILS OF THE QUESTIONNAIRE ADMINISTRATION

Name of Institution: _____

Date of interview: _____

District_____

Province _____

Start Time _____ End time _____

1.0 IDENTIFICATION OF THE ROLES OF THE INSTITUTION

1.1 What are the responsibilities of the institution in the district? Of these responsibilities are there any that are related to revenue collection and forest management? If so what particular activities do you conduct? Please tick where appropriate?

	Type of responsibility	**Activity**	**Related to research topic, Please tick**
1	Protect forests	Patrolling in forest reserves	
		Early burning	
		Forest Reserve boundary maintenance	
		Tree planting	
2	Licencing	Collection of money	
		Receipting	
		Banking and reporting	
		Measuring forest products	
		Inspections	
3	Law enforcement	High way and forest patrols	
		Road blocks	
		Arresting offenders of forest law	
		Inspection of charcoal production areas	
4	Forest extension services delivery	Training	
		Education	
		Awareness raising	
5	Others explain		

2.0 IDENTIFICATION OF LICENCES ISSUED FROM 2008 TO 2017

If issuance of licensing or permits is one the responsibilities performed by your institution, what type of licenses did you issue out from 2008 to 2017, for what product and for how long?

	Type of forest licence issued	**Type of product licenced**	**Duration period of licence**
1			
2			
3			
4			
5			

3.0 IDENTIFICATION OF FOREST PRODUCTS SOLD, ACTORS INVOLVED AND MARKETS TO WHICH PRODUCTS WERE SOLD FROM 2008 TO 2017

3.1 Of the licences issued, what forest products did your institution sell from 2008 to 2017, to which customers and to which market did they intend to sell the product?

	Type of forest product sold	**Customer to whom product is sold**	**Target market for licenced product?**
1			
2			
3			
4			
5			
6			
7			
8			

3.2 If timber was one of the products licences, what type of licences were issued, for which species and duration of licence?

Name of License	Type of License	Date of issue	District/ concession area location	Tree species	Licence duration/ when expiring	Area covered	Authorized volume

3.3 What were the quantities of the 5 major forest products sold under Q3.1 from 2008 to 2017?

Year	Quantity of charcoal licenced				Quantity & species of timber licenced m^3					
	90kg	50kg	25kg	10kg	Mukwa (m^3)	Mukula (m^3)	Mupapa (m^3)			
2017										
2016										
2015										
2014										
2013										
2012										
2011										
2010										
2009										
2008										

3.4 If charcoal was one of the revenue sources for the district, who manufactured the charcoal and from which areas in the district? And to what market did they mainly sell the charcoal?

Type of charcoal producer	**Major areas of production**	**Intended market for trade**

3.5 If the mines were part of the markets to which the major forest products were sold, did you have a way of check on the legality of the wood or wood products that was supplied to the mines?

Yes No

3.6 If yes, to 3.5 how often did you inspect the mines for delivered charcoal?

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3.7 If no what stopped you from doing so? Explain.

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4.0 FOREST REVENUE COLLECTION AND SOURCES FROM WHICH REVENUE WAS COLLECTED FROM 2008 TO 2017

4.1 From each of the forest products you sold from 2008 to 2017, how much revenue was collected? State the product and amount of revenue collected each year.

YEAR	TOTAL REVENUE	SOURCE OF REVENUE									
		Timber	Charcoal	Firewood							
2017											
2016											
2015											
2014											
2013											
2012											
2011											
2010											
2009											
2008											

4.2 Did you observe any changes in the amounts of revenues collected from the sale of forest products from 2008 to 2017? Give reasons for your answer.

Period	Forest product	Observed change	Reasons for the change
2008-2011			
2012-2016			
2016-2017			

5.0 CHARCOAL PRODUCTION DEVELOPMENT SCENARIOS IN SERENJE DISTRICT

5.1 How do you see the rate of production and trade of the licenced forest products by the year 2030?

Type of forest product	**Rate of production**			
	Same	**Moderately increasing**	**Increasing at alarming rate**	**Reducing**

5.2 What activities do you see to have potential to contribute to the alluded developments in 5.1 in Serenje District?

Type of forest product	**Rate of production**	**Potential contributing factor**
	Same	**Moderately increasing**

5.3 Impact will the observed impact observed in 5.2 have on the amounts of revenue to be collected from the sale of forest products in Serenje District?

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7.0 CHALLENGES FACED IN THE COLLECTION FOREST REVENUE IN SERENJE DISTRICT

7.1 What challenges did you face when collecting revenue from the sale of forest produce in Serenje District?

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Of the challenges experienced in 7.1, which ones are specific to charcoal?

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7.2 What challenges did you face in enforcing the law regarding illegal production of forest produce?

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7.3 Of the challenges observed in 7.3, which ones are specific to charcoal?

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8.0 MANAGEMENT OF AREAS WERE FOREST PRODUCTS WERE HARVESTED FROM 2008 TO 2017

8.1 Did you have any system for managing areas that were allocated for harvesting of forest produce and manufacturing if charcoal from 2008 to 2017? If yes, how many times did you monitor such areas per month?

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8.2 What challenges did you face in the monitoring and managing of areas were forest products are harvested?

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8.3 How do you think the observed challenges in 8.2 can be improve so that you are to effectively collect forest revenue and monitor forest areas that are allocated for harvesting of forest produce?

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THANK YOU VERY MUCH FOR YOUR RESPONSES