EFFECTS OF CHARCOAL PRODUCTION ON ENVIRONMENT IN THE LOWER SHEBELLE REGION, SOMALIA

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A Research Project Submitted in Partial Fulfillment of the Requirements for the Award of the Degree of Master of Arts in Environmental Planning and Management, Department of Geography, Population and Environmental Studies, University of Nairobi

DECLARATION

This project was my own original work and it has not been submitted to any other institution for an award. Where other people's works have been used, the same have been appropriately acknowledged and referenced according to the University of Nairobi anti-plagiarism policy.

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(C50/36457/2020)

This research project has been submitted for examination with our approval as university supervisors.

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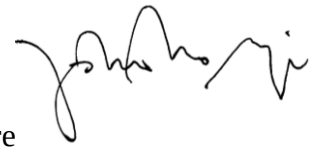
Signature  Date **…2…/..11.. /…2022....**

Dr. John Kioki Musingi

DEDICATION

To my loving mother Fadumo Mohamed Ibrahim and to my loving father Mohamed Abdi Jim'ale for their unconditional support and enthusiastic involvement in my academic progress.

ACKNOWLEDGEMENT

All glory be to Allah, the Almighty for his generosity in allowing me to complete the project. I also recognize the contributions of my both supervisors and unwavering support Dr. Shadrack Mulei Kithiia and Dr. John Kioki Musingi. Regular guiding and corrections from both of my supervisors enabled me to complete my project and reach this milestone achievement. It was a huge honor for me to have both of you as supervisors. The extra time you gave me over and above your formal working hours allowed me to finish my project.

I'd also like to express my gratitude to the rest of the teachers at the University of Nairobi's Department of Geography, Population, & Environmental Studies, as well as everyone else at the university, for their contributions to my achievements.

I'm thankful to my own beautiful family for their inspiration and support in assisting me in accelerating progress. My family also deserves to be thanked for their moral, spiritual, and financial support during my academic path. This would not have been possible without their constant assistance and support. My feelings for them are limitless.

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LIST OF ABBREVIATIONS AND ACRONYMS

CITES Convention on International Trade in Endangered Species of Wild Fauna and Flora

FAO Food and Agricultural Organization

FGS Federal Government of Somalia

FSNAU Food Security and Nutrition Analysis Unit

IGAD Intergovernmental Authority on Development

IUCN International Union for Conservation of Nature

RMSN Resource Management Somali Network

NAPA National Adaptation Programme of Action

NRA National Range Agency

SPSS Statistical Package for Social Science

GHGs Greenhouse Gas Emissions

SWALIM Somalia Water and Land Information Management

UAE United Arab Emirates

UNDP United Nation Development Programme

UNEP United Nation Environment Programme

USAID United States Agency for International Development

UNCCD United Nations Convention to Combat Desertification

CHAPOSA Charcoal Potential in South Africa

HO_2 Water

SEI Swedish Environmental Institute

GLOSSARY OF TERMS

Jilaal From December through March, there is a protracted dry season.

Gu Short rainy season which starts from April and lasts till June.

Hagaa Short dry season that stars from July and ends in September.

Deyr Stars from October to November and is long rainy season.

Qurac (Acacia bussei) a tree that grows in several parts of Somalia and is used to make charcoal.

ABSTRACT

Every country requires energy in order to develop. Somalia, a developing country relies to a large extent on wood fuel (especially charcoal) to satisfy its energy demands. Charcoal energy plays a major role in the rapid growth of Somalia's urban centers. This study looked into the environmental effects of charcoal production in Somalia with a focus on the Lower Shebelle region, a region that has been experiencing rapid deforestation but there is little or no data to inform a deeper understanding of the issues and concerns. This study set out to address three objectives: to determine factors motivating charcoal production activities in the lower Shebelle region; to examine effects of charcoal production on the environment in lower Shebelle region and; to assess how different measures put in place are regulating charcoal production in the lower Shebelle. Using a cross-sectional research strategy, the study employed a questionnaire to obtain data from a simple random sample of 384 households which were producers. Data were analyzed by applying procedures in the Statistical Package for Social Science (SPSS) software, and the results were displayed as text, tables, and charts in accordance with study objectives.

The study findings and conclusions include that the market demand has shown a great preference for charcoal produced from the acacia tree (49%) and the highest price per sack of charcoal was $15. Unemployment was a major motivating factor of charcoal production. Therefore, Producers have established lucrative charcoal firms and reap tremendous profits by taking advantage of high demand and good prices on the international/local market, as well as a weak or non-existent regulatory framework for charcoal in Somalia. In addition to that, the study found that loss of plants (42%) was the most important environmental effect, followed by desertification (15%), soil erosion (15%), and loss of soil productivity (29%). The greatest advantage of burning charcoal for the locals was a source of income or employment. It was found that diversifying economic activities was the most effective strategy to control charcoal production.

Therefore, the study recommends that; to alter present charcoal production techniques, such as the traditional ones (earth mound kiln), and introduce more improved charcoal manufacturing technologies (Drum kiln & improved earth kiln) and also to help the charcoal burners and other people make a living, trainings on how to run small-scale income-generating businesses should be given to them.

CHAPTER ONE: STUDY BACKGROUND

1.0 Introduction

One of the greatest difficulties currently confronting the globe today is access to sustainable energy (Zidago, 2016). This challenge is glaringly evident in the high cost of fuels like oil (petroleum products), coal and natural gas as well as inaccessibility of sources of renewable energy like solar energy and also wind energy. Sharp rises in the cost of such forms of energy often mean an exclusion of many households who then resort to alternatives such as charcoal and firewood for heating and cooking. This also may often explain why the poor and middle classes of most societies make up the bulk of charcoal users as they cannot afford Liquid Petroleum Gas (LPG) or electricity (Mugo, 2007). Therefore, major source of energy in less developed countries, particularly urban areas, is charcoal, which is anticipated to grow at a pace of 6% per year, which is directly related to the rate of urbanization (Njenga, 2013).

Charcoal is a fuel wood that is generated by burning wood in a low oxygen (O_2) area. Per kilogram, it gives higher energy and heat content than firewood (Boucher, 2011). Charcoal making is a sequence of interconnected operations that begin with wood identification, continue through wood harvesting, kiln type selection, carbonization, and eventually yield production. Wood and other biomass sources are used to produce charcoal by using a technique known as carbonization. The carbonization is a process by which wood and other biomass are converted into liquids, gases, and charcoal in the absence of oxygen. There are various technologies utilized in the making of charcoal. The technique utilized to make charcoal distinguishes the various charcoal production systems. Therefore, some of the charcoal production technologies are traditional, such as each pit kilns and earth mound kilns, while others are improved, such as casamance kilns, brick kilns, and steel kilns, which are more efficient than previous ones (Odour, 2006).

According to a study, the manufacturing of charcoal from wood historically may be traced back to a very primitive age around 4000 BC in China and West Asia, North and South America, Africa and Europe also made use of charcoal (Mba, 2018). In addition to that, humans have used charcoal from time immemorial. Natural wood charcoal was extensively utilized as an energy source in cave drawings 30,000 years ago (Van Beavering, 2007). Between 1965 and 2005, global charcoal production patterns showed an increase, with Africa topping the list, with about

1.5 billion people in developing nations relying on charcoal for cooking and warmth (Tassie, 2021). For example, in year of 2015, there was a significant increase in wood charcoal production globally and it was estimated to be 52 million tons, with Africa producing more than half of it (Abbas, 2006). The most popular kind of wood fuel used by urban homes is charcoal, which is especially prevalent in Africa and other developing countries (Akpalu, 2011). In urban areas including Mogadishu, the most important fuel source for domestic cooking is charcoal and domestic charcoal production meets the country's demand. Domestic consumption, on the other hand accounts for less than a fifth of total production, with international demand accounting for the vast majority of the rest. The majority of Somali people will continue to rely largely on traditional solid fuels mainly charcoal and firewood, but these energy resources are fast depleting (SWALIM, 2014).

At least 14% of the world's main energy produce comes from charcoal and fuel wood, with over 2 billion people in developing world particularly in rural areas, being dependent on wood for their primary energy source (FAO, 2010). In Sub-Saharan Africa, 94% and 73% of rural and urban Africans respectively used wood-based fuels by 2007 (Bailus, 2007; Sedano, 2016) with rural areas largely reliant on wood and urban areas reliant on charcoal (Seidel, 2008). These statistics highlight the significance of wood and charcoal in satisfying the energy needs of the developing world.

In Somalia, charcoal constitutes a major energy source for cooking to many households and families, it is referred to as "black gold" due to the money it brings in (Robinson, 1988). Despite the income derived from charcoal, the "black gold" has been a significant contributor to deforestation and associated environmental devastation as well as a major threat to pastoralism as an economy among most communities of Somalia. In areas where charcoal production has assumed a major place in the local economy, there have been reports of increasing rates of deforestation, land degradation and related adverse environmental phenomena (USAID, 2014). One such area is the lower Shebelle region, which produces tons of charcoal per year that constitutes about huge percentages of all the charcoal produced from Somalia. While most Somali people traditionally relied on forest wood for fuel, the new dimension of charcoal as profitable export product that ranks second only behind livestock has completely changed how charcoal is perceived in the mix of the economy (Beier, 2014). On the whole, charcoal export

forex earnings have motivated a chain of events that threaten not only the entire pastoral economy but also the potential of the environment to support local livelihoods (Omuto, 2009).

Although the rate of charcoal for export and consumption is known to be extremely high in Somalia, and the capability of charcoal to lead a plant loss is also known to be pretty high, there is very little data on plant loss in the last few years. In Somalia, the decline of certain trees, soil deterioration, and soil erosion in some regions are the key indications of land degradation types. It is known that plants are necessary for soil erosion control, agricultural land conservation, and rangeland preservation. Due to the issues such as removing of plants for charcoal making, destroying cover plants, maintaining monoculture, and relying on surface irrigation might have negative implications such as land degradation (SWALIM, 2014).

1.1 Statement of Problem

In many regions of the developing world, large-scale charcoal production has already been linked to dangers of deforestation, land degradation and climate change (Jones, 2015). In Somalia, these concerns revolve around the challenges of sustainable charcoal production, consumption, and their effects on local livelihoods of the predominantly nomadic pastoralist Somali population. On the charcoal production side, deforestation and related land degradation destroy pasturelands and farmlands thereby becoming a root cause of decline of Somali pastoralism and food security. One recent study in Puntland shows, a yearly decline rate of 5% in some key Acacia tree species, that rate appears to be applicable across Somalia, including the lower Shebelle region (SWALIM, 2014). Another SWALIM study projected a sharp decline in plant cover in the Jilib Area, a nearby district of Juba, between 2011 and 2013, a trend that is seen across Somalia (OCHA, 2012). On the consumption side, Domestic consumption accounts for less than a 5^{th} of overall consumption, with international demand accounting for the vast majority of the rest. Therefore, in order to meet the demands of charcoal for international markets, an estimated 4.4 million trees (mostly indigenous species) are cut down to make 250 thousand tons of charcoal each year for export, an indication that international charcoal markets are major threat to tree cover in Somalia. For example, 80% of all charcoal produced in Somalia is exported to international markets mainly in the Middle East and Africa (UNEP, 2005). These markets are certainly a major part of the array of things that motivate demand and production.

With its relatively better-endowed tree cover, the lower Shebelle region is one of the main producers and exporters of charcoal, but charcoal production accelerates desertification in the region and forcing residents to leave areas that have become uninhabitable due to the charcoal producers have cut down all the trees as well (Tessie, 2021). Deforestation also decreases biodiversity since species that depend on tree groves for survival can't exist without them. Rangelands in Somalia have been destroyed because trees were chopped down or removed to satisfy the increasing demand for charcoal (Horn, 2006). So, inhabitants of the lower Shebelle region have been subjected to periodic droughts as a result of widespread deforestation for charcoal manufacturing (RMSN, 2003).

Though existing data seem to point to the important role of the charcoal economy of Somalia, there is only scanty evidence of how this charcoal economy works and its implications for the social, political and environmental spheres of the country. Therefore, this study was focused on gathering empirical data to promote a clearer picture of the effects of charcoal production on the environment in Somalia, taking a case study of the Lower Shebelle region. The findings of the study may be useful to the fledging government of the Federal Republic of Somalia in formulating policy and other frameworks that promote sustainable livelihoods and environmental management.

1.2 Research Questions

The study focused on acquiring data to answer three major questions:

1. What are the factors that motivate charcoal production activities in the lower Shebelle region?
2. How do charcoal production activities affect the environment in the lower Shebelle region?
3. What measures have been put in place to ensure proper management of vegetation in the region?

1.3 General Objectives

The main study objective was to contribute to a greater understanding of the effects of charcoal production on environment in Lower Shebelle region of the Republic of Somalia.

1.4 Specific Objectives

The specific objectives of the study were:

1. To determine factors motivating charcoal production activities in the lower Shebelle region;
2. To examine effects of charcoal production on the environment in lower Shebelle region, and;
3. To assess how the different measures put in place are regulating charcoal production in the lower Shebelle.

1.5 Justification of the Study

Although charcoal production is detrimental to the environment, it is also source of income for a most of families in Somalia. Since the Somali state's collapse in 1991, a huge number of unemployed males have made a living by producing charcoal. Due to the lack of environmental regulations and protection, a large number of acacia plants are cut down and burned for charcoal, resulting in the depletion of Somalia's natural resources (Dini, 2011). Therefore, this study was raised local people's understanding of the impact of charcoal producing operations and how to prevent any action that is harmful to the environment. The findings of the study could have aided policymakers in assessing the charcoal-producing activities in the lower Shebelle region so that, appropriate policies could be put in place to effectively control them. Academics who want to do more research on the same or a similar topic could find the study's literature to be quite useful. It may also help to build a community-wide awareness of how to accomplish rural development through sustainable charcoal production. It also emphasizes the significance of environmental conservation in generally, and vegetation conservation in particularly, for academics who are excited in studying that field, as well as stakeholders who are involved in developmental programs, such as government agencies, the United Nations Development Program, and other local and international non-governmental organizations. The researcher was developed new research skills that can be applied to similar activities in the future.

1.6 Scope and Limitation of the Study

The purpose of this study was to look at the environmental effects of charcoal production in the lower Shebelle region. Therefore, it did not consider production of charcoal in other regions of the country because of financial inabilities and time that can be huge burden to the researcher. Thus, the study focused on environmental implications of charcoal production in lower Shebelle, Somalia. Language barrier was one of the study's limitations so, the questionnaire was used as

direct interview into Somali language in order to obtain accurate and valid data for the study. Finance was also a limiting element because the study was self-funded but family and friends helped out. Security concerns arose from time to time, such as a suspect, but the researcher eventually was able to overcome them with the help of locals who were relatives and a letter of approval from local authorities. Another concern was monetary demands from study respondents because they assume you work for a non-governmental organization, but the researcher persuaded them that he was conducting the research for academic purposes.

1.7 definitions of key terms

Wood-fuel: contain different types of biofuels obtained straight or not from plant especially evergreen trees and shrubs that are planted on both forest and non-forest area.

Charcoal: is a light black carbon and ash waste hydro-carbon gained through eliminating HO_2 and other volatile elements from animals & plants, particularly trees.

charcoal Production: is defined to the technique and tasks involved in the production of charcoal.

Carbonization: is known as the process of transforming an organic material such wood in to charcoal.

Household: can be defined as an individual or a number of people who are generally linked by kinship bind and stay together below a single roof or within one building, sharing a life community in which they are all accountable to the same head and have access to the same food source.

Fuel: is every substance that can be consumed to produce heat, light, or power i.e. energy, such as charcoal, kerosene, or Liquid Petroleum Gas.

Environment: is the term refers to the circumstances or settings in which we live. Physical, ecological, social, and economic settings are all part of it.

Biodiversity: refers to the diversity of organisms. This encompasses differences within and between species, as well as within and between environments.

Tree Species refers the different varieties of plant that are utilized in the production of charcoal.

Livelihoods are the skills, possessions, and pursuits that enable individuals to make a living and maintain a standard of life.

A charcoal kiln is a location where carbonaceous materials, such as wood or other materials, are burned to make charcoal.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter concentrated on a comprehensive review of key literature on charcoal production and its environmental effects. The literature on strategies used to control and ensure the long-term management of charcoal was also reviewed. Three study objectives affected the literature in this section. Other topics discussed in this chapter include Somalia's environmental governance and policy, as well as the theoretical and conceptual frameworks.

2.1 Sustainable Charcoal Production and Consumption

Wood fuel and charcoal are used as a food cooking energy source in poor nations around the world, accounting for 50 to 90 percent of total fuel use (FAO, 2010). Moreover, half of the world's population cooks their meals with biomass energy. Biomass consumers choose charcoal above all different types of biomass fuels such as wood, charcoal, remnants, & manure for cooking. It gives higher energy and heat content than wood and other types of biomass energy sources, and it is also suitable for long-term storage due to having to no worry about insects. Charcoal has a number of advantages when it comes to cooking food, including the ability to burn for an extended amount of time and the ability to quickly extinguish and reheat. Charcoal is even valued even in industrialized countries such as the United States for the tastes it gives to grilled cuisine (Lew, 2005).

Charcoal is the product of wood and its components (branches and trunk) that is generated by burning in a low O2 environment (Boucher, 2011). The easiest technique to increase the value of wood is transforming wood to charcoal as a fuel. Charcoal production is a sequence of interconnected operations that begin with wood identification, continue through wood harvesting, kiln type selection, carbonization, and eventually yield production. The production of charcoal can either be small-scale charcoal production or large-scale charcoal production. The small-scale charcoal production entails cultivating wood, collecting it, and preparing it for carbonization process, and finally arranging charcoal for sale and transfer. Wood and other biomass sources are used to produce charcoal by using a technique known as carbonization. Carbonization is the process of converting wood or other biomass into liquids, gases, and charcoal in the absence of oxygen. In other words, carbonization is known as the process of transforming an organic material such wood in to charcoal (Siko, 2019).

Both the amount of charcoal consumed in Sub-Saharan Africa and the amount of wood fuel used to produce charcoal are forecasted to increase by up to a factor of two by the year 2030, reaching 544.8 million m3 and 46.1 million tons, respectively (K Tassie, 2021).

In Sub-Saharan Africa, also ninety-three percent of families in rural areas and fifty-eight percent of families in cities rely on wood fuel for everyday cooking. As a result, use of wood as energy source is a significant. Wood accounts for more than eighty percent of the energy source in African countries. it also contributes around ninety percent of overall consumption of wood in Africa, with eighty-one percent of families consuming solid fuels and seventy percent relying on them as their main source of energy for cooking. Woody biomass is also used as a source of energy by over 60% of city dwellers for cooking (L Defo, 2021).

In 1992, the globe utilized 24 million tons of charcoal. The majority of this consumption occurs in poor countries, with African countries using more than half of global produce. Global charcoal production trends increased between 1981 and 1992, and this rise is expected to continue with the fast expanding population in less developed countries. The most widely used energy sources are fuel wood and charcoal (Hosier, 1993). By far wood is the most relevant biomass; globally wood removals yearly exceed 3.3 billion m^3 and greater than half of that being utilized as energy or any other forms of wood fuel (Tomaselli, 2007). According to a research conducted in 2015, Brazil was identified as the world leader in charcoal production (FAO, 2016). In Africa and other underdeveloped countries, charcoal is the most predominant and widespread type of wood fuel used by urban families. Africa generates 55 percent of the world's charcoal, according to FAO estimates (FAO, 2010).

For many years, charcoal has been the basic cooking energy source for a number of Somali families and it will continue to be so, if no other energy is introduced. Acacias are the most common trees used to make charcoal. Acacia bussei is a kind of acacia trees that can take up to 100 years to grow and is prone to charcoal logging. These trees are crucial to the nomadic society's survival because they give shelter to herds of sheep, goats, cows, and as well as donkeys. Also traditional houses were made from acacia trees. Men and women who had lost their occupations and had fled from civil wars turned to charcoal production. Even previously unskilled workers could succeed in this position, because charcoal production requires strength to fell down and burn trees for charcoal. As a consequence, plants have become scarce due to

extensive production of charcoal and now are very few. In reality, no vegetation remains in some towns and this is an indication of reliance and consumption of charcoal and firewood (Dini, 2011).

2.1.1 The process of making charcoal

Fuelwood is harvested and chopped to size before being deposited in a kiln, which can be underground or above the surface. The kiln is lit and the fuelwood begins to heat up and pyrolyze. Albeit some air pockets were initially left exposed to allow smoke and steam to escape, the kiln is mostly shut. The charcoal producer might close a few spaces of air as the kiln emissions change color (Kammen, 2005). The production process could take many weeks. The process normally loses around half of the fuelwood energy, but solid fuel generated has a higher content of energy per unit mass. The kilns are dug up or opened after the process is complete, and the charcoal is removed. As a result, the charcoal produced resembles smaller, lighter pieces of blackened wood. The produced charcoal has higher contents of energy than fuelwood in terms of weight (Kammen, 2005). In general, charcoal is made by three sequential steps. First and foremost, charcoal burners choose plants that are suited for charcoal production. In the second step, the chopped woods are then placed in a kiln and coated with straw and soil. The kiln is eventually ignited as well as allowed to burn gently for up to 3 weeks. The charcoal is now prepared to be gathered into bags and delivered to markets for sale or to be sold individually by the side of the road (Wurster, 2010).

During the process of production of charcoal, a variety of factors come into play, including wood moisture content, kiln structure, wood organization in the kiln, and carbonization control. Together, these factors account for a broad range of productivity gains in earth kilns of 10-20 percent (Njenga, 2013).

In Somalia, acacia trees are commonly used to make charcoal, and Somalia has a large number of these trees. Also in Somalia, Kilns which are usually ovens are used to make charcoal. The felled trees are stacked and buried in sand after being coated with iron sheets. The oven has been burning for one week before the sand and sheets are removed. After that, the wood is turned into charcoal, which is then packaged in bags or sacks for export or local consumption (typically utilizing tracks and dhows, which are lateen-rigged ships with one or two masts used in the Indian Ocean) (FAO, 2017). The production of charcoal was restricted to a very few number of

cutters who used hand axes to meet an internal and local need. In Somalia, the majority of families utilized charcoal to cook their meals. However, charcoal became a profitable export industry to the Arab world later on (Ismail, 2011).

2.1.2 Charcoal production techniques

The technology used to produce charcoal distinguishes the various charcoal production systems. Therefore, some charcoal production technologies are traditional, such as earth pit kilns and earth mound kilns, while others are improved, such as casamance kilns, brick kilns, and steel kilns, which are more efficient than previous ones (Brobbey, 2019). As a result, the quality of the produced charcoal and the performance of a kiln utilized are directly rely on wood moisture content, wood volume, kiln type, plant species, charcoal producer expertise, and meteorological events (Brobbey, 2019). Charcoal production can either be small-scale or large scale and traditional kilns are appropriate for small scale charcoal production which has very low efficiency of 15-20% and carbonization time is 5-10 days on average. Most charcoal producers prefer this method due to inexpensive cost and minimal material requirements but it demands a lot of wood because its conversion rate is too low. On the other hand, improved kilns are suitable for large and small scale charcoal production and has higher efficiency rate of 26-30% but they are more expensive. The 3 almost famous techniques for manufacturing charcoal include metal kilns, earth kilns, and masonry kilns (Odour, 2006). Earth kiln is the most preferable technique of frequently producing charcoal inside Somalia and also other parts of Sub-Saharan Africa. Almost all charcoal producers in the study region utilize poor carbonization techniques, which result in significant wood loss and greenhouse gas emissions (FAO, 2017). In Somalia, charcoal is made in kilns which are similar to ovens. The cut trees are stacked, coated in iron sheets and buried in sand. The sand and sheets are removed after the oven has burned for up to a week. The wood is then converted into charcoal, which is then packaged in bags/sacks for export or domestic consumption (FAO, 2017).

2.1.3 Traditional earth kiln

For a long period of time, up to the start of the last twentieth century, charcoal was used to make traditional methods. Therefore, the most frequent technique for producing charcoal is through the application of traditional earth kiln. Woods were placed inside earth trenches scooped out of the ground, ignited, and then covered with soil. The heat created by the burning of some of the wood

was sufficient to carbonize the remains (Abdallah, 2007). This approach gave you a little more management over burning and carbonization than the pit method. Due to their low cost, both approaches are still used in many poor nations. In any case, the charcoal generated by both procedures is very low. For example, 1kg of charcoal requires 8 to 12kg of wood, perhaps more. Poor quality due to the carbonization maintaining problems and pollution such as tars and harmful gases are emitted. Therefore, the efficiency of this technique is low that is estimated between 15 and 20% and carbonization may last 5-10 days and the cost of constructing is not much compared to improved ones. Together all these matters, charcoal producers have strong preference in this technique (Abdallah, 2007).

2.1.4 Improved earth kiln

Another useful technique of producing charcoal is improved earth kiln which applies same process as traditional earth kiln but the charcoal is less contaminated. Metal sheet is frequently used in this approach to prevent contamination (Njoroge, 2013). It is also useful to apply chimneys in order to promote the management of carbonization process but, the purchase of chimneys and metal sheet has resulted in an increase in production input. Improved earth kiln can also be applied for both small-scale charcoal production as well as large-scale charcoal production. This technique is proven to have higher efficiency than traditional earth kiln and is estimated around 27–35% (Njoroge, 2013).

2.1.5 The root causes of charcoal production

The fundamental underlying cause of deforestation in Somalia, which has now overtaken the region, is a lack of energy alternatives. Deforestation caused by illicit plant removal for charcoal, its export, and animal feeds, as well as mining, timber, fire, and starvation, have had a terrible influence on Somalia (Ismail, 2011).

Since the Somali state's collapse in 1991, men and women who had lost their occupations and had fled from civil wars turned to charcoal production. Even previously unskilled workers could succeed in this position, because charcoal production requires strength to fell down and burn trees for charcoal (Dini, 2011). As a consequence, plants have become scarce due to extensive production of charcoal and now are very few. In reality, no vegetation remains in some towns and this is an indication of reliance and consumption of charcoal and firewood (Dini, 2011).

Many individuals start cutting plants and converting them into charcoal due to a lack of solid economic opportunities. This generally occurs when a drought kills these people's livestock and they have no other alternative than to turn to fallen trees for charcoal to generate income for their survival. The money they earn from charcoal production is used to compensate for the loss of their animals and the majority of charcoal producers are between the ages of 17 and 30 years old, (Dahir, 2012).

Charcoal dealers in Bander Beyla (a small city near the Indian Ocean) in Puntland (a self-governing Somalia state) act as if the environment is unconcerned about their selfishness, and thus their final goal is to earn money and they are unaware to the environmental destruction they are wreaking. Their main goal is to get money by chopping and set burning plants in order to manufacture a huge number of charcoal bags (Shukri, 2006).

Furthermore, according to a research on the dynamics of wood-based energy in Somalia, it was forecasted that 4.8 million bags of charcoal, each one of them weighing between 25 and 30 kilograms, would be produced in Somalia (particularly the north-east) by the year 1996. A total of 2.1 million acacia tree species were required to produce that quantity of charcoal. Therefore, every hectare sixty plants were felled down as an average which automatically means mass deforestation of land that is estimated 350,000 ha per annum (Ismail, 2011).

2.2 Motivating Factors for Production and Consumption of Charcoal

Charcoal has the ability to assist millions of rural and urban livelihoods by generating money, creating urban-rural financial flows, and boosting the country's economy. It also has the potential to supply millions of homes with accessible, inexpensive, and dependable energy (Smith, 2017).

Charcoal gives higher energy and heat content than wood and other types of biomass energy sources, and it is also suitable for long-term storage due to having to no worry about insects. It has a number of advantages when it comes to cooking food, including the ability to burn for an extended amount of time and the ability to quickly extinguish and reheat. These properties of charcoal are what motivates consumers to use it, and are even valued in industrialized countries such as the United States for the tastes it gives to grilled cuisine (Lew, 2005).

Years after the fall of Mohamed Siad Barre's rule, to begin a commerce became a simple task for anybody and the lack of regulatory structure (especially charcoal regulatory structure) in Somalia cleared the path for illicit charcoal business (Ismail, 2011). Many households in south and central Somalia have turned to the charcoal trade as a source of income as a result of civil turmoil and the catastrophic drought that has plagued millions of people. The production of charcoal only takes place in rural areas; after that, it is carried to cities and towns for use in cooking, keep warm, however other families use plants for housing and furniture and export. The charcoal was then processed in southern Somalia before being transported via the ports of Mogadishu and Kismayo (Ismail, 2011).

Less than 5% of total consumption is accounted for by domestic consumption, with the great bulk of the remaining consumption being driven by international demand (UNEP, 2005). The estimated 4.4 million trees (mainly indigenous species) are chopped down to produce 250 thousand tons of charcoal each year for export in order to fulfill the demand for charcoal for international markets is proof that Somalia's tree cover is seriously threatened by the global charcoal market. For instance, 80% of all the charcoal produced in Somalia is shipped to international markets, mostly those in the Middle East and Africa (UNEP, 2005). The ever-increasing demands for charcoal in the urban areas and international markets had motivated many citizens to get involved in charcoal production activities and do not see it as a poor man’s business anymore (Eniola, 2018).

2.3 Environmental Effects of Charcoal Production

Charcoal burning has a number of environmental effects which might either be short-term or long-term. The intensity of the implications of charcoal production on native ecosystems is determined by specific production of charcoal partners, and its adoption is strongly based on social, economic, and cultural variables. As a consequence, the implications are dependent on the properties of the location (past and ongoing) as well as control techniques prior to and after plant harvesting (Iiyama, 2014).

Deforestation has been associated with the production of charcoal, according to several reports. When charcoal consumption appears to be excessive due to poor forest management and the absence of commercial charcoal control legislation, this issue is largely underestimated (L. Defo, 2021).

The process of producing charcoal causes plenty of environmental issues like; Deforestation, Greenhouse gas emission, Soil Impact and Ecosystem (Mba, 2018). Also, unsustainable charcoal producing activities may result in: Deforestation and forest degradation which reduces biodiversity. Wildlife loses habitat and becomes more vulnerable to hunting when forest cover is eliminated (Bailis R. E., 2003).

Deforestation is responsible for 15% of all world GHGs, due to mankind activity, emissions of carbon dioxide account for up to a 1/3 of all carbon dioxide emissions.

Plants can't afford to evaporate under-groundwater because of disrupted cycles of water as a result of deforestation and this is leading to a substantially drier local climate.

Deforestation accelerates rate of erosion of soil by enhancing water-runoff and lowering soil protection from tree litter.

A number of people depend on forests directly for their livelihoods, whether via little farming, hunting and gathering, or harvesting forest goods like rubber. Deforestation continues to cause serious socioeconomic difficulties, leading to violent conflict in some cases.

Rapid deforestation due to the destructive charcoal production, over-grazing and poor state of land are causing irreparable damage to the environment in Somali. The charcoal industry has resulted in increased damage of different vegetation especially acacia species as a result of expanding need of charcoal and poor technology usually applied in the production of charcoal (ICRAF, 2002). Somalia is one of the countries in the globe that is grappling with this growing problem. In Somalia, Typically, the production of charcoal is the major factor in deforestation. Therefore, effects of deforestation on the country are detrimental. 25% of a million tons of charcoal produced using traditional technology is exported from Somalia to Gulf countries annually and production of that amount requires the felling of 4.4 million trees and the clearing of 72,900 hectares of land. The effects of that on the pure community and environment that depend on it for existence have been disastrous in a country that is already prone to natural disasters like drought and floods (UNDP, 2013).

The increasing rate of deforestation in Somalia is due to more than just the indigenous use of charcoal fuels. Because of the great demand for charcoal in the Arab Nations, significant shipments of this product have been made to those nations. In many regions of the nation, particularly in the south, several warlords and Al-Shabab make a lot of money from the charcoal

trade, which is their major source of revenue. Then, by storm, the charcoal trade appeared to be the most successful and profitable trade of this poor nation's largest note currency generating industry (Farah, 2015).

Charcoal making also poses a severe influence on biodiversity since it focuses on single tree species that are often available in forests and woodlands, with the majority of them being neglected and contributing to harvest insecurity. The potential for regeneration in drylands is relatively low, and the lack of a well-planned and regulated charcoal production stimulates the events that cause to desertification (mutimba, 2005). The lack of this crucial characteristic, replanting practice, hastens desertification and land deterioration. Almost all charcoal producers in the study region utilize poor carbonization techniques, which result in significant wood loss and greenhouse gas emissions (mutimba, 2005).

Normally, forests have important functions in the environment. They aid in the prevention of natural calamities such as floods, global warming, erosion, and biodiversity control. As a result, forests act as climate regulators and are essential to the survival of life on Earth. Most of the tropical forests in Somalia are alongside the Shebelle River and Jubba rivers, as well as the lands between the two rivers, but have been removed for agricultural use and charcoal production. The total forests cover in the country is around 10.5% (World Bank, 2012).

On the other hand, in struggle for survival and development, man has a variety of negative effects on the environment, including misuse of natural resources, ecosystem devastation, and pollution. The mismanagement of natural resources has been a growing subject of worry; as non-sustainable exploitation of natural resources threatens human survival (Hashi, 2010).

In tropical countries of the world, the majority of the trees that are currently used for the manufacture of charcoal are cut from forest which typically, its recovery relies on regeneration. Therefore, the basic causes for general worries regarding environmental implications of production of charcoal are a typical pattern of virtually full reliance on forests for charcoal production, as well as the perception of non-sustainable harvesting and inadequate post-harvest forest management (Chidumayo, 2013).

The production of charcoal degrades both vegetation and biodiversity. The degradation of vegetation includes the decline of the quality and quantity of various plants (grasses, herbs, and

shrubs) in the ecosystem. Deforestation, overgrazing, fires, and agricultural activities contributed to this. On the other side, the term "biodiversity degradation" focuses on the reduction of various species, environmental variation and genetic resources as a result of reduced habitat function for affected animals and plants (Bell, 1993). The persistent use of wood varieties for charcoal making in arid regions leads to biodiversity loss. According to research on charcoal production, it promotes deforestation on susceptible rangelands, resulting in a 2.8 percent loss of trees every year on average and limited regeneration (Bell, 1993).

Charcoal production hastens desertification by reducing the quantity of land available for cultivation or grazing, as well as driving inhabitants out of regions that have become uninhabitable after charcoal producers have cut down the entire plants. Also deforestation reduces biodiversity because species that rely on plant groves can't afford to live in the absence of them. Rangelands have been degraded in Somalia as a result of tree removal to supply the rising needs for charcoal (Kiruki, 2020).

Since 1991, a new sort of violence has erupted in Somali country, one that is wreaking damage on the already fragile environment. The degradation of acacia bussei in order to get charcoal for the worldwide markets and local markets is part of this violence. Since the Somali government collapse, a substantial an unemployed male has created a living by producing charcoal. Lack of protection and environmental regulations, acacia bussei are cut and burned in a huge quantity for charcoal, resulting in the destruction of natural resources of Somalia (Dini, 2011). Plant community structures are altered as a result of tree removal with regard to species diversity, distinct species' distribution, and density of plant. Charcoal production and consumption has become a key driver of forest cover loss due to the targeting of specific plant species for production of charcoal. Most of the charcoal produced in SSA, for example Kenya and Somalia is derived from indigenous tree species (Onekon, 2010).

Acacia bussei is a woody plant which grows slowly and it might take its growth for an extended period of time, may be hundreds of years. This plant normally is an evergreen and drought resistant plant that is native to the area. The tree was feed for Somali pastoral animals and assisted them to withstand natural disasters like drought. On the other side, acacia bussei has been backbone for the Somali charcoal business (UNEP, 2018). In order to meet the rising requirement of charcoal for both domestic and at same time global markets, acacia bussei was

used for charcoal production instead of fodder source for animals as result of this has posed dander to the livelihoods of many nomad pastoralists. Because of the frequent droughts, it is expected that the losses would rise and globally, Somalia ranks 7th out of 233 nations in terms of climate change impact susceptibility. In order to solve the environmental concerns caused by charcoal production, institutions must be strengthened and sustainable alternative forms of economic chances must be provided (UNEP, 2018).

Otherwise, this fragile environment is under particular stress as a result of the breakdown of governance and the following non-stop decline in civil security opened a door to unchecked resource depletion and frequently results in serious threats to local communities' ability to manage resources sustainably. Degradation of land has been recognized as a severe concern throughout the country, and efforts to address have been hampered by the country's ongoing institutional and humanitarian crises (Omuto, 2009).

In Somalia, the net land area dominated by forests is estimated to be roughly 11.4 percent of total nation area. Various tree species, mainly acacias, flourish in vast numbers in rangeland. The flood plain woodlands along the Shebelle River have been harmed by land clearing for small farms and plantations (Beier, 2014). Forests are home to 1,078 and 3,028 documented species of animals as well as plants, respectively in Somalia. Some of these creatures are one-of-a-kind. Between 1990 and 2005, there was a 13.9 percent loss of forest and woody habitat, or 1,151,000 acres, due to pressure from charcoal industry and agriculture. Charcoal production has risen to be a significant source of income for pastoralists, who make up 70 percent of the population and need the estimated cutting down of four trees for every sack of charcoal. As a result, the charcoal sector has significant effects on livelihood security, intensifying societal tensions, raising the risk of drought, and rapidly depleting forest resources (Beier, 2014).

From the 1980s, Somalia has been one of the countries hit by severe drought. Somalia is a drought-prone country, and the cause is not only the country's dependency on precipitation such as rains for water and food in order to prevent food and water insecurity, as well as the societies' lack of resilience, weak governance, and, finally, environmental pressure (Abdulkadir, 2019).

Droughts caused by climate change, which are more frequent and last longer, are wreaking havoc on nomad pastoralists' livestock in Somalia. According to data published by the (World Bank, 2017), Between US$1.3 billion and US$1.7 billion was lost due to livestock losses as a result of

the drought during 2016-2017, as well as crop output losses of up to US$60 million. Pastoralists' livelihoods have been harmed as a result of deforestation and degradation associated to charcoal production, and their ability to adapt to climate change has been harmed as well. Considering that climate change has become a factor, full deforestation will worsen the effects of climatic risks in Somalia's societies (Ogallo, 2018). Rapid deforestation due to the destructive charcoal production is causing irreparable damage to the environment in Somalia. The production of charcoal will be a significant source of concern for naturally growing flora. Total deforestation will raise society's sensitivity to extreme climate variability by reducing the major food supply of nomad pastoralists and disturbing indigenous water cycles (Ogallo, 2018).

2.4 Measures Put in Place to Ensure Sustainable Management of Vegetation

The largest manufacturers of charcoal in the industry were households in rural areas; As a result, if correctly managed, it had the potential to be a substantial source of income. As a result, maintaining the industry will improve rural livelihoods. To strike a balance between the sustainability of livelihoods and forest conservation, it is necessary to use efficient, suitable technologies and strategies for charcoal burning (Lurimuah, 2011). This will necessitate the government subsidizing the expense of adopting improved technologies, such as the kiln technique. Increased wood supply can also be achieved by establishing agroforestry in farming regions and communal woodlots. it is better to be restricted Charcoal production in to particular forests and parks and also not permitted all forests as it is recently (Lurimuah, 2011).

In order to prevent deforestation and carry out forest management plans intended to maintain a cyclical and sustainable harvest for the production of charcoal, the government of Senegal and its international partners have launched initiatives in some previously protected areas as well as some other new areas (Wurster, 2010).

The promotion of end-use technology in Ghana has increased, particularly when it was observed that traditional wood-burning stoves had poor efficiency and produced a significant amount of smoke in the cooking environment, causing health problems, notably respiratory ailments. Despite the fact that traditional stoves cost around 20% less than contemporary stoves, it is believed that the anticipated fuel cost reductions will be sufficient to cover the cost of the new stoves. As a result, the end-use technology strategy intends to promote the use of more efficient wood-burning cook stoves (Energy Commission, 2010).

The removal of plants may never always possess negative consequences for the environment, Scholars and foresters have known for many years that coppiced stems and branches develop faster than older stems and branches, a fact that has long been exploited in European woodland management (Rackham, 2001). Compared to other land use practices like industrial logging or clearing agricultural fields, the removal of fuel wood has a significantly smaller negative impact on the environment. In general, tree-cutting that does not completely eliminate or kill trees across a vast area is unlikely to have a significant negative impact on the environment. (Rackham, 2001).

Despite the fact that many nations' reliance on fuels like charcoal and woods for cooking food will persist in the future, the extent of this reliance is jeopardized in many sections of the country due to desertification and deforestation. As a result, policymakers and policy implementers in Ghana have been extremely concerned about the production of charcoal. Aside from the financial difficulties, charcoal production adds to the continued deterioration of the natural environment through deforestation. Forest resources in Ghana are under severe stress, therefore, necessitating the consideration of the length resources control programs (Lurimuah, 2011).

The ideal approach for attaining sustainable charcoal production is regarded improved kiln type, which is in high demand, but the casamance kiln has proven to be effective. Despite the fact that improved kilns were introduced in East African countries, they still don't know much about them and continue to use traditional kilns (Mutimba, 2005). For example, 90 percent of Kenyan charcoal burners apply less efficient technology for charcoal production which is traditional kilns, and charcoal producers in neighboring Uganda were exposed to improved kilns in the 1960s but are still unknown well to this day. There could be several explanations for this. to begin with, the brick and concrete kiln are static, however charcoal is typically made using moveable kilns or built on-site for the length of production. Second, there is no enough of money to invest in a lot of improved kilns, particularly mobile metal kilns. Lastly, knowledge and expertise was required to build and run improved kilns (Mutimba, 2005).

A few African nations such as Tanzania, Malawi, Kenya, and Mauritania forbade the burning of charcoal as an energy fuel in reaction to the detrimental implications of charcoal production, but this had little effect and had the opposite effect because the charcoal was produced in secret. As a

result, it was hindering the introduction of improved charcoal production technologies. Because the use of charcoal was unaffected, the price climbed on a regular basis and remained high even after the prohibition was lifted (Andre, 2008).

(Andre, 2008) went on to say that a number of programs begun to address the issues connected with utilizing charcoal as a cooking energy by taking 3 valuable and distinguished perspectives: initially, through increasing the fire-wood offering through afforestation programs as well as sustainability of natural resource management. Furthermore, improved kiln technology is being used to increase the efficiency of charcoal manufacturing and finally, stimulating charcoal consumption through the development of fuel-efficient stoves. In Madagascar, the GREEN-MAD initiative for example strives to establish sustainability in charcoal production using a combination of measures such as forest intervention, fuel efficient stoves, and better kiln types. A project in Malawi aimed to construct a marketing system for charcoal, whilst programs across Africa, particularly in the south, emphasized on research and development techniques that could lead to the sustainability of charcoal production in various Southern African countries. In order to attain the aim of this project, it intervenes multiple standards including; Planting fast-growing trees like eucalyptus. Indigenous people are in charge of managing the plantings to ensure that consumption is sustainable. People also carried out program for managing resources which are in nature and they also expressed that there was strong desire for re-planting. A total of three thousand five hundred acres of fuel-wood trees have been planted (Andre, 2008).

A study paper from the CHAPOSA (2001) noted that it is better for any project presented to concentrate on research and creation of tactics in order to achieve sustainable charcoal production. SEI coordinated numerous universities such as Stuttgart, Lusaka, Maputo, and Dar-es-Salaam with the project "Charcoal Potential in Southern Africa" between 1998 and 2001 (Andre, 2008).

2.5 The Contribution of Charcoal Economy to Livelihoods in Somalia

Large African societies heavily rely on revenue from the sale of wood and non-timber forest products, which together make up a considerable portion of the continent's urban livelihood. Charcoal is a significant forest resource that helps millions of people in the region make a living (Ndegwa, 2016).

In Somalia, the production and export of charcoal is a pre-colonial economic activity that has long met the needs for energy in the local and regional areas as well as given many families opportunities for a living, especially those who have been affected by cyclical droughts and the loss of livestock and agricultural land (World Bank, 2020).

According to a recent study, charcoal revenue plays a significant part in the day-to-day livelihoods of rural people since it is mostly used to meet their fundamental necessities. Additionally, while charcoal revenue doesn't have a great probability of lifting people out of poverty for good, it can be a vital "gap filler," "diversification plan," or "last-resort" operations depending on other forms of income (Kiruki, 2020).

Since the collapse of the Somali state in 1991, a sizable population has turned to the production of charcoal, comprising both men and women who had lost their occupations and fled from the wars. Even those who were previously inexperienced people may succeed in this occupation since generating charcoal requires only physical power in order to cut and burn trees for charcoal (Dini, 2011). Many individuals start cutting plants/trees and converting them into charcoal due to a lack of other solid economic opportunities. The production of charcoal only takes place in rural areas; after that, it is carried to cities and towns for use in cooking and export (Ismail, 2011). The money they earn from charcoal production is used to compensate for the loss of their animals and other wealth (Dahir, 2012). In certain parts of country, charcoal is referred to as "black gold" because of the wealth it generates. As a result, the production of charcoal has become an important component of the local economy (USAID, 2014). The perception of charcoal in the economy as a whole has been dramatically altered by its new role as a valuable export product that comes in second only to livestock (Beier, 2014).

2.5.1 Somalia's environmental governance and policy

Environmental policy and legislation are ineffective and outdated. Peace is elusive, obstructing the re-establishment of institutions. Even with the establishment of the Somalia Federal Government, the country must prioritize state formation and security before any development plan. Somalia has however developed a NAPA. The last legislation on conservation of Flora and Fauna was issued before the former government before its collapse. This law saw to the conservation of the rangelands and forests by a specialized agency called the NRA. A report stated that the Siad Barre government engaged the local community in conservation and management of forests (UNEP, 1998). The country has yet to complete and adopt a constitution that will govern how the country's newly established states interact with the central government.

The following international and regional conventions influencing Somalia's forests are signed by Somalia:

Convention on International Trade in Endangered Species of Wild Fauna and Flora;

Protocol concerning Protected Areas and Wild Fauna and Flora in the Eastern Africa region;

The IGAD Environment and Natural Resources Strategy;

The IGAD Sub-Regional Action Programme to implement regional needs of the IGAD member states priorities;

United Nations Convention to Combat Desertification;

According to the UNEP report, Somalia has signed the African Convention on the Conservation of Nature and Natural Resources but yet ratification is the failure (UNEP, 2005).

2.6 Theoretical Framework

Regarding the destruction of the environment in African society, it is crucial to comprehend the tragedy of the commons. According to this theory known as the tragedy of the commons says that several individuals operating freely and rationally in their own interest shall eventually exhaust limited resources, which were shared, even when it is clear that this is not in everyone's best interests in the long run (Garrett, 1968). According to the theory, when a resource is owned in common and used by everyone, it will eventually be depleted. Trees cut down in order to produce charcoal; in this case trees are shared resources in common. In order to avoid the destruction of shared resources in common, there is a need to change human values and moral ideas. The assumption of this theory is that every person who uses shared resources in common

is motivated by self-interest. When the commons' carrying capacity is achieved, the self-seeking exploiters may be faced with the decision of whether or not to continue their operations. The benefits of exploitation are solely to them but the consequences will affect the whole community, thus they would not stop their actions. An exploiter who just cares about himself will not transform his habits since their privatized advantage will excess his share of the communized loss (Garrett, 1968). Others who make similar reasoning may do the same, and the property in common will finally be destroyed (Ostrom *et al*, 2002).

The spoiling method is split into two phases. For starters, the non-angel has benefits from the competitive advantage of following one's own interests to the detriment of others. When they see they are losing, the noble angels endeavor to seize a piece of the commons before their rivals do. It thus means that any well-functioning supply system has to handle the problem of human self-interest. A poorly administered common eventually results in catastrophe in a world of finite and limited material wealth as well as unbounded desires. The term "tragedy" is justified by its inevitability (Garrett, 1968).

The activity of charcoal producers is based on this theory. Unsustainable fuel wood exploitation for charcoal production destroys forests, which charcoal burners are aware of yet continue to do the same for selfish economic gain, despite the fact that it has far-reaching consequences. They are careless about the long-term effects of their activities. As a result, the theory is pertinent to the research because it shows how the unsustainable nature of the charcoal business originates as a result of the drive to satisfy self-interest.

2.7 Conceptual Framework

A conceptual framework is an illustration where the investigator comprehends the previous literature review to present the relationship between two or more variables graphically. The rationale of conceptualization is to assist the person who reads quickly see the projected relationship. This conceptual framework also demonstrates the link between the specified variables; the independent variables that have a direct influence on the dependent variable.

The tragedy of commons theory states that people attempt to get their interests by utilizing the naturally available limited and common resources. Rapidly increasing population leads poverty by putting more burden on the already fragile and limited resources of the environment. As result, people mostly exploit resources of forest in order to produce charcoal and they sell it so as

to make income and use as fuel. Some people generate income this way and improve their livelihoods. Forest resource exploitation is carried out in an unsustainable manner, with little regard for the future, because everyone seeks to satisfy his or her own short-term self-interest. People compete over limiting resources, which can result in resource degradation. Sustainable charcoal production will be achieved by efforts like the adoption of the cutting 1 tree and planting 2 trees concepts, diversifying of income generation, the consumption of other alternatives of energy sources like solar, also the application of modern technology. Figure 1 is a summary of the conceptual framework.

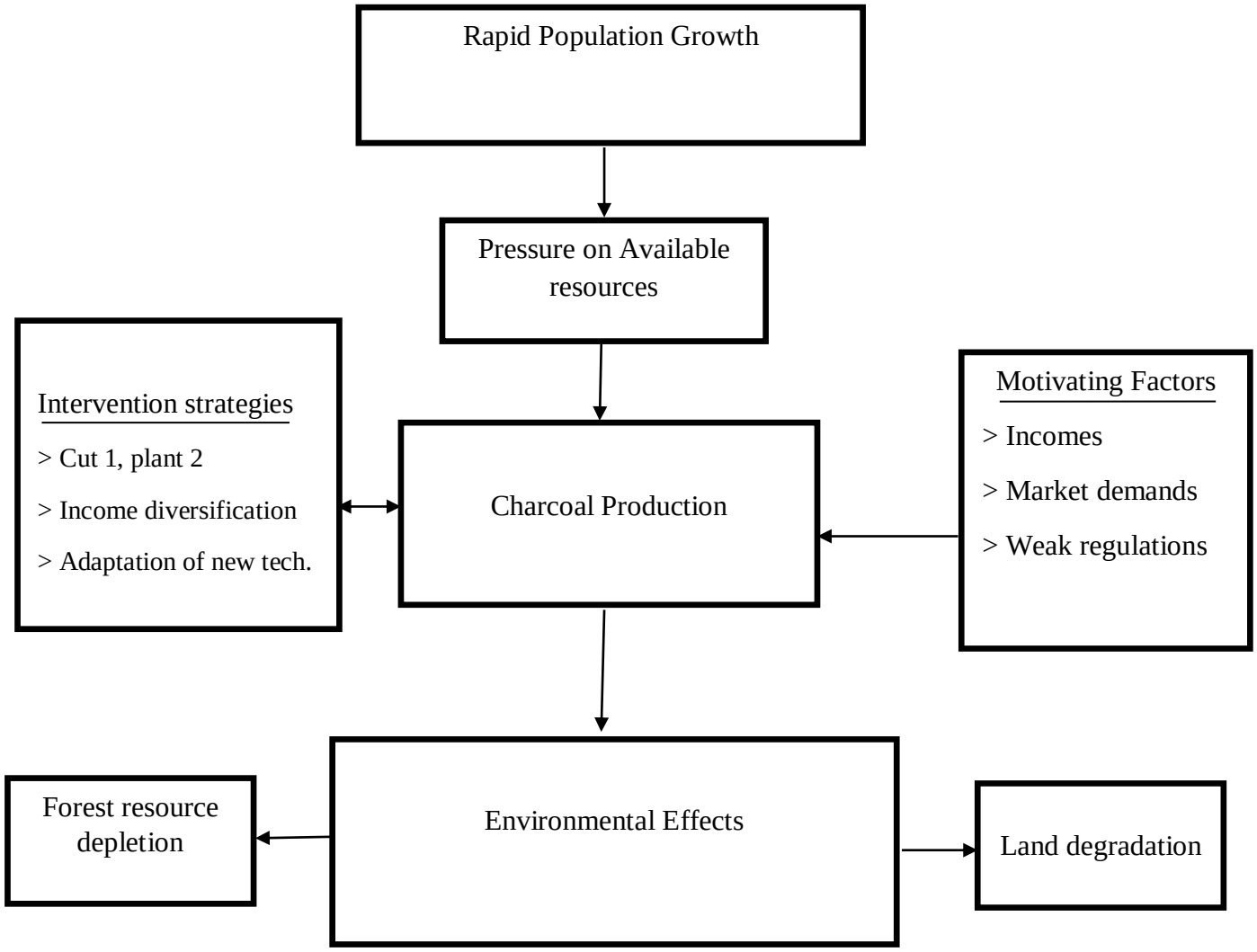


Figure 1: Conceptual Framework on Production of Charcoal

Source: Researcher, (2022)

CHAPTER THREE: RESEARCH METHODOLOGY

3.0 Introduction

Sections and tools described in this chapter were incredibly important to understand and they are; study area, research design, population of research , research tools, study sample size and sampling methods, validity and reliability of the research, data analyze methods, as well as ethical considerations.

3.1 Study Area

The researcher provided some information on the area of study in this section. This study was conducted in Somalia as the research site. It is situated at the horn of Africa and has western border with Ethiopian country, as well as the country also shares a northwestern border with Djibouti, a northern border with the Gulf of Aden, an eastern border with the Indian Ocean, and finally a southwest border with Kenya. Somalia has the largest coast line in the continent of Africa. It also has two rivers and they are Jubba and Shebelle. The total land area of Somalia is about 637,600 km^2, with 45 percent of it classified as livestock grazing rangelands, 30 percent as desert-land, 14 percent as forest, and 11 percent as arable land suitable for agriculture (Sebhat, 2014).

3.1.1 Description of the study area

In terms of weather and climate, the Lower Shebelle region experiences hot and dry weather, as well as the rest parts of Somalia. The region has a border with Juba state, on the eastern part of the region shares a border with the Indian Ocean and Mogadishu, on the north by the Middle Shebelle region, and on the west by the Bay region. The size of this region is roughly 29,761km^2 and about 40% of its area is a forestland while the other 60% is an agriculture land. This region consists of seven districts; Afgooye, Marka, Wanla Weyn, Qoryooley, Baraawe, Kuntunwaarey and Sablaale. A large stretch of Indian Ocean shoreline runs across the districts of Marka and Barawe (Farah, 2019).

The Lowlands of Lower Shebelle make up a large portion of this region and it is dominated by the Shebelle River, which gave the region its name (the Shebelle). The districts of Marka and Barawe have a long shoreline of Indian Ocean (Land info, 2014). The Afgooye district also has some Indian Ocean coastline, but the region has also some districts which are the inland districts and they are Wanla Weyn, Qoryooley, Kurtunwarey, and Sablale. The river flows approximately

parallel to the direction of coast from northeast part of Middle Shebelle to the southwest part of Middle Juba in the country. The river and the coast are around 30 kilometers apart. Although the soil fertility along the river's banks is relatively high, the area is vulnerable to extensive flooding during wet seasons. The plain and scrubland of the region's inland part, which is distant from the river, are also threatened by floods. Throughout all inland areas of the region acacia trees spread and grow very well (Land info, 2014).

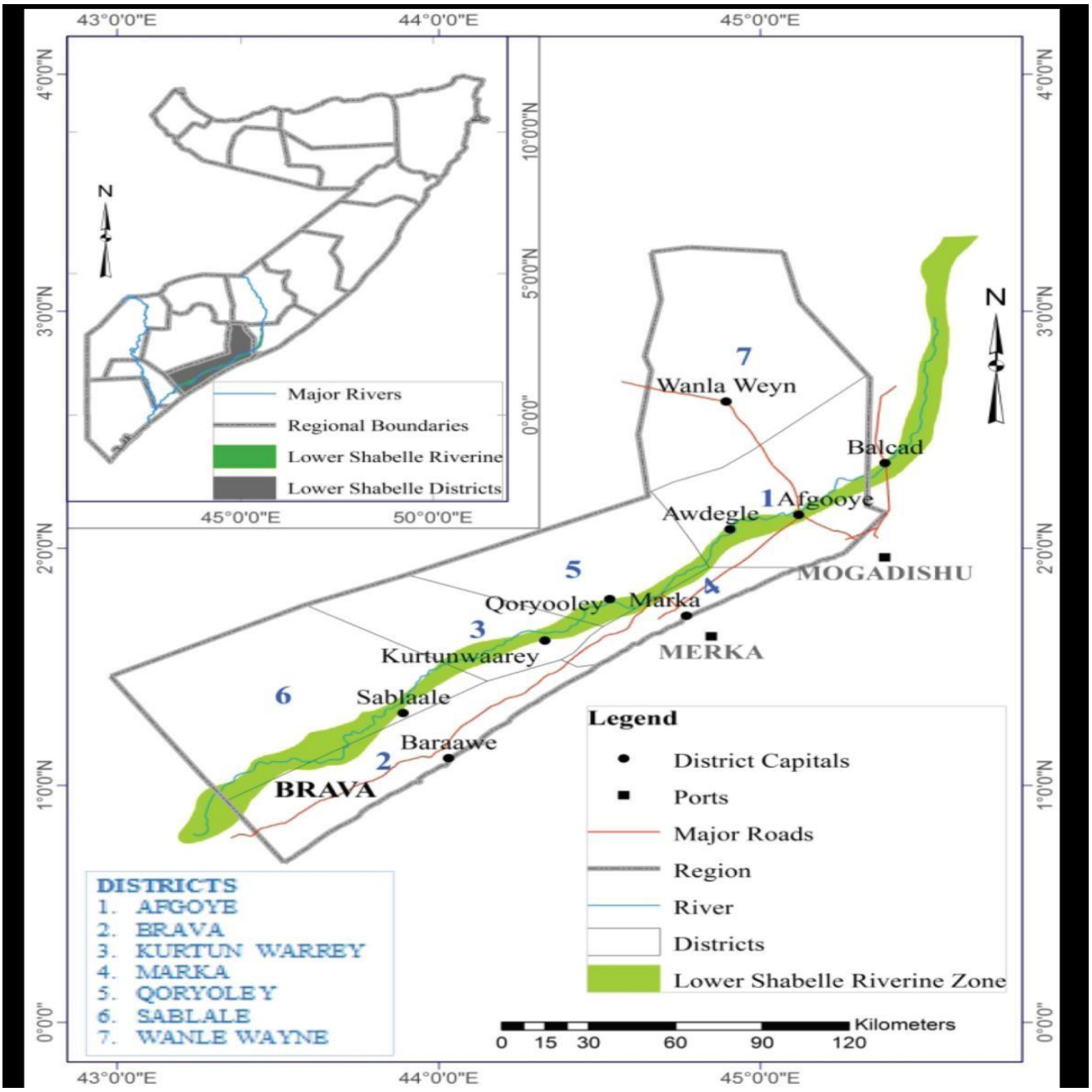


Figure 2: Lower Shebelle region Map

Source: (FSNU, 2013)

3.1.2 Size of the population of the study region

The Food Security and Nutrition Analysis Unit Somalia (FSNAU), which produces regular studies of living circumstances for the Somali population, assumes a total population of 7.5 million, with 850,651 people living in Lower Shebelle (FSNAU, 2013). Because there is no accurate census, most researches rely on the FSNAU-estimated population figures for the areas. The districts which are Wanla Weyn, Afgooye were the focus of the study and their total population figure was 367,355.

3.1.3 Climate of the study area

The majority of Somalia's areas experience the same climate occurrences. As a result, the climate in the lower Shebelle region is dry and hot all year round, similar to the other parts of the country. The annual mean temperature in the country ranges from 26 to 28°c. In terms of temperature, the coldest months are July to August with temperatures occasionally might drop below 16°c, while the warmest months are December to March and there isn't much of a degree difference between them, however inland locations have slightly higher temperatures than those along the coastline areas. The mean highest temperature per month is 35 degrees Celsius. Rainy seasons are the most defining characteristic of the climate:

- *Jilaal (winter) is the warmest season, lasting from December to March. There are no precipitation and long periods of dryness during this season.*

- *Gu (spring) is a cold season with a lot of precipitation and the longest rainy season. It begins in April and lasts through June. Due to cultivating crops and livestock production, this rainy season is extremely essential for the community of Lower Shebelle.*

- *Haggai (summer) starts from July till September, this season is the coolest season but it is also short dry season.*

- *Deyr (Autumn) is also rainy season but short lasts from October to November, the amount of rains in this season has far fewer rains than the spring.*

It is possible that there will be no rain for a few weeks during the rainy season, and it is also possible that rain will fall during the dry season. Spring is the most vital season of all, as farmers and pastoralists begin cultivating crops and raising livestock due to direct rain dependency. The amount of rain that falls might be vary significantly over a number of successive years, as a result of that, it may have dangerous consequences for both human population and animals. The

Shebelle River dries up for a period of time, making winter the most challenging season for the entire people live in the region (Land info, 2014).

3.1.4 Livelihoods of the study area

Lower Shebelle is a more productive region of Somalia, and it is one of the regions with the highest fertility soil. As a result, the people of this region produce food as a means of livelihood and it is also the main source of income. The area's agricultural production can be divided into two categories: commercial farming and subsistence farming. The production area of the region runs parallel to the Shebelle River. The region's most distinguishing characteristic is its vast irrigation system, which includes enormous canals and dams used to irrigate both types of agricultural lands. In addition to natural precipitation such as rainfall, the region's food production system is viable all year. Mango, maize, bananas, and sesame are among the region's most frequent crops. In various portions of the region, durra and coconut are also produced as crops. Pastoralism and charcoal production are the most common way of life in the inland portions of the Lower Shebelle adjacent bay region, as well as in the south west part of it. In the coastal cities of Marka and Barawe, which make up the region's coastal areas, fishing and trading are the two main modes of life (Land info, 2014). In general, people who live in lower Shebelle region engage in economic activities such as farming, fishing, charcoal production and pastoralism.

3.2 Study Design

A study design may be defined as the framework within which data is gathered and analyzed (Bryman, 2008). The cross-sectional design was used in this study to measure effects of charcoal production on environment. Due to the its suitability, this design was chosen and it enabled for the collection of data from a wide population at a single point of time. Therefore, it was economic and flexible. A careful inspection of the research questions indicates that the design selection was sound due to the pattern of relationships between and among the important variables which were investigated. Cross-sectional data on a sample of charcoal producers was gathered in two districts.

3.3 Research Population

This study's target population was households (especially charcoal producers) in the lower Shebelle region, specifically two districts chosen purposively for their ability to produce more charcoal than other districts and the availability of good plant species for charcoal production. The districts have a total population of 367,355 and 44,858 households (FSNU, 2013).

3.3.1 Determination of sample size and selection of sample size

Two districts were chosen purposively as sample due to the large quantity of charcoal produced than other districts of the region in order to determine 384 respondents from sample districts. Using a simple random sampling approach, sample households of charcoal producers from the two districts were chosen based on a sample frame that was adopted from the respective administrations. The possibility of any respondents being chosen for the research was the same for all of them. So, respondents of charcoal producers took part in the survey. The sample size for this study was determined using the Cochrane formula, which is shown below,

$$n = \frac{Z^2\, pq}{d^2}$$

where p is denoted the anticipated proportion of the target population that possesses the traits being measured, n is also denoted the sample size which is required, Z^2 is the 95 percent confidence interval, which is 1.96, and q = 1-p is the percentage of the target population that does not exhibit the characteristics being measured and its statistical significance level expressed as a percentage, d (standard value of 0.05). Fisher *et al* suggested that 50% of the population be utilized because there was no prior information in the study on the number of charcoal producers in the region. The sample size will be calculated using the following formulas with a confidence level of 95% and an error rate of 5%:

$$n = \frac{(1.96)^2\,(0.5)(0.5)}{(0.5)^2} = 384 \quad \text{.....EQN (1)}$$

Table 1: Sample size and population of each sample districts

Sample Districts	Population of Districts	Estimated Households	Sample Size
Afgooye	211,712	26,348	239
Wanla-weyn	155,643	18,510	145
Total	367,355	44,858	384

Source: Researcher (2022)

According to the table 1, Afgooye which is the most populous and productive district in terms of charcoal production was allocated 62% of households (charcoal producers) to be interviewed out of 384 households' equivalent to 235 households of charcoal producers. Wanla-Weyn is a second largest producer of charcoal, as well as out of 384 households of charcoal producers, 38 % were chosen to be questioned, equating to 149 households (charcoal producers).

3.4 Data collection

Both primary and secondary sources were used to gather data for this project. After physically paying a visit to the field and interacting with the participants, the primary sources of data were acquired via questionnaires from households (especially producers) as a face-to-face interview. Also, acquired data through observation complemented questionnaire data. Secondary data was obtained from books, journals, magazines. In other words, secondary data was collected through desktop review.

3.4.1 Questionnaire

A household survey for the charcoal producers was administered. Questionnaire was used to capture data. It was in the form of closed and open questions which met the objectives and topic of the research. The questionnaire was administered with the help of enumerators. During data collection, close supervision to the enumerators was done to ensure quality data was collected throughout the study.

3.4.2 Observation

The observation technique was also being used to acquire data that needs to be recorded immediately and to serve as a backup for information that was absent from the questionnaire. The tool was also used to observe technologies adopted to produce charcoal and how different tree species were harvested within the study area.

3.5 Data Analysis

Data cross-checking was done after the data collection activity to identify likely errors before data entering. The raw data was coded in the appropriate way. The date then entered into (SPSS) and cleaned before being analyzed. Finally, it was analyzed using the descriptive data analysis technique and literary analysis. Descriptive statistics were used to determine frequency. The answers were calculated using descriptive analyses and displayed in tables, charts and texts and the results were then used to draw suitable deductions and conclusions.

3.6 Ethical Consideration

Before administrating questionnaires, the researcher asked permission to the relevant authorities of the districts. The research subjects were chosen at random and given crucial information about the study's goals. The Participants of the study gave their informed consent and chose to take part in the study on their own. A true identity of the study participants was kept hidden throughout. The information gathered would be kept confidential, according to the study participants.

CHAPTER FOUR: RESULTS AND DISCUSSIONS

4.0 Introduction

All of the discussions as well as all of the findings of this project were presented in the sections of this chapter. Therefore, it was focused on the analysis of data, presentation of data, and interpretation of data which were acquired during the time of research using various insights.

4.1 Preliminary Demographic Data of Respondents

The first section contains the basic and relevant information on the respondents who took part in the study. Therefore, the primary goal of this basic data was to identify profile of respondents and to demonstrate or show the demographic dispersion of the study.

4.1.1 Gender of the respondents

Table 2: Gender distribution of respondents

Sex	Frequency	Percent
Male	246	64.1
Female	138	35.9
Total	384	100

Source: Field data, (2022)

The sex of the respondents was taken into account in this study. As a result, according to table 2, 64% of the respondents who participated the study were male, while the female number of participants who also took part in the study was only 36%. This indicated that there was a significant gap between genders in gathering data. However, the views of both genders were represented properly. This difference in percentages of gender highlights that male gender outnumber female in the charcoal production industry due to physical energy required to cut down and burn trees to make charcoal.

4.1.2 Age of respondents

Table 3: Age of respondents

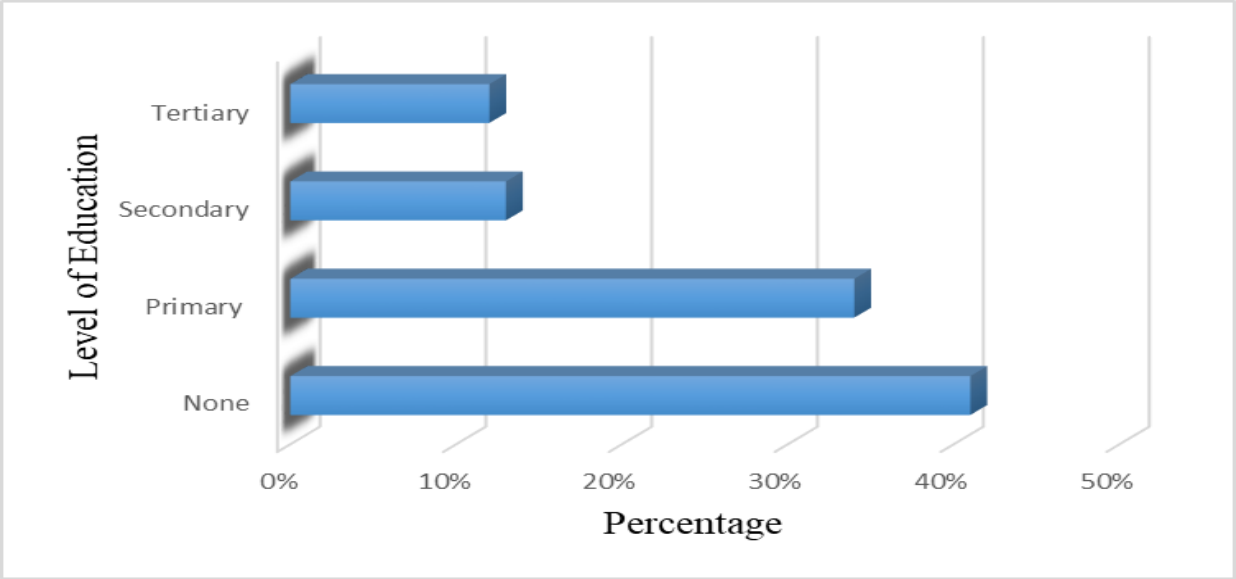
Age	Frequency	Percent
Less than 35 yrs.	218	56.7
Between 35-45 yrs.	90	23.5
More than 45 yrs.	76	19.8
Total	**384**	**100**

Source: Field data, (2022)

The study looked at the age of the respondents as well. As presented in table 3, it was identified that individuals whose ages were less than 35 years had the greatest percentage of (61%) indicating that this age group was becoming increasingly involved in the production of charcoal at a greater rate than other age groups in the study region, and then followed by those individuals between the age group of 35 and 45, with a percent rate score of (23%), and finally the smallest group in number were those of the age above 45 years of age with a percentage score of (16%). The second group, whose ages ranged from 35 to 45, had the necessary abilities and experience, and due to that, the youth, especially the young males, were expanding their charcoal-burning activities. As a result of the lack of alternative sources of income to improve their livelihood and that of their families, middle-aged adults in the study area had a greater effect on the environment than others.

4.1.3 Educational level of respondents

Figure 3: Educational level of respondents



Source: Field data, (2022)

The educational level of the people involved in charcoal production was also taken into account in the survey and as indicated in figure 3. 41% of the respondents have no education in any form and were the majority group, 34% of the respondents attained primary education and were second highest respondent group in percentage, 13% of the respondents acquired secondary level of education and only 12% of the respondents had tertiary education and this group were the highest in education level. This implies that large portion of charcoal production in the study area were caused by lower levels of education or lack of education, and that lower levels of education were caused by the area's isolation and distance from the service center, as well as the government's inability to provide education services. It also suggests that the vast majority of responders lacked the ability to comprehend questions in the questionnaire. As a result, we used a questionnaire similar to a personnel interview.

4.2 Factors Motivating Charcoal Production Activities

4.2.1 Source of employment

Table 4: Sources of Employment

Involvement time	Frequency	Percent
More than 10 yrs.	184	48
Between 5-10 yrs.	115	30
Less than 5 yrs.	83	22
Total	**384**	**100**

Source: Field data, (2022)

As shown in table 4, 48 percent of charcoal producers have been involved in the charcoal industry for more than 10 years; this group has devoted more than ten years of their lives to produce charcoal, illustrating their long-term connection to the industry and how they relied on it as an employment. While 30% of them have also been involved in active charcoal burning for 5-10 years, only 22% of them mentioned that they have been involved in the production of charcoal in the five years. This implies that, in the last centuries charcoal was produced illegally in the study area and motivated many individuals to seek work as well as attracting many others who weren't involved in it.

4.2.2 Sources of livelihoods

Table 5: Sources of livelihoods

Sources of Livelihood	Frequency	Percent
None	209	54
Livestock	74	19
Farm	64	17
Mixed livestock and farm	37	10
Total	**384**	**100**

Source: Field data, (2022)

As indicated to a table 5, 54% of the charcoal producers didn't have other means of living besides charcoal production, 19% of them had some livestock, and 17% of the respondents had crop farms while only 10% had mixed crop farm and livestock. Therefore, the primary motivation for charcoal production, according to many respondents, was lack of better economic opportunities or alternatives and also to meet domestic needs. As result, they depended directly or indirectly on natural resources (trees) for charcoal production and they cut down trees to transform them into charcoal particularly after their livestock died or crops failed due to the drought. Their actions for charcoal production resulted environmental damage.

4.2.3 Competitive charcoal price

Table 6: Competitive charcoal price

Charcoal Price ($)	Frequency	Percent
$10/bag	87	23
$13/bag	196	51
$15/bag	101	26
Total	**384**	**100**

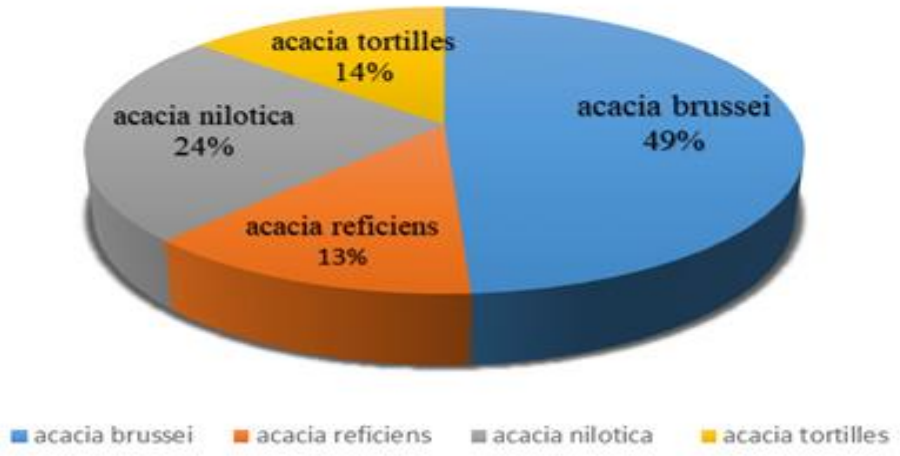
Source: Field data, (2022)

Table 6 represents charcoal price in terms of a bag or sack, which is the most common measurement instrument in the area. Charcoal prices, on the other hand, vary relying on where you buy it, whether it's at home or at the market, as well as supply and demand considerations. As a result, it was determined that buying charcoal at the production site and at home was less expensive than purchasing from market locations. The study also found that the cheapest charcoal cost was $10, while the most expensive cost was $15 and the average price of one sack of charcoal was $13, as most people preferred to buy or sell charcoal at this price. As a result, the price of charcoal was not constant and often varies, but regardless of whether they sell at the lowest or highest price, they earn a substantial amount of money with which they can support

themselves, and that was the reason why majority of the interviewed people were involved in the charcoal industry.

4.2.4 Market demand and absent regulatory framework for charcoal

Figure 4: Charcoal tree preference for market demand



Source: Field data, (2022)

The market has shown a great preference for charcoal produced from the acacia tree. Local trees were used to make charcoal in the area of study and the charcoal producers from the area had strong preferences of Acacia Bussei for charcoal (49%) which is known in Somalia as Qurac. This is due to the superior quality of the charcoal made from Acacia Bussei. Therefore, it was more preferred than other species and became a high target for producers. They have also exploited demand and good prices on the international/local market and a weak or absent regulatory framework for charcoal production in Somalia to build lucrative charcoal businesses and rake in astronomical profits. Others species preferred for charcoal production due to their high market demand were Acacia Nilotica (24%), Acacia Tortilles 14% and Acacia Reficiens 13% respectively. These trees were also used to feed and shade different animals including goats, lambs, calves, and donkeys and as well as being utilized in housing.

Plate 1: kiln type for charcoal production

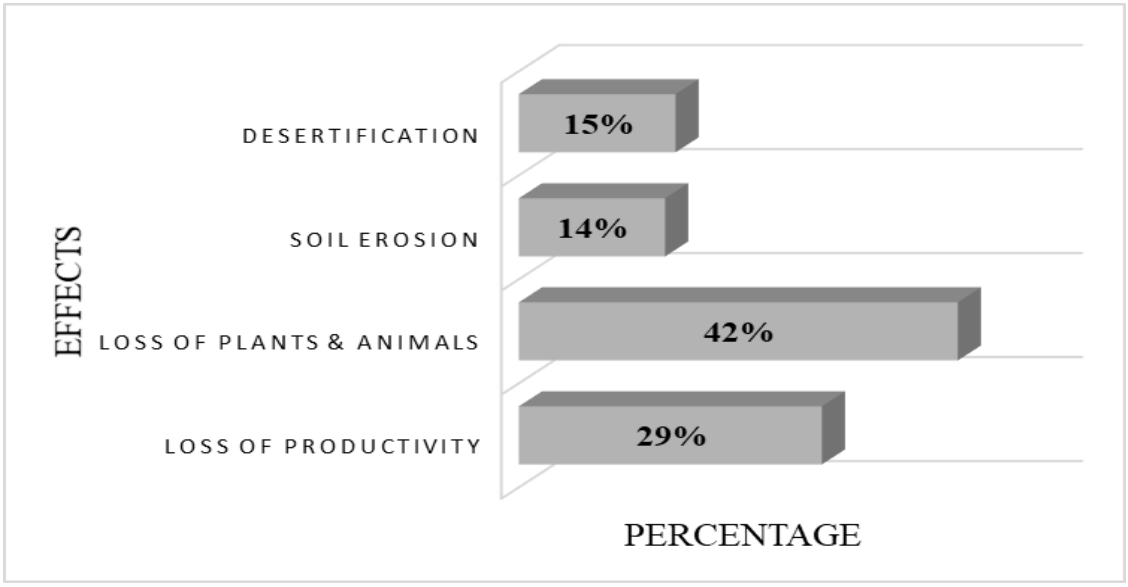
Source: Field data, (2022)

In the study area, Traditional earth mound kiln was the most common technology applied to produce charcoal although it has very low efficiency when compared to improved kilns (plate 1). The majority of producers mentioned that they were familiar with this type of technology because it has been utilized for a very long period. They also stated that they do not receive government training on new charcoal making technology and best practices for the purpose of ensuring the long-term sustainability of their industry. They said that the charcoal industry is self-sustaining and that the government's role only is to collect money in the form of taxes. Furthermore, almost all of the producers surveyed in the study area stated that they applied the traditional earth kiln technique for making charcoal. They indicated that they had adopted it and that they were not interested in improved charcoal production due to the required expertise, competence, and greater production costs. It means that the procedure was inefficient, that a substantial amount of wood was lost, and the charcoal produced was of poor quality. It also posed a hazard to the environment, particularly the soil surface, because it required a large amount of wood for charcoal, resulting in mass tree cutting and the production of smoke.

4.3 Effects of Charcoal Production on Environment

4.3.1 Negative effects of charcoal

Figure 5: Negative effects of charcoal



Source: Field data, (2022)

In accordance with the outcomes depicted in figure 5, one of the worst impacts of charcoal production on the environment was a 29% decrease in soil productivity and/or loss of soil fertility due to the soil erosion as the soils were constantly exposed to erosive forces. Other plant species, particularly the grasses in the area, have subsequently grown poorly as a result of this.

Deforestation also resulted in a 26% loss of plant and animal species, which was clearly demonstrated by the decline in the number of acacia tree species, which has forced people to sometimes cut down other tree species that were present in order to see if they produce high charcoal yields after burning like the Acacia. A few wild animals have also been compelled to move to new habitats, and what's worse was local residents have been relentlessly hunting the animals, which has resulted in their extinction.

13% of the negative effects were attributable to soil erosion, which was mostly caused by the soils being exposed to agents that cause soil erosion. Loss of soil nutrients resulted in decreased crop yields and the growth of other savannah plants. As a result of deforestation causing drought and subsequent desert-like conditions marked by protracted dry spells, excessive wind, low

vegetation cover, and little rainfall. some respondents identified desertification as another negative effect of drought, ranking at 9%. This has caused the region to be a semi-desert.

4.3.2 Causes of deforestation

Table 7: Causes of forest degradation

Causes	Frequency	Percent
Farm Clearance	103	26.6
Charcoal Production	221	57.6
Settlement	61	15.8
Total	**384**	**100**

Source: Field data, (2022)

According to table 7, charcoal production (57.6%) was the first negative cause of deforestation in the study area. Farm clearance (26.6%), after charcoal production (57.6%), was the second biggest cause of deforestation. The demand for huge farms due to the agricultural activities had increased in the recent past and it was one of the key forces driving the destruction of forest cover and its decline in the region. Another aspect that contributes to deforestation was settlement (15.8%). Some respondents claimed that salinization occurred as a result of deforestation, as well as other reasons such as drought and desertification, because insufficient rainfall exposed soil salts to the surface soil, making agricultural and other plant growth difficult. Therefore, crop plants start to fail or reduce their production. 78 percent of charcoal producers have limited awareness of the effects of their action to the forest status/cover. Only 22% believe that charcoal production activities were a major contributor of land degradation of their area.

4.3.3 Positive effects of charcoal production

Table 8: Positive effects of charcoal production

Positive Effects	Frequency	Percent
Employment/source of income	208	54
Source of energy	176	46
Total	**384**	**100**

Source: Field data, (2022)

In terms of positive effects of charcoal production, many people relied on and benefited from the charcoal industry. The industry allowed and assisted these people in obtaining fundamental necessities for their survival and most of the respondents (54%) considered charcoal production as source of income or employment, Therefore, charcoal industry provided employment and revenue to charcoal producers in the study region and they spend the money they make from the charcoal industry on other things like farming and animal raising. Other parts of the respondents (46%) identified that charcoal production as source of energy which was essential for cooking. It means that charcoal production has tangible advantages for them as a society and that it provided them with employment as temporary labor and it was energy source for a variety of household tasks such as cooking, ironing clothes and boiling water. Because of the charcoal money, people were also able to their livelihoods by buying consumer items such as food, clothing, and educational essentials for kids and hospital expenditures and improved their overall livelihoods.

4.4 Measures Put in Place to Ensure Proper Management of Vegetation

4.4.1 Measures put in place to regulate charcoal production

Table 9: Measures in place to control the production of charcoal

Measures	Frequency	Percent
Anti-charcoal burning forces	32	8
Monitoring and evaluation	24	6
Community sensitization	54	14
Strict rules and regulations, policies and laws	41	10
Implementation of laws	35	9
Infrastructural development	16	4
Training and skills	36	12
Microfinance institutions	33	8
Diversification of economic activities	113	29
Total	**384**	**100**

Source: Field data, (2022)

According to Table 9 above, the diversification of economic activities at 29% resulted in the creation of jobs and chances for employment, which was a good strategy to control the production of charcoal as unemployment was seen as the main driver of charcoal production. A substantial part of raising knowledge of the negative effects of charcoal manufacturing on vegetation has been community sensitization (14% of the total). In order to help the local population, increase their economic options and prospects and reduce their heavy dependency on trees for the production of charcoal, training and skills development at a rate of 12% has proven to be a successful technique. Among the stringent rules, regulations, policies, and laws that have been put into place was a prohibition on the production of charcoal by the local authority in the area. However, the majority of respondents were not consulted, notified, or made aware of these regulations, which resulted in a low and challenging implementation rate of 9% by the local community and enforcement authorities.

To aid in the implementation of the laws and ordinances, local leaders have also created watchdog organizations to prevent charcoal burning called as the Local Anti-Charcoal Burning Forces at 8%. Furthermore, microfinance institutions are being built at a rate of 8% to ensure the provision of financial services to the local population, including the provision of small loans to help local firms and, on occasion, the distribution of government money for modest projects.

6% monitoring and evaluation has contributed to the preservation of certain trees and other resources in the area, but it has not yet been entirely completed, indicating that the majority of the actions implemented are not being watched and evaluated to determine how they affect the local population. The 4% share of infrastructure development indicates that in order to meet the demands of the people, additional infrastructures, such as hospitals, adequate roads for easy accessibility, and schools, among others, must be constructed to complement the existing ones. Because locals won't need to spend a lot of money to use these services, there will be less widespread deforestation for the burning of charcoal.

CHAPTER FIVE: FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

The researcher's main emphasis in this chapter is on the findings and conclusions of the study, as well as providing recommendations that link to the investigation.

5.1 Findings

The traditional method of charcoal making was used extensively in the study area (earth mound kiln). This method affects top layer of the soil due to digging and burning in the process of charcoal production. It also harms re-vegetation because plants take several years to recover on a deserted kiln site. According to the study, charcoal manufacturing in the study area is not viable. Charcoal producers adhered to traditional earth mound kilns and they didn't have appetite to advanced kiln technologies for charcoal production. They believed that no need for replanting trees due to natural regeneration of trees (plate 1).

Charcoal producers preferred to make charcoal from local native tree species in the study area. Acacia trees were mostly used to make charcoal and the charcoal produces from this plant species had more quality than others but current rate of massive destruction of this plant species may result in its extinction in the near future (figure 4). Acacia bussei trees were very relevant for the life of some pastoral community due to offering shade for their animal herds which include goats, sheep, cattle, and donkeys. Acacia reficiens, Acacia nilotica, and Acacia tortilles were among the other trees targeted by charcoal producers.

The research furthermore looked at the advantages of charcoal production for local communities especially charcoal producers. According to the study findings, the vast majority of charcoal producers were motivated to engage in charcoal producing activities for the cash they earn and high market demand. They regard charcoal manufacturing to be a source of income or job since it helps them to obtain basic essentials for survival. This study found out that the cost of one sack of charcoal was on average $13 per bag when it is sold. This charcoal money enabled charcoal dealers to afford consumer goods such as food, clothing, educational essentials for children, and healthcare expenses.

Charcoal production has resulted to a number of negative effects including; desertification, loss of animals & plants, soil erosion and loss of soil productivity (Table 9). A number of significant

native plants are rapidly vanishing due to the production of charcoal; farm clearing and settlement activities which are the major causes contributing to the loss of native tree cover and vegetation damage depicted in Table 7.

Therefore, the study found that charcoal production is a major cause of environmental degradation in the study area and that diversification of economic activities was the most effective measure for regulating charcoal production; however, there are other strategies in place to regulate charcoal production, such as training and skills, strict rules, regulations, policies, and laws, and finally implementation.

5.2 Conclusion

According to the study, residents did not regard charcoal production as a threat to the environment, and hence drive to burn charcoal. Charcoal burning was primarily caused by unemployment, and illiteracy. The present study found that environmental deterioration has occurred from the massive exploitation of native species of plants to promote charcoal production. The financial gains and high market demand inspire charcoal producers to continue being involved in this industry. Furthermore, unrestrained native species wood cutting without matching replacement measures reduces plant cover's ability to provide pasture, mitigate soil erosion, and meet the community's and animals' energy demands. As a result, human suffering is alleviated.

The loss of vegetative cover will have rapid and negative effects for ecological equilibrium and species survival. Animal species will be endangered as a result of the ongoing loss of wildlife habitats, the lowering of natural forest cover, and the resulting destruction of tree species. The traditional earth mound kiln, which is inefficient, has been adopted by producers of charcoal in the area of study and as a result of this practice; the charcoal industry has become unsustainable. Effects of charcoal production on plants will be reduced while economic gains from the industry are increased if proper charcoal rules and regulations are implemented and forest resources are used in a controlled manner. Individuals entering into the production of charcoal, which could have major environmental implications, will be minimized if good unemployment solutions are developed and alternative income sources (farming, fishing and pastoralism) are increased in the area of study.

5.3 Recommendations

Following are some recommendations that have been made in light of the study findings:

i. To intervene existing charcoal production technologies such as traditional ones (earth mound kiln) and adopt in to improved charcoal production technologies which are more efficient (Drum kiln & improved earth kiln).

ii. To help the charcoal burners and other people make a living, trainings on how to run small-scale income-generating businesses should be given to them. This implies that people will no longer burn charcoal in order to make a living, but rather will participate in these income-generating activities.

iii. To establish voluntary best practices aimed at mitigating the negative effects of charcoal production.

iv. Community awareness is a critical component of preventing environmental deterioration and rangeland loss.

v. Using biogas as a substitute to charcoal as a source of energy.

5.4 Areas for Further Studies

1. It is recommended that further studies on the health implications of charcoal production, particularly using traditional technologies, should be conducted in each of the selected districts to determine the extent to which charcoal production can be harmful to the producers and reduce their overall quality of life.
2. It is also recommended that more research into the applicability of modern improved charcoal production technology, particularly on a small scale, should be conducted.

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APPENDICES

APPENDIX 1: LETTER OF INTRODUCTION

Dear respondent,

RE: COLLECTION OF DATA

I'm a student at the University of Nairobi, and my name is Said Mohamed Abdi. At the Department of Geography, Population and Environmental Studies at the University of Nairobi, I'm pursuing toward a Master of Arts degree in environmental planning and management. It is a requirement for me to submit a project for a Master's degree award. The topic of my study is "Effects of Charcoal Production on Environment in Lower Shebelle Region, Somalia." I sincerely ask that you help me fill out the questionnaire that is provided below as a consequence. Please complete the following questionnaire and answer all of the questions.

The findings of the study will be exclusively utilized for academic reasons and will also be handled correctly. Your help will be much appreciated.

your faithfully,

Said Mohamed Abdi

APPENDIX 2: HOUSEHOLD QUESTIONNIARE

The goal of this questionnaire is to collect data on your views about effects of charcoal production on the environment; The answers you have provided will only be used for academic purposes. All of responses will be much grateful.

I. Household Characteristic Information

1. What are the characteristics of this household head? Please tick (✓) the boxes appropriately.

<table>
<tr><th>Gender</th><th colspan="2">Age</th><th>Education level</th></tr>
<tr><td rowspan="2">Male ( )</td><td colspan="2" rowspan="2"><35 ( )</td><td>None ( )</td></tr>
<tr><td>primary ( )</td></tr>
<tr><td rowspan="2">Female ( )</td><td rowspan="2">35-45 ( )</td><td rowspan="2">> 46 ( )</td><td>Secondary ( )</td></tr>
<tr><td>Tertiary ( )</td></tr>
</table>

2. What is the length of time that you have been producing charcoal?

a) last 5 years ( ) b) last 10 years ( ) c) more than years ( )

II. Sources of Charcoal Production Material

1. Do you make a living through any other ways except making charcoal?

a) No ( ) b) if yes ( ), mention…….

2. Which kinds of trees do you prefer to use for making charcoal?

a) Acacia brussei/Galool ( ) b) Acacia reficiens/Qansax ( ) c) Acacia nilotica/Maraay ( )

d) Acacia tortilles/Qurac ( )

3. What method of charcoal production do you often use?

a) Metal kiln ( ) b) Pit kiln ( ) c) Traditional Earth mound kiln ( )

III. Charcoal Production Welfare Issues

1. How many sacks do you make in a single production?

a) 1-15 sacks ( ) b) 16-25 sacks ( ) c) above 26 sacks ( )

2. What price do you sell per sack?

a) $10 ( ) b) $13 ( ) c) $15 ( ) d) > $15

give details of your answer…….....

IV. Effects of Charcoal Production On the Environment

1. Do you think that charcoal burning may reduce forest cover?

a) Yes ( ) b) No ( )

2. Which do you think is the most severe cause of deforestation in your area?

a. Settlement ( ) b. Farm clearance ( ) c. Charcoal production ( )

3. What are negative effects of charcoal production experienced in your area?

a) Soil erosion ( ) b) Loss of plants & animals ( ) c) Desertification ( )

if there are others, mention kindly

……..

4. What are some of the positive effects of charcoal production on you and the Somali people?

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V. Measures Put in Place to Ensure Proper Management of Vegetation

1. Do you believe that enough has been done by the government to control the manufacturing of charcoal?

a. Yes ( ) b) No ( )

Give reasons for your answer

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2. Which measures have been put in place to assure that charcoal is produced properly in your area?

……

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3. What other solutions would you suggest to be implemented by the government?

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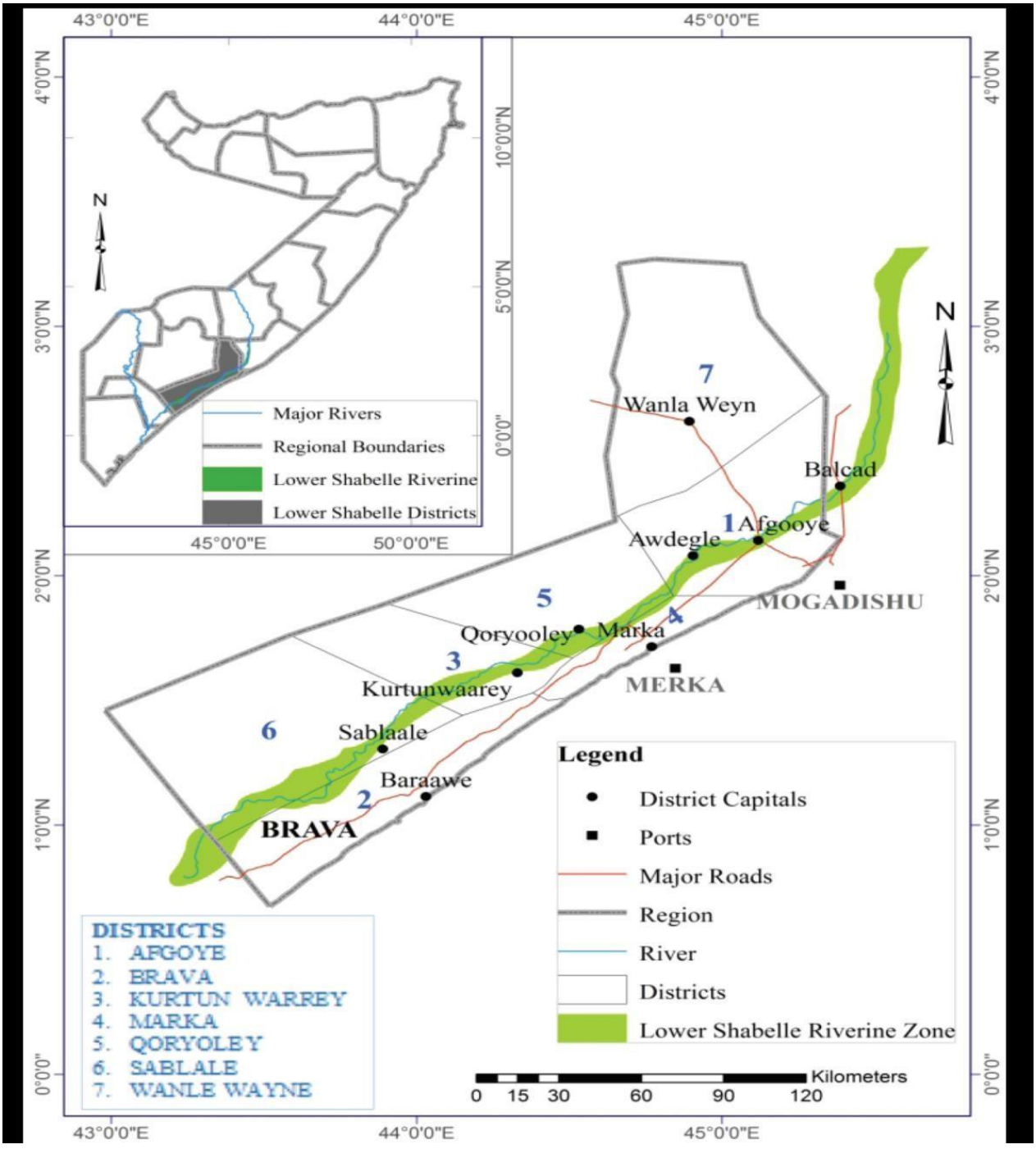
Thank you very much

APPENDIX 3: OBSERVATION GUIDE

Brief description on the following

Items	Description
Predominant kiln in sure	
Nature of tree harvesting	
Technology adopted to produce charcoal	

APPENDIX 4: STUDY AREA MAP



FIELD WORK