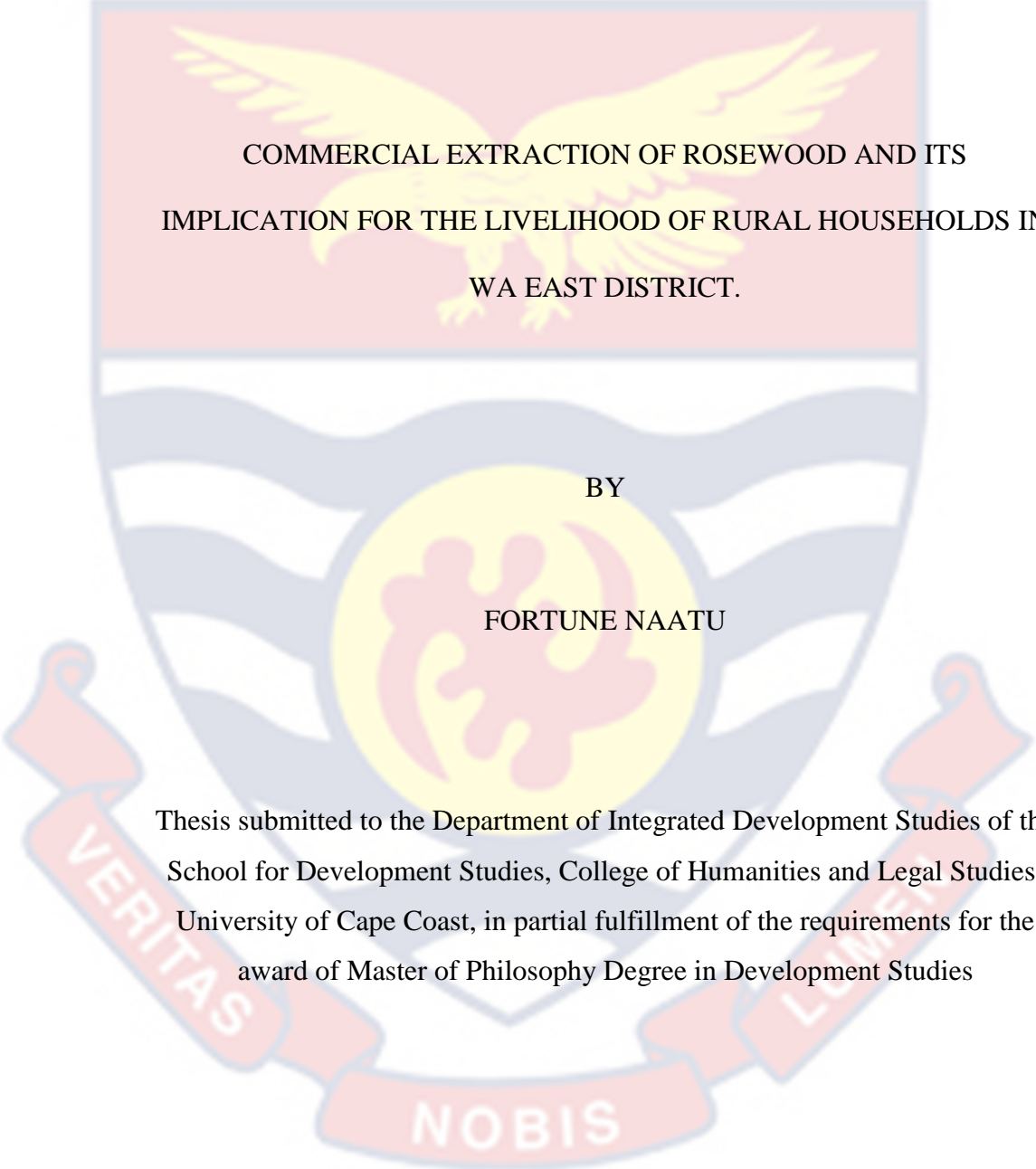


UNIVERSITY OF CAPE COAST



COMMERCIAL EXTRACTION OF ROSEWOOD AND ITS
IMPLICATION FOR THE LIVELIHOOD OF RURAL HOUSEHOLDS IN
WA EAST DISTRICT.

BY

FORTUNE NAATU

Thesis submitted to the Department of Integrated Development Studies of the
School for Development Studies, College of Humanities and Legal Studies,
University of Cape Coast, in partial fulfillment of the requirements for the
award of Master of Philosophy Degree in Development Studies

JANUARY 2023

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original research and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature..... Date:

Name:

Supervisors' Declaration

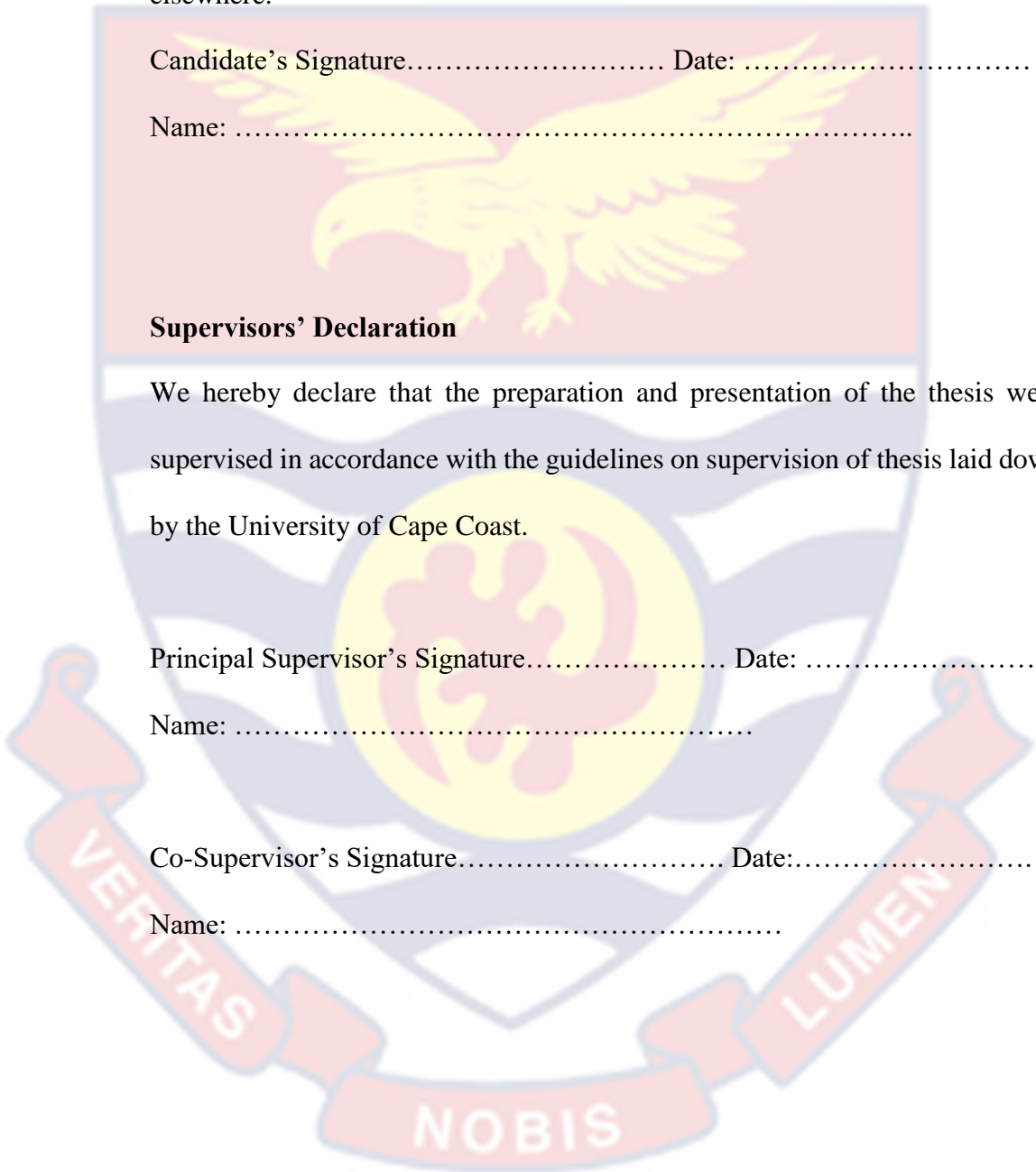
We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

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ABSTRACT

Rosewood, one of Ghana's ten most important timber species, is endangered and may become extinct as a result of selective and excessive harvesting. This, however, has consequences for the environment as well as rural livelihoods. In this case, the study looked at how commercial rosewood extraction affects rural communities in the Wa East District. To gather data, the researcher used purposive sampling for the chiefs, land owners, assembly members and Forestry Commission officials while the simple random sampling was used to select household respondents. Three hundred and twenty one respondents took part, and data was collected qualitatively and quantitatively utilizing an interview schedule literature guide. In order to analyze the quantitative data, descriptive statistics were used. Thematic analysis was also utilized to analyse the qualitative data and find themes that needed to be investigated further. This study discovered that over the years, Wa East populations have been subjected to extensive commercial rosewood exploitation, particularly by the Chinese resulting in the near-extinction of rosewood. Furthermore, the study found that livelihoods of rural folks included farming, livestock rearing and charcoal sellers. Therefore, this has had an impact on the environment, which has ramifications for rural livelihoods because several rural people's survival is linked to their environment basically, poverty is worsening, resulting in environmental degradation. It is recommended that the Forestry Commission should collaborate with the traditional authorities to begin a replanting and sensitization project to educate the rural residents about the value of rosewood.

KEY WORDS

Deforestation

Environmental degradation

Environment

Extraction

Implications

Livelihood

Rosewood

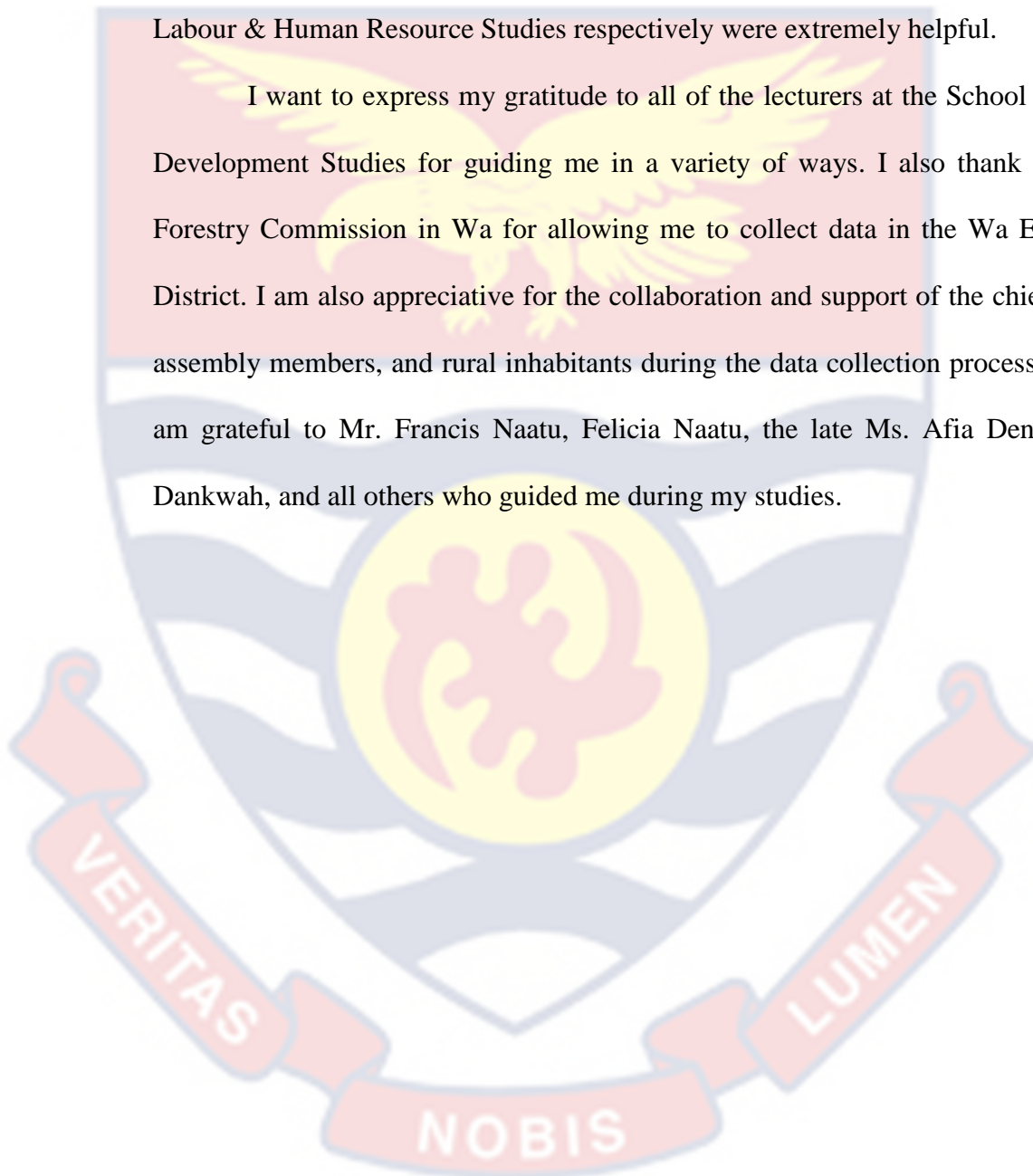
Wa East



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DEDICATION

To my parents, also my son, Ian Guyir



TABLE OF CONTENTS

	Page
DECLARATION	ii
ABSTRACT	iii
KEY WORDS	iv
ACKNOWLEDGEMENTS	v
DEDICATION	vi
TABLE OF CONTENTS	vii
LIST OF TABLES	x
LIST OF FIGURES	xi
LIST OF PLATES	xii
LIST OF ABBREVIATIONS	xiii
CHAPTER ONE: INTRODUCTION	
Background to the Study	1
Problem Statement	6
Research Objectives	7
Research Questions	7
The Significance of the Study	8
Delimitations	8
The Organization of the Study	9
CHAPTER TWO: REVIEW OF LITERATURE	
Introduction	10
Theoretical Review	10
Common Pool Resource Theory	11
The Theory of Ecological Value Capture	13
Forest Resilience Theory (FRT)	16

Conceptual Review	20
Rosewood	20
Commercial Extraction of Rosewood	22
Illegal Logging	26
Effects of Commercial Extraction of Rosewood on the Environment	29
Livelihood	32
Effects of the Commercial Extraction of Rosewood on Livelihoods	35
Empirical Review	37
Lessons Learnt	44
Conceptual Framework	45
CHAPTER THREE: RESEARCH METHODOLOGY	
Introduction	49
Study Area	49
Philosophy of Research	51
Research Design	53
Target Population	54
Sample and Sampling Procedure	55
Data Collection	56
Instruments Design	59
Data Processing and Analysis	60
Chapter Summary	60
CHAPTER FOUR: RESULTS AND DISCUSSIONS	
Introduction	62
Participants Background Characteristics	62
Dynamics of the Extraction of Rosewood	66

Environmental Laws, Policies, Rules and Regulations	69
The Effect of Rosewood Extraction	73
Implication of Rosewood Extraction on the Environment	73
Implications of the Commercial Extraction of Rosewood on Rural Livelihoods	78
CHAPTER FIVE: SUMMARY, CONCLUSION, AND RECOMMENDATIONS	
Overview	82
Summary	82
Key Results	83
Conclusions	85
Recommendations	85
Suggestions for Further Studies	86
REFERENCE	88
APPENDIX A: Interview Guide for Forestry Commission Officials	114
APPENDIX B: Interview Guide for Households	119
APPENDIX C: Interview Guide for Chiefs	123
APPENDIX D: Interview Guide for Assembly Members	127

LIST OF TABLES

Table		Page
1	Summary of Empirical Reviews	42
2	Community Demographic and Household Characteristics	55
3	Household Sample Proportional Distribution	56
4	Objectives of the study, Data Types, Variables, Measurement Scales, Data Sources, Target Populations, Methods, and Analytical Methods.	58
5	Research Participants of Study Communities	63
6	Respondents Age Distribution in Study Communities	64
7	Occupations of Household Respondents in the Study Communities	64
8	Implications of Rosewood Extraction	74
9	Implication of Rosewood Extraction on Livelihood	79



LIST OF FIGURES

Figure		Page
1	Sustainable livelihood Framework	33
2	Dynamics for the Extraction of Rosewood and its Implication on the Environment and Livelihood	46
3	Wa East District Map	51



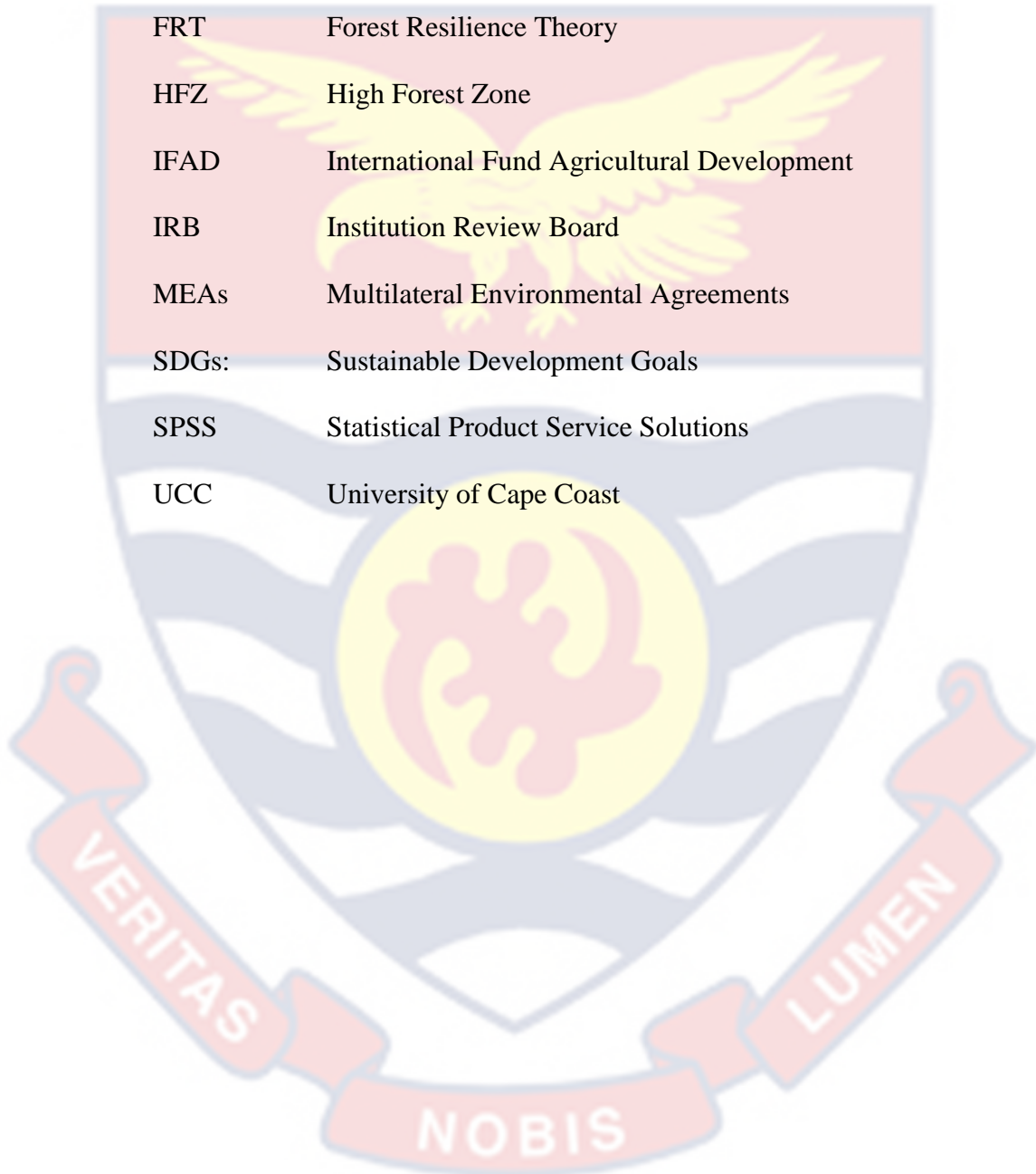
LIST OF PLATES

Plate		Page
1	Extracted Rosewood in Goripe Forest	68
2	Flood and Soil Erosion in Funsì	77
3	Flood in Funsì	77
4	Crops destroyed in Sissala East	79



LIST OF ABBREVIATIONS

CITES	Convention International Trade Endangered Species
DFID	Department for International Development
FAO	Food Agriculture Organization
FRT	Forest Resilience Theory
HFZ	High Forest Zone
IFAD	International Fund Agricultural Development
IRB	Institution Review Board
MEAs	Multilateral Environmental Agreements
SDGs:	Sustainable Development Goals
SPSS	Statistical Product Service Solutions
UCC	University of Cape Coast



CHAPTER ONE

INTRODUCTION

Background to the Study

Ghanaian timber exports have traditionally been dependent on natural forest harvest in the country's High Forest Zone (HFZ). The decline of forest stock in high forest zones has necessitated the consideration of other feasible alternatives throughout time (Tuffour, 2013). Therefore, attention is expected to shift not only to more sustainable timber sources such as plantations but also to species within the savannah zone that have export demand. As a result, the extraction of rosewood species has gained global attention (Treanor, 2015). The growing global prominence of the rosewood species as an exceptional timber and a high-value wood has placed enormous pressure on the specie within its natural distribution range (Dumenu, 2019; Dumenu & Bandoh, 2016).

As a multipurpose tree, rosewood produces valuable products such as wood, fodder, fuelwood, medicine and shows potential for use in agroforestry systems (Abdul-Rahaman, Kabanda & Braimah, 2016). Furthermore, through revenue production, energy provision, biodiversity protection, agriculture, and rural development, the tree plays a critical role in poverty reduction, carbon sequestration, and livelihoods (Allen & Pruitt, 1991). In addition, as the bark, roots, leaves, fruit and sap are all used in herbal medicine preparations, the species also holds pharmacological promise. It produces a protein-rich leafy fodder essential for the existence of animals throughout the dry season, on which livestock keepers rely heavily (Dumenu, 2019).

Due to the importance of rosewood, demand for the tree is high leading to an increase in supply leading to its unsustainable extraction (Dumenu & Bando, 2016). This plant species has compelled some countries such as Madagascar, Congo, and Zimbabwe, to list it on the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) as endangered species, and as such, trade on the timber species is deemed illegal (CITES, 2006). Nonetheless, on the international market, the demand for the tree appears to be on the ascendancy which has compounded the levels of exploitation and the general unsustainable harvest of timber currently being witnessed across the globe (Hensenn & Treue, 2008).

Literature has established that the main threats to the rosewood species are human-induced activities (Malloy, Brock, Floyd, Livingston & Webb, 2013; Rapport, Lasley, Rolston, Nielsen, Qualset & Damania, 2002). In addition, as proposed by the forest resilience theory, the rosewood species is vulnerable to unsustainable harvest due to the long period it takes to grow and mature (Bosu, 2013). The weak status of the tree is established in the proposition of the forest resilience theory, which indicates the capacity of forest ecosystems to go back to their previous form after disturbances, as well as maintaining their essential features, structures, and functions (Reyer, Brouwers, et al. 2015). Thus, the length of the plant's maturity period affects the extent and level to which the species is resilient.

Rosewood is an essential element in the ecological system. For example, the species constitute a significant cover tree in the woodland savanna ecological area (Bosu, Apetorgbor, Nkrumah & Bando, 2013). Hence the commercial extraction of the plant impacts the sustainable development of the

environment, which has a telling effect on the area temperature, wildlife, habitat loss, soil erosion, and high fuel fire intensity (Bosu, 2013). Additionally, the felling of such plant species results in a decrease in the carbon sequestration rate of the area (Reyer, Brouwers, et al., 2015).

Socially, this has affected the livelihoods of rural dwellers in which the plant species provide a source of employment (Dumenu & Bandoh 2016). As defined by Dumenu and Bandoh (2016), these livelihood strategies indicate that they comprise a range of events and choices individuals undertake to ensure survival. With the various farm, off-farm, and informal livelihood strategies adopted by the people, the rosewood tree entails an essential raw material to these strategies (Scherr, White & Kaimowitz, 2004). The commercial exploitation of rosewood trees loosens the soil and fastens the desertification of the area, making farming difficult. This thus results in enhancing poverty levels.

On the international front, the Convention on International Trade in Endangered Species (CITES) was founded in 1973 as one of the multilateral environmental agreements (MEAs) to strengthen and call attention to the need for natural resource conservation, protection, and efficient use (Dumenu, 2019). Members of the Convention on International Trade in Endangered Species (CITES), of which Ghana is a member, are required to monitor and regulate international trade in wildlife goods and to take action if necessary (Dumenu & Bandoh, 2016). As a result, several states have begun to take steps to register specific animal and plant species that they deem to be endangered or on the verge of extinction on CITES. The need to improve rural household livelihoods while also preserving the environment has become a global concern for

international, governmental, and non-governmental organizations, as well as individuals.

The Sustainable Development Goals recognize the necessity of addressing the extraction of endangered plants (SDGs). Goal 15 seeks to preserve biodiversity, sustainably manage forests, combat desertification, and halt and reverse land degradation (Tuokuu, Kpinpuo & Hinson, 2019). The SDGs have identified the necessary actions to sustainably manage forest bodies in order to foster sustainable livelihood as expressed in the sustainable livelihood framework, in order to safeguard the livelihood of rural dwellers. As a result, it is necessary to describe how people operate within a given vulnerability context, as well as to draw on various types of livelihood assets to develop a variety of livelihood strategies (Twigg, 2001).

In Africa, the commercial extraction of Rosewood has gained much attention due to the intensive nature of the activity (Bandoh, 2017). There have been reports of the species being illegally logged and exported out of various nations via prohibited ways (Treanor, 2015). Some African governments have expressed worry about the nature of the extraction and trade (Blondel, 2014). Authorities in Madagascar, Congo, Nigeria, and Cote d'Ivoire have had to confiscate lorries filled with rosewood in the past. These factors influenced certain administrations' decisions to impose a ban on rosewood extraction. Madagascar, Congo, and a few other African countries, on the other hand, went even further by writing to CITES to get it listed as an endangered species, making any commerce in it illegal.

Ghana's deforestation rate is expected to be 1.82 percent each year, or 135,395 hectares (Food and Agriculture Organization, 2013). Two-thirds of the

country is now categorized as savanna woodland, which is worrying because deforested land accounts for more than half of Ghana's total area (Olorunfemi, Olufayo, Fasinmirin & Komolafe, 2022). In recent years, deforestation in Ghana has had a significant impact on the Rosewood tree in the savanna woodland area (Abdul-Rahaman, Kabanda & Braimah, 2016). The logging of timber appears to be unsustainable, according to Dumenu's (2019) study. In order to protect the tree from excessive exploitation, Ghana's Forest and Wildlife Policy of 1994 was implemented, with the goal of improving and developing the forest and wildlife resource base through the development of a strategic plan.

Rosewood was not considered one of the most widely traded Ghanaian timber species on international markets until about a decade ago, when samples of the species were introduced and displayed for promotion (The Forestry Commission of Ghana, 2017). Following the introduction of rosewood to the international market, numerous timber firms in Ghana were granted harvesting permits for export (Environmental Investigation Agency, 2019). Rosewood is the most often used species in Ghana for fuelwood and charcoal manufacture (Scholz, 2018). Given that biomass fuels, primarily firewood and charcoal, still account for approximately 35% of total energy use, this shows a heavy reliance on rosewood species.

The government in an attempt to curb the ongoing logging activity banned the harvesting of rosewood from the year 2013 to 2016 intending to evaluate the situation (Forest Trends, 2014). Licensed timber companies obtained permits in 2015 to salvage the stock of already confiscated rosewood according to Scholz, (2018). The salvage initiative further aggravated the indiscriminate felling of fresh rosewood species which resulted in the placement

of another ban in 2017 and subsequently on 15th March 2019 (Adams, 2019) and the establishment of a task force to address the issues.

The Upper West Region of Ghana is home to a variety of rosewood species. As previously stated, the plant species' international and national demand has resulted in large commercial extraction in the Region, particularly in the Wa East District (Bandoh, 2017). These high and unsustainable extraction rates may have an impact on plant biodiversity as well as the district's people's livelihood security (Bandoh, 2017).

Problem Statement

Despite the government's and other organizations' attempts to reduce rosewood exploitation, chainsaw operators and timber merchants' actions continue to make rosewood logging in the savanna regions unsustainable (Abdul-Rahaman, Kabanda, and Braimah, 2016; Oduro, Arts, Hoogstra-Klein, Kyereh & Mohren, 2014), including a growing preference for rosewood in the manufacturing of charcoal (Bosu, 2013). Because of the unsustainable consumption and preference rates of rural and urban households for the plant species Okoti, Keya, Esilaba, and Cheruiyot (2006), the quality of the plant species are declining.

Although some scholars (Innes, 2010; Ahmed, Y. M., Oruonye, Tukura, 2016; Dumenu and Bandoh, 2016; Bandoh, 2017) studied the dynamics of rosewood exploitation in Madagascar, Nigeria, and Ghana, their research concentrated on different aspects of rosewood. Furthermore, such studies in Ghana remained silent on the effects of rosewood extraction on the environment and rural life in Wa east, where rosewood exploitation is prevalent. As a result, the researcher is driven to investigate how commercial rosewood extraction

affects the environment and rural communities' livelihoods in the Wa East District.

Research Objectives

The study's main purpose was to determine how commercial rosewood extraction impacts rural households in the Wa East District. The specific objectives were:

1. To explore the rate of rosewood depletion and methods of extraction in the Wa East District.
2. To investigate the range of rural livelihoods affected by the commercial exploitation of rosewood in the Wa East District.
3. To examine the effect of rosewood exploitation on the natural environment in the Wa East District.
4. To propose interventions and policy entry points for the sustainable exploitation of rosewood and rural livelihoods in Ghana.

Research Questions

The following are the research questions:

1. What is the rate of rosewood depletion and methods of extraction in the Wa East District?
2. What is the range of rural livelihoods affected by the commercial exploitation of rosewood in the Wa East?
3. What are the effects of rosewood extraction on the natural environment in the Wa East District?

The Significance of the Study

By shedding light on the key mechanisms that drive the phenomenon, this study will add to our understanding of how commercial rosewood extraction affects the ecosystem and the livelihoods of rural inhabitants. This will enable the creation and execution of appropriate policy actions to aid the environment and protect the livelihoods of affected rural households in the district and across the country. The findings of the study could also aid policymakers in developing procedures for national conservation and management plans.

Furthermore, the findings of the study could be utilised to inform stakeholders within the industry on environmental and livelihood challenges associated with the uncontrolled commercial extraction of rosewood. Due to the lack of empirical investigation into the rural livelihoods in the region and the district, in particular, this study will provide the springboard for other researchers to conduct further research in other aspects of the commercial extraction of rosewood in the district and the region in the wider context. In addition, the study will contribute to knowledge and also serve as reference work for future researchers who will delve into the same or similar issue.

Delimitations

This thesis focuses on the commercial extraction of rosewood and its implications on the environment and rural livelihoods. It specifically, captures conditions that lead to excessive extraction rate of rosewood. Also, the implication on the environment covers issues pertaining to loss of forest cover, degradation of the environment and the threat of the total extinction of the species.

Geographically, the research was conducted in Wa East. It concentrates on the Wa East district because it has seen a lot of logging and exploitation in recent years. Assembly members, chiefs, and landowners in the affected communities, as well as affected households and forestry commission personnel, were the target group. Because the study's goal is to identify and examine the consequences of extraction on livelihoods, the target geographic location was chosen. These individuals were able to supply information that aided in the completion of the research objectives..

The Organization of the Study

There are five chapters to the study. The study's background, problem, statement, research objectives, research questions, study importance, delimitations, and thesis arrangement are all outlined in the first chapter. Chapter 2 discusses the relevant literature that was reviewed for the study. The research methodology is discussed in the third chapter, which highlights the numerous methodologies utilized in the study and chapter four analyzes the data and discusses key conclusions. The overview of major findings, conclusions, and suggestions are included in Chapter 5.

CHAPTER TWO

REVIEW OF LITERATURE

Introduction

Literature review allows researchers to fine-tune the structure of their study topic by offering data on the current state of knowledge in that field (Hart, 2018). In addition, according to Lai (2011), the review reveals the contradicting disputes and arguments that make up the study area, allowing researchers to compare, link, contrast, and evaluate the gaps found. This chapter examines and provides a theoretical, conceptual, and empirical review, as well as conceptual frameworks, that drive commercial rosewood extraction and its effects on rural populations' lives.

Theoretical Review

According to Bryman (2016), theoretical review gives the fundamental thoughts that regulate the research field's logical consistency and complications. The notion of the Tragedy of the Commons, the theory of capture of ecological value, and the forest resilience theory are used to create a theoretical lens for interpreting commercial extraction of rosewood and its repercussions on subsistence. A single concept is insufficient to explain the amount to which commercial rosewood extraction impacts both the environment and the livelihood of rural households, hence the ideas must be combined. As a result, these ideas complement one another in understanding the study's numerous notions.

These theories speak to the same phenomenon but from different perspectives. The theories selected also addresses the same issue but draw on a

related or common set of explanatory factors. In this study, the common pool resource theory in the study is used to bring forth the challenges involved in the usage of a common property by society. This theory describes how environmental degradation occurs due to its overuse. The ecological value capture theory highlights factors that enhances change which are, population pressures, resource intensification and environmental deterioration. This is where the forest resilience theory comes in to complement the two theories by explaining how the overuse of a resource can reduce its ability to be resilient. The FRT further goes on to explain that, these disruptions affects the resource level of resilience and its ability to bounce back to its original state.

Common Pool Resource Theory

The tragedy of the commons as developed by Lloyd (1833) seeks to explain how the overuse of common property by society leads to the destruction of the property. Building on Lloyd's assumptions, Hardin (1968) further developed the theory of the Tragedy of the commons by applying it to unregulated open access land, used by herders as pasture for their animals. From the perspective of a rational herder, an extra animal would yield him additional benefits which will go beyond the carrying capacity of the field. To further advance the argument, Hardin concluded by stating that ruin is the end product to which all men rush, with each pursuing his selfish desire (Friedman, 1971, Singh, 1998). Hence, it is acknowledged as a principle by the emerging environmental movements (Anukwonke, 2015).

The Tragedy of the Commons, according to Hardin (1968), attempts to predict the outcome of widespread usage of a shared resource. In such instances, short-term interests were set against the greater good, resulting in congestion,

pollution, and environmental degradation. Similarly, according to Ostrom (1990), the Tragedy of the Commons has come to signify environmental degradation as a pre-determined result of the use of a scarce natural resource. As a result, rural people consider rosewood to be a collective asset rather than an individual asset (Fagariba, Song, & Soule, 2018).

Aristotle (1996) claimed that common features receive only limited attention, implying that individual interests are favored over community interests. Furthermore, the difficulty of preventing potential beneficiaries from gaining access to a shared resource contributes to the resource's destruction (Ostrom, 1999). Similarly, Gordon (1954) backs up the old adage that "property that belongs to everyone belongs to nobody". This according to Muller & Whillans, (2008) can be attributed either to the unavailability or breakdown of private property rights or institutional arrangements.

Diverse perspectives on how individuals organize to manage various types of resources have emerged in the quest to secure common resources (Bromley, 1992; McCay & Acheson, 1987; Ostrom, 1990, 1992). For example, Ostrom (1990) suggested that natural resources should be privatized to resolve the issue of environmental degradation. This is because the individual usage of Common resources subtracts from the amount available to others. Alternatively, other scholars believe that the state should take control of natural resources to prevent their destruction (Holling, Meffe, 1996; Kula, 2012).

In addition, Ostrom (1992) devised eight principles that must be applied to the management of common resources in order to maintain a community-governed commons that is sustainable. The first principle considers the establishment of unambiguous resource limits. The consistency of appropriation

and provision regulations with local situations comes next. All stakeholders are then able to make changes to the operational rules that control the resources. Implementing monitoring measures, graded sanctions, and dispute resolution processes are the fourth, fifth, and sixth principles, respectively (Ostrom, 1999). Finally, the seventh and eighth principles emphasize easily accessible, low-cost conflict resolution processes as well as well-organized norms enforced by several layers of nested organizations.

The application of the regulations as outlined by Ostrom (1990), has been acknowledged by various scholars as a possible way of overcoming the problem of the Tragedy of the commons (Pu Putzel, Kelly, Cerutti & Artati, 2015; Villamayor-Tomas, Avagyan, Firlus, Helbing & Kabakova, 2016).

The Theory of Ecological Value Capture

The notion of ecological value capture discusses how intra- and inter-societal political and economic power asymmetries are exploited to extract distant ecological value (Lawrence & Abrutyn, 2015). As a result, the quality of environmental services suffers, causing most civilizations to become more concerned about the environment. According to Cordell, Murphy, Riitters, and Harvard, (2005) ecological value refers to the level of benefits that space, water, minerals, biota, and all other factors that make up natural ecosystems provide to support local life forms. The theory highlights three important aspects that contribute to change: population pressures, resource intensification, and environmental deterioration.

Population pressure destroys the land, hurting the economy's productive resource base. It also depletes natural resources and the environment more quickly. These environmental consequences have a greater impact on the

environment (Weber & Sciubba, 2019). Population expansion is associated with environmental challenges such as biodiversity loss, air and water pollution, and increased strain on arable land, primarily due to over use of natural resources and the creation of waste. Environmental deterioration is regarded to be a cause as well as a result of poverty.

Furthermore, Weber and Sciubba (2019) believed that there is a clear link between population and the environment; more people have a greater impact on the ecosystem. Similarly, Repetto and Holmes (1983) observed that in emerging countries, population pressure contributes to the decrease and depletion of vital natural resources. Natural resources are depleted or wiped out as a result of high demand. The growing population and business market place increased demands on our already limited resources, which can quickly deplete them. According to Boserup (1965, cited in Broughton 1994, p.372), resource intensification is a process in which total production per area of land is raised at the expense of overall forest losses. This is linked to the increased consumption of natural resources.

When resources like air, water, and soil are depleted, ecosystems are destroyed, and species become extinct, the environment deteriorates (Rani & Agarwal, 2019). The development processes of man's economic and technical activities are frequently blamed for environmental degradation. Gatti et al. (2015) recognise that growing commercial species extraction and selective logging contribute to environmental degradation. The logging of hardwoods for fuelwood and charcoal has been the driving force behind environmental deterioration in Africa. Exports of logs and wood from Ghana and other developing nations to the Asian market are rapidly increasing..

Population pressures, according to Chase-Dunn (2009), put pressure on groups due to unfulfilled resource needs by their members. As a result, the increased demand for resource production to meet consumption demands, such as more food, space, shelter, and clothing, is a challenge associated with population growth (Food and Agriculture Organization, 2004). As a result, such resources must be efficiently used in order to meet the population's ever-increasing demands. Several authors (Abrutyn & Lawrence, 2010; Johnson & Earle, 2000) contend that as resource demand rises, so does resource extraction.

The inefficiencies that plague the extraction process have an influence on the ecosystem, threatening the domain's integrity and long-term viability (Adhikari & Ozarska, 2018). Environmental degradation, biodiversity loss, higher trash generation rates, and silting of rivers and lakes are all mentioned by Obasi, Agbo, and Onyenekwe (2015). The environmental cost of the extraction process is climate change/global warming. When environmental degradation reduces accessible resources, there is a strong need to replace them externally (Lawrence & Abrutyn, 2015). Capturing ecological value refers to the desire to obtain resources from outside sources. The multiple benefits (direct and indirect) of ecosystem services provide environmental value.

Unbalanced natural resource exchanges, according to Rice, (2007) and Lawrence, & Abrutyn, (2015). involve the migration of economic and ecological resources at a cheaper cost to industrialized countries. These resources are converted into finished goods and then shipped back to underdeveloped countries at a high cost. As a result, Hornborg & Martinez-Alier, (2016) noted that as environmental awareness grows within local circles, acquiring ecological value from others may deprive rural inhabitants of their

livelihood sources. This might arise due to the depletion of some essential forest resources.

Forest Resilience Theory (FRT)

The Forest Resilience Theory (FRT) claims that a forest's ecosystem is resilient when it can recover from disruptions and return to its previous state (Gunderson, 2000). The FRT arose from Holling's engineering resilience theory (1973). Engineering resilience theory was developed by Holling (1973) to envision a system's ability to transition from one stable condition to another. Pimm (1991) defined engineering resilience as a structure's ability to preserve its state or return to its original condition following a disturbance. As a consequence, the forest ecological resilience theory was established.

Holling (1975) defines ecological resilience as an environmental unit's ability to absorb and survive changes in its structure. As a result, Gunderson (2000) defines resilience as the amount of stress an ecosystem can sustain while maintaining its current condition or structure. However, ecologists and other related scholars had differing opinions on its meaning (Berkes, Colding, and Folke, 1998). In addition, Peterson, Allen, and Holling (1973) argue that forests are highly resilient in that they can revert to their pre-disturbance condition after a period of time following a catastrophic disturbance, keeping, more-or-less, the original species composition. As a result, Berkes and Folke (1998) defined resilience as an ecological network's ability to tolerate (absorb) external stressors and recover to its pre-disturbance state over time, while still achieving its main goals of supporting biodiversity and providing ecosystem services.

The ecosystem's resilience is exclusively based on species persistence, intra-specific genetic diversity, gene flow, and generational turnover, according

to Folke et al. (2004). The total amount of genetic features in a species' genetic composition is referred to as intra-specific genetic diversity (Lebret, Kritzberg, Figueroa & Rengefors, 2012). Genetic variety, according to Adger, Kelly, Winkels, Huy, and Locke (2002), allows populations to adapt to changing surroundings. Furthermore, it helps an ecosystem function and recover (Reusch, Ehlers, Hammerli, & Worm, 2005), because genetic diversity and biodiversity are interdependent.

The cycle can break down when a specific species is removed from the system, and the ecosystem becomes dominated by a single species (Carpente & Gunderson, 2001). Trees are the only plant species that live for a long period, mature sexually late, and grow in groups with overlapping generations. The Rosewood plant, which is an important part of the forest ecology, is also subject to some disturbances. According to Bando (2017), the plant's failure to regenerate at a rapid rate jeopardizes its ability to withstand both natural and human-caused disturbances.

Forest ecosystems can be harvested and used to provide services. Nonetheless, the exploitation of those services cannot go beyond what is sustainable, and items cannot be removed in a way that disrupts ecological processes (Peters, 1994). A tipping point or ecological threshold, according to Scheffer and Carpenter (2003), is the moment at which an ecosystem loses its resilience and integrity. Changes in the environment are frequently unpredictable once a tipping point is reached. According to various scholars (Walker & Shiels, 2012; Veraart et al., 2012), it has been possible to identify alternative possible, stable states, tipping points, and associated warning signals

beyond which resilience capacity is exceeded, and thus to develop strategies for restoring the original condition, based on the theory.

The disruptions that affect the plant's level of resilience are either natural or caused by humans (Standish et al., 2014). The wild disorder, as described by Mugerauer, (2010) is any discrete occurrence that disrupts the ecosystem, community, or population, thereby altering the physical environment. Changes in windstorms and wildfires, as well as insect outbreaks, could be among them. Chemical pollution, mining, deforestation, and overexploitation are examples of human-caused disruptions (Emmanuel, Jerry & Dzigbodi, 2018; FAO, 2011; Slingenberg, Braat, Van Der Windt, Rademaekers, Eichler & Turner, 2009). The cumulative influence of human actions on the ecological system is substantial (Day, Yanez-Arancibia & Kemp, 2012; Oldfield & Dearing, 2003).

Furthermore, resilience is an important aspect of how people's and social groups' adaptation to environmental change. Communities' reliance on ecosystems and economic activity may be linked to ecological and social resilience (Adger 2000; Barthel, Folke, & Colding). Species persistence, intra-specific genetic diversity, gene flow, and generational turnover are all factors that contribute to the ecosystem's resilience (Nasi, Wunder & Campos, 2002). The tree aids the community by providing charcoal fuelwood.

As demonstrated in a study by (Piabuo, Minang, Tieguhong, Foundjem-Tita, and Nghobuoche, 2021; Valdez, 2019), the Rosewood plant is resistant to extreme weather conditions and, as a result, to changes in weather conditions and patterns. Scholars agree, however, that when resilience declines, systems become increasingly vulnerable to major risks and uncertainties (Loorbach &

Shiroyama, 2016; Gitz & Meybeck, 2012). Hence, the system can only withstand mild external and internal shocks (Folke *et al.*, 2002).

Despite the recent focus on resilience, specific concerns demand additional attention. First, pragmatic techniques that raise the possibility of socially positive outcomes while reducing the risk of negative consequences must be identified (Chapin *et al.*, 2009). Resource users can track changes in these stressors and their repercussions over time and limit their stress exposure by tracking trends in these stressors and their consequences. In essence, initiatives that increase and sustain natural, human, and social capital, as well as extend the range of livelihood options, reduce society's vulnerability to a variety of stresses (Chapin *et al.* 2009).

According to Pierce, Budd, and Lovrich (2011), society is facing growing uncertainty due to climate change, human migration, and ecosystems' ability to create goods and services. Ecosystem activities, such as better water and air quality, storm protection, flood mitigation, sewage treatment, microclimate regulation, and recreation and health values, are intricately tied to urban services such as transportation, housing, medical aid, jobs, and financial markets (Daily 1997; Boyd & Juhola, 2015; Beilin & Wilkinson, 2015). Climate change, for example, is a significant disturbance for urban forestry.

The loss of functional groups as a result of ecological changes like as large-scale climate change, inadequate forest management, or a sufficiently extensive or continuous adjustment of natural disturbance regimes can all contribute to a loss of resilience (Folke *et al.*, 2004). The prevailing floristic (tree) composition and stand structure expected for a given perspective define an ecosystem state. A loss of resilience causes a shift in forest state, with a

partial or complete shift to a different ecosystem type than what is expected for that location (Thompson, 2011). In effect, forest management is critical to maintaining forest resilience..

Conceptual Review

According to Yin (2003), the conceptual review enables the screening of variables for the study. This indicates the benchmark in determining the measurement of the variables to set the units of analysis. In conceptualizing the research problem and objectives, the main concepts discussed in this section include rosewood, livelihood, environment, environmental degradation, and deforestation.

Rosewood

Rosewood, also known as *Pterocarpus Erinaceus*, is found in Senegal, Gambia, Guinea-Bissau, Guinea, Mali, Côte d'Ivoire, Burkina Faso, Ghana, and Niger, as well as the Sudan-Guinea region of West Africa (Leggett, 2018). The species belongs to the genus *Dalbergia* and is prized for its fragrant, beautiful qualities (Treanor, 2015). According to Kossi, Towanou, Habou, Novinyo, Elikplim, Nathalie, and Ali (2019), the species is naturally black, densely grained, and yellowish to reddish-brown in color with darker veining. Drought-resistant rosewood species grow in arid climates (Barrett, Brown, Morikawa, Labat & Yoder, 2010). According to Aubreville (2013), the tree survives periodic savannah fire outbreaks and sprouts bare ground.

The *Pterocarpus Erinaceus* can withstand high temperatures despite its modest growth rate. Rosewood blooms during the dry season, from December to February, before producing new leaves, according to Kyei (2017). At times,

flowers and new leaves coexist. Bees frequently visit the flowers, according to, which may be responsible for pollination. Furthermore, the species may produce more fruits giving the impression that the species is covered with leaves when the fruits are green (Damaiyani and Prabowo 2019).

Rosewood has a tough, black, and rough bark. Long downward-bending shoots protrude from the branches. The flowers are a golden yellowish color, and they bloom in January. Leaflets are also 10-15 foliolate, with most being oblong-elliptic, 6 to 11 long, and 3 to 6cm wide. The precise population and standard thickness of stalks hectares of rosewood species in Ghana's Savannah region are unknown (Carmenates, 2010). Rosewood is found in abundance in the Bono East, Ahafo, Upper East, Volta, Savannah, Northern, and Brong Ahafo areas of Ghana (Kansanga, Dinko, Nyantakyi-Frimpong, Arku & Luginaah, 2021).

Pterocarpus Erinaceus serves an important role in its surroundings. The tree fixes nitrogen in the atmosphere through a symbiotic relationship with *Rhizobium* earth bacteria (Ugochukwu, Hobbs, Phillips & Kerr, 2018). Furthermore, the species is mostly utilized by rural people to build houses, medicine, musical instruments, furniture, livestock fodder, fuel, and charcoal (Arunkamar, Warriar, Kher & Teixeira, 2021). As a result, Kossi, Towanou, Habou, Novinyo, Elikplim, Nathalie, and Ali (2019) claim that the species is critical to the rural community's survival because it provides a large source of income. *Pterocarpus Erinaceus* is also employed as a windbreak and shelterbelt in intercropping, as well as a shade tree. As a result, the value of rosewood cannot be overstated (Sharma et al., 2019).

Pterocarpus Erinaceus grows to a marketable height of about 20 feet in about five years. After ten years, the diameter increases to 6 inches and 30 feet tall. At this stage, *Pterocarpus Erinaceus* can be sold for a small revenue through immatured (Patel, 2007). However, there are proposed minimum felling diameter enforced by forestry authorities to ensure the management of the resource as well as encourage a sustainable harvest (Fontodji, Atsri, Adjonou, Radji, Kokutse, Nuto & Kokou, 2011); Segla, Rabiou, Adjonou, Moussa, Saley, Radji & Kokou, 2016)). Guinean, Sudanese and Sahelian zones adopted a minimum felling diameter from 35-65cm for 20 years. Some authors argue that, due to the delay in maturity, the excessive harvest of the species can affect its resilience to subsequent disturbances (Fraver, Jain, Bradford, D'amato, Kastendick, Palik & Stanovick, 2011; Kansanga, Dinko, Nyantakyi-Frimpong, Arku & Luginaah, 2021).

Commercial Extraction of Rosewood

Extraction transports logs from their original location to a more convenient location (Dykstra, 1996). There are a variety of wood extraction processes, and they differ, particularly in the locations where they are most appropriate. According to Jourgholami (2012), labor-intensive, intermediate-technology, and completely mechanized extractions are among the techniques. When rudimentary instruments like cutlasses and chainsaws are utilized on a limited scale, mainly targeting smaller trees, the labor-intensive technique is known as manual extraction (Marfo, 2010).

As the process of extractions occurs, it sometimes causes irreversible damage to forest ecosystems which is hazardous to the entire environment (Bala, 2017). Damages caused during rosewood extraction include

environmental degradation, deforestation, and slow forest recovery (Ojeh, Philip-Humshie, Garba, Naabil, Obiano, Boyitie, & Boyiga, 2020). This further reduces the volume and value of rosewood available for the subsequent harvest (Kansanga, Dinko, Nyantakyi-Frimpong, Arku, & Luginaah, 2021).

Rosewood is highly valued internationally, especially in China, according to numerous researches (Legget, 2018; Treanor, 2015; Waeber et al., 2018). As a result, it is used in commercial extraction to meet demand. According to Leggett (2018), growing demand led to widespread illegal rosewood harvest both locally and globally. According to Wilmé, Innes, Schuurman, Ramamonjisoa, Langrand, Barber, and Waeber (2019), certain governments listed all rosewood species with the Convention on International Trade Endangered Species of Wild Fauna and Flora in order to prevent illicit exploitation.

In most parts of West Africa, the Rosewood species is considered the most illegally extracted, harvested unlawfully, and trafficked species in terms of volume and value (Dumenu & Bandoh, 2016; Kossi et al, 2019). The Guinea savannah areas where rosewood is abundant have been designated as places where the species is endangered (WWF, 2015; Barrett, Brown, Morikawa, Labat & Yoder, 2010). According to environmentalists, irresponsible commercial harvesting of mature species will induce population decrease, environmental degradation, reduced carbon sequestration, climate change, and extraction targeted toward juvenile individuals (Ahmed, Oruonye & Tukura, 2016). These actions progressively have an impact on the livelihoods and assets of a number of poor rural people whose survival is inextricably related to the environment in which they live (Oduro).

In various West African countries, such as Burkina Faso, Togo, and Ghana, the impact of excessive rosewood harvesting has been recognized (Devineau, 1999; Glèlè, et al, 2011; Ouedraogo, 2008; Marks, Aflakpui, Nkem, Poch, Khouma, Kokou & Sebastià, 2009; Adjonou, 2010; Dumenu & Bandoh, 2014). In addition, Treanor (2015) reported in his study that imports of *Pterocarpus Erinaceus* have increased by 70% in China since 2010. The species was also Ghana's top shipped timber in 2015, according to the author. The major threat to rosewood, according to Bandoh and Dumenu (2016), was the overharvesting of the leaves for animal feed.

Innes (2010) and Dumenu (2019) both indicated that the rosewood tree's recent unlawful and excessive harvesting had become a severe threat to the species. This can be seen in the current increase in its furniture trade in the Asian market (Bandoh, 2017; Ghana & Apaak, 2017). As a result, rosewood has been classified as one of China's thirty-three redwood species. According to Trends (2014), the rapid increase in commerce of the species from West Africa was fueled by a rise in prices and a fall in South East Asian rosewood supplies.

Since 2010, China has seen a 700 percent growth in African rosewood logs and sawn wood (Treanor, 2015). According to Waeber, Schuurman, Ramamonjisoa, Langrand, Barber, Innes, and Wilmé (2019), West Africa was the leading supply of the species to China in 2015. This accounted for almost 64% of all wood imports (Treanor, 2015). Leggett (2018) also claimed that in 2015, 8 of the 15 countries supplying wood to China were from West Africa, which Ghana is a part of.

According to Treanor (2015), Ghana, Nigeria, Benin, and Cote d'Ivoire are among the countries in the West African sub-region that have been badly

impacted by excessive extraction. According to some reports, these countries have a similar activity trend (Oduro, 2016). Only two countries, however, are currently involved in the legal trading of rosewood. At the same time, three have taken steps to put a stop to unlawful extraction and trade (CITES, 2015).

In 2013, China received 99 percent of Ghana's rosewood exports (Treanor, 2015). According to Ghana and Apaak (2017), 'salvage permits' are used to extract the species within Ghana. As a result, the harvest and exchange of freshly cut logs became even more intense. However, due to the rising rate of illicit logging, Ghanaian authorities imposed a ban on timber harvesting and trading in 2012. (Dumenu, 2019). Authorities re-imposed a harvesting, processing, and export ban on all species in July 2014. Following evidence of Ghanaian rosewood laundering in adjacent countries, the ban includes a prohibition on rosewood transshipment from other countries (Africa, 2015).

In 2014, a paramount chief from the Gonja land chief called on authorities to put a stop to the unlawful exploitation of rosewood because of the negative effects it had on their water sources and the ecosystem in general (Norglo, 2015). According to the Randriamalala, (2009), over 200 trucks stocked with rosewood leave the district every week. As a result, practically all of the rosewood that has been illegally removed is exported (Norglo, 2015). In addition, in the years 2012 and 2014, officials intercepted some rosewood-laden cargo at the port, totaling around \$800,000 in value (Kasanga, Dinko, Nyantakyi-Frimpong, Arku & Luginaah, 2021; Bosu, 2013).

Excessive rosewood extraction has also put the species on the point of extinction (Africa, 2015). According to (D'Cruze & Macdonald, 2016), owing to the different uses of rosewood, unsustainable harvesting could have

damaging effects, particularly for rural people's livelihoods. As a result, according to D'Cruze & Macdonald (2016), domestic demand for the species is negligible compared to the worldwide market. Illegal logging has stemmed from rising global demand for the species.

Illegal Logging

Illegal logging, according to Hansen and Treue (2008), is characterized as processing logs without valid permissions and evading import or export charges. Logging in Nationally Protected Areas, over-allowing logging quotas, and evading import or export tariffs are only a few examples. There are two forms of logging, according to Brack (2003): selective and clear-cutting. Clear-cutting focuses on removing all trees in the logged region, whereas selective logging concentrates on removing high valued and demanded trees. Both types of deforestation cause significant challenges in developing nations because they damage ecosystems and make them more vulnerable to total deforestation (Reboredo, 2013). According to Bandoh (2017), the existence of bad governance and policies has aided the presence and prevalence of illicit logging in the forest sector.

Various researchers point to poor administration, non-enforcement of regulations, and a lack of logistics as contributory factors to the high rate of illicit logging in some parts of Africa (Kansanga, Dinko, Nyantakyi-Frimpong, Arku & Luginaah, 2021). This practice has a negative impact on the country's overall revenue base. According to the Piabuo, Minang, Tieguhong, Foundjem-Tita, and Nghobuoche, 2021, illicit logging generates 10 to 15 billion dollars in lost revenue each year. The species' risk of extinction was reaffirmed in 2008 when it was added to the CITES list (Winfield, Scott & Grayson, 2016).

The confiscation of rosewood in several jurisdictions demonstrated the failure of the techniques used to prevent excessive and uncontrolled extraction (Kansanga, Dinko, Nyantakyi-Frimpong, Arku & Luginaah, 2021). Despite the fact that some nations prohibit rosewood harvest, documents from China show that trade between specific countries and China continues (Obiri et al, 2022). Experts have overstated governments' inability to control or restrict the recent threat of unlawful and excessive work (Dumenu, 2019).

According to Carmentis (2010), habitat loss and degradation due to human activity is the most major danger to rosewood species populations. Because the species is largely found in forested areas, high rates of deforestation are thought to be linked to the species' decline (Barrett, Brown, Morikawa, Labat & Yoder, 2010). Rosewood appears to be extracted from natural sources at the moment, according to Dumenu (2019), however statistics reveal that it is propagated in Senegal and Ghana.

Illegal logging in the timber industry have gained the attention of government at both international and national front. Because, illegal logging is an unacceptable practice and have a detrimental effects on the environment, economy and livelihoods. Illegal logging impacts negatively on rural livelihoods and deprives government from accruing important revenue for the country. To effectively reduce illegal logging and unacceptable forest practices, institutions have been strengthened in order to enforce laws (Owusu, Nketiah & Aggrey, 2011). These include improvement in training, enforcement of codes of conducts and the introduction schemes to help reduce the menace of illegal logging.

Multilateral and environmental agreements such as CITES and Montreal Protocol were established to improve and enforce international legislations against illegal logging and trade. These agreements were created to restrict and bann the trade of species considered endangered by establishing licensing systems.

Enforcement agencies such as the police and customs department have been provided with the requisite equipment, training and resources to enable them identify illegal timber products. this initiative have succeeded in the prohibition in trade of illegally sourced timber products.

The European union for instance launched a flagship anti -illegal logging policy which is the Forest Law Enforcement, Governace and Trade (FLEGT) Action Plan. This resquires companies to verify the legality of their timber products. Also, tariff reductions are awarded to countries that comply to sustainability standards (Brack & Hayman, 2001).

Sanctions are applied against companies which violate these measures and continue to purchase illegally sourced timber. The introduction of this scheme have been considered effective since its enforcement. Because it places administrative burden on timber companies to prove compliance by purchasing from legal sources (Owusu, Nketiah & Aggrey, 2011).

However, despite the introduction of measures and regulations to address illegal logging, some challenges still persist. Such challenges include, under resourced personnel, inadequate training, equipments and corruption. An effective method to deal with this menace is to strengthen the capacity of the necessary institutions.

Effects of Commercial Extraction of Rosewood on the Environment

According to Ford-Robertson (1971), a forest can be defined as a parcel of land that has been designated as such by a Forest Act or Ordinance. As a result, Helms (2002) described a forest as an ecosystem typified by a large bush with stands that differ in species composition, structure, and age class. Helms (2002) went on to say that plantations may be considered orchard processes, which include things like streams, fish, groves, and wildlife. Similarly, Lund (2002) and Sasaki & Putz (2009) suggest that forests are classified as industrial, nonindustrial private woods, plantations, public forests, production forests, urban forests, parks, and wilderness-based based on their diverse uses.

The immediate surrounds of an object that has a direct influence on it are referred to as the environment (Barbier, Burgess, Aylward & Bishop, 1992). The environment, according to Larsson (1957), is the surroundings or situations in which a person, animal, or plant survives. According to the Alexandre-Benavent et al, (2018), humanity's entire survival is dependent on a healthy environment. Because it provides the universe with oxygen, ecosystem services, food, water, medicine, fuelwood, regulates and controls climate and disease, and supports and oxygen production, the environment is critical to society's functioning and existence. Other environmental benefits include cultural, spiritual, and recreational objectives (Cooper, Brady, Steen, & Bryce, 2016; United Nations Environment Programme, 1999).

Nwazi & Debski (2020) stated that unrestricted commercial rosewood harvest has underlying detrimental environmental implications. Environmental degradation, deforestation, soil organism depletion, habitat destruction, soil erosion, and a decrease in the climate's carbon sequestration rate are examples

of these (Barrett, Brown, Morikawa, Labat, & Yoder, 2010; Dumenu, 2019; Dumenu, & Bandoh, 2016; Abdul-Rahaman, Kabanda & Braimah, 2016; Ahmed, Oruonye & Tukura, 2016).

Several authors have explained the notion of environmental degradation in various ways (Duguma, 2019; Ghazoul, Burivalova, Garcia-Ulloa, and King, 2015; Thompson et al., 2013; Johnson et al, 1997; FAO, 2011). Environmental degradation is defined by Johnson, Ambrose, Bassett, Bowen, Crummey, Isaacson, and WinterNelson (1997) as any change that causes the natural environment to be destroyed or deteriorated. The FAO (2011) defines ecological degradation as a process that damages the natural environment due to a change that reduces productivity. Forest degradation, according to Simula (2009) is defined as the loss of a forest's ability to provide goods and services. Regardless of the discrepancies in the many explanations, the tragedy of the commons and the concept of the common good are at the center of their argument. Regardless of the discrepancies in the many explanations, the core of their argument is traceable to the tragedy of the commons and the concept of sustainable livelihood.

According to Choudhary, Chauhan, and Kushwah (2015), the depletion of the integrity of resources such as air, water, and soil, as well as the destruction of ecosystems and the extinction of species, can be used to determine the magnitude of degradation. As a result, environmental degradation can be defined as a loss of biodiversity, which leads to further ecosystem changes and a reduction in the ecosystem's ability to deliver services (Zari, 2014).

According to the FAO, deforestation is defined as the conversion of a woody area to non-forest uses and other uses, or the permanent decline of forest

canopy cover (2004). The act entails the deliberate logging of trees and other plant species by persons or as a result of a natural calamity (Innes, 2010, European Union, 2014). As a result, practically all forests have been depleted, soils have been degraded in some cases, and biodiversity in natural ecosystems has been lost. Deforestation, for example, is still a major worry in Ghana's heavily forested areas, owing to both legal and illegal logging (Amisah et al, 2009). Logging, according to Burivalova, Wahyudi, Boucher, Ellis, Truskinger, Towsey, and Game (2019), is a more important direct driver of deforestation in Africa.

Agricultural development, deforestation, and overgrazing (Wright & MullerLandau, 2006), all of which have been fueled by rapid human population growth and poverty, have resulted in the loss of over 65 percent of Africa's original wildlife habitat since the 1990s (Barbier, Burgess, Aylward & Bishop, 1992; Innes, 2010; Hammond, 2019). Between 1990 and 2000, dry forest and woodland countries in Sub-Saharan Africa lost about 5 million hectares of forest cover per year, accounting for nearly 1% of total forest cover in 2000 (Peng, Pan, Liu, Zhao & Wang, 2018).

Bandoh (2017) and Johnson (2019) explained that harvesting rosewood disturbs sensitive sites or destroys habitats of rare and unique species of both plants and animals. Logging practices such as selective and clearcutting are mainly aimed at cutting specific trees, moving them to a landing, processing, loading, and transporting sites. Subsequently destroying habitats of these rare and unique species. Also, extraction activities result in soil compaction, erosion limits, reduced water absorption by plants, and the degree to which water moves laterally and vertically through the soil (Adhikari & Ozarska, 2018).

Furthermore, due to the unsustainable exploitation of the tree, climate change is a significant influence (FAO, 2013). Because the tree's branches and leaves are burned or allowed to rot, the climate of the area is altered. Carbon dioxide is emitted into the atmosphere as a result of their stored carbon. The accumulation of greenhouse gases in the atmosphere occurs due to carbon dioxide release. As a result of deforestation and environmental degradation, carbon sequestration decreases, resulting in global warming and, eventually, global warming (Sedjo, 2001).

Livelihood

Chambers (1995) defined livelihood as a means of subsistence. Farm activities are included in livelihood approaches (Alemu, 2012; De Janvry & Sadoulet, 2000; International Fund for Agricultural Development [IFAD], 2011). Similarly, DFID (1999) defined livelihood as a collection of resources, capacities, and actions necessary for survival. According to Alemu (2012), there is consensus on the classification of livelihood strategies, which include farm and off-farm.

Various sources of revenue are listed by the Chambers and Conway, (1992). Smallholder agriculture, including cattle production, hunting, artisanal fisheries, agricultural wage labor, and rural non-farm activities, such as wage or self-employment in the rural non-farm economy, are all included. It is assumed that rural people's livelihood strategies include both farm and non-farm occupations. (Ellis, n.d.)

According to Chambers and Conway (1992) livelihood strategies are sustainable when they can absorb shocks and stress without depleting their original state and without jeopardizing their natural resource base. Carney et al.

(1999) proposed a framework (Figure 2) to encompass the numerous variables that influence the sustainability of a livelihood in order to further define the notion. The ecological system concepts of sensitivity and resilience were also included in the framework, referring to how well a livelihood system can bounce back, withstand the test of time, and recover from shocks (its sensitivity) and how well it can bounce back, withstand the test of time, and recover from such shocks (its resilience) (Walker & Shiels, 2012).

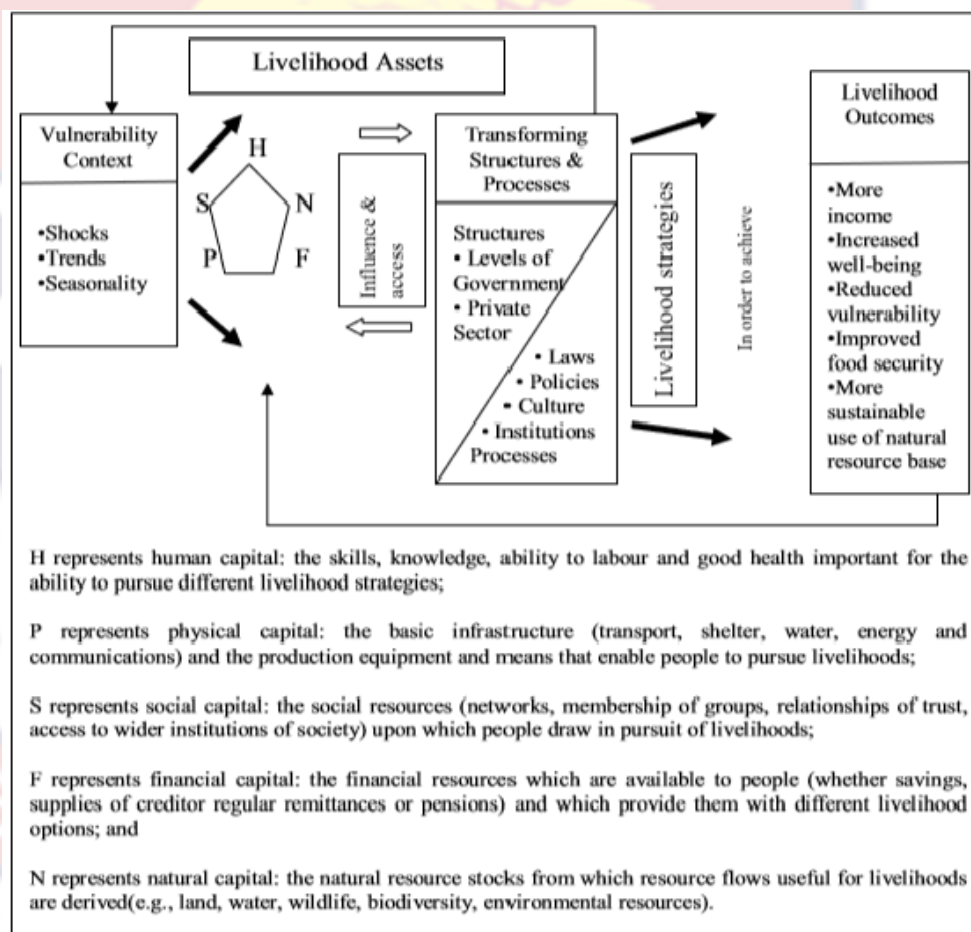


Figure 1: Sustainable livelihood Framework

Source: Adopted from Carney et al. (1999)

Diversification of income is used by people to ensure and improve their existence (Hussein & Nelson, 1998). This is aided by the reduction of risk that each livelihood approach entails (Khatun & Roy, 2012). Following this,

Hussein and Nelson (1998) stated that livelihood diversification entails people's efforts to find new ways to improve incomes and reduce environmental risk, with the degree of freedom to diversify or not and the reversibility of the result varying substantially. According to Ellis (1998), rural people build a diverse variety of activities and social support capacities in order to better their standard of life. According to Hussein and Nelson (1998) and Ellis (1998), livelihood diversification means participating in many activities simultaneously to generate or improve one's earning potential. This, according to Alemu (2012), may entail participation in both on- and off-farm successes.

Certain livelihood assets are often required for livelihood diversification. Financial, physical, human capital, natural resources, and social support are examples of these livelihood assets (De Janvry & Sadoulet, 2000; Devereux & Sabates-Wheeler, 2004). The lack of these assets makes it impossible to diversify one's source of income. As a result, low asset base, lack of finance, lack of awareness and training, fear of taking risks, lack of rural infrastructure, lack of chances in the non-farm sector, and poor transportation facilities, according to Khatun and Roy (2012), are all challenges to livelihood diversification.

A sustainable livelihood strategy prioritizes the needs of the poor (Chambers & Conway, 1992) in order to enhance their living conditions (Devereux & Sabates-Wheeler, 2004). According to Chambers & Conway, (1992) sustainable livelihood focuses on how the poor live their life and the structural concerns that influence the way they live. According to Hussein and Nelson (1998), sustainable livelihood is defined as a way of life that can withstand and recover from stressors and shocks, retain or increase capacities

and assets both now and in the future, and does not deplete natural resources. As a result, the type of livelihood activities a person engages in determines their poverty status.

Forest products are very important for the poor, both for income generation and subsistence. In this context, rosewood have been heavily exploited with serious threat to the resource and damage to the forested area. Rosewood is an important forest commodity to the rural people. The livelihood framework views the people as operation in a context of vulnerability. Within this context, they have access to certain assets or poverty reducing factors. They gain their values from the environment. The environment influences the livelihood strategies that are open to the people in pursuit of beneficial livelihood outcomes that meet their own livelihood objectives. Has to do with people's livelihood and how it changes overtime. The framework helps to organize the factors which constrain or provide the opportunities and to show how these relate to one another.

Effects of the Commercial Extraction of Rosewood on Livelihoods

Rosewood extraction for commercial use has a variety of consequences for society. Several studies show that the unsustainable nature of the extraction impacts the community's economic, social, and environmental sustainability (Ghana & Apaak, 2017; Bandoh, 2017; Ahmed, Oruonye, & Tukura, 2016). The aspect of livelihood that is impacted by extraction comprises the social dimension of society's long-term viability (Reboredo, 2013). "The deteriorated environment might worsen the process of impoverishment because the poor rely directly on natural resources," Pearce and Warford (1993, p. 262) wrote. According to Scoones (1998), poverty and environmental deterioration are

linked. As a result, poverty encourages people to put pressure on or exploit the environment in order to meet their requirements, leading to domain depletion.

Similarly, Ascher and Healy (1990) claimed that poor people tend to mine natural capital by excessively harvesting trees for firewood and failing to replenish them in order to meet their periodic needs such as food, energy, income, and water. Several studies show that the unsustainable nature of the extraction impacts the community's economic, social, and environmental sustainability (Ghana & Apaak, 2017; Bandoh, 2017; Ahmed, Oruonye, & Tukura, 2016).

Environmental deterioration, such as deforestation and habitat destruction, is intrinsically linked to the poor's struggle for survival, ecosystem damage, and wildlife extinction (Boyce, 1994). As a result, as grasslands deteriorate, livestock suffers and money is lost, impacting livelihoods. This is the foundation of the relationship in which agriculture is rely on the environment, and humans are reliant on agriculture (Padmanaba & Corlett, 2014). The outcome of this in the local economy is a decrease in rural people's economic activities.

The worth of environmental resources is determined by how a community recognizes growth opportunities and hazards (Freudenburg & Frickel, 1994; Freudenburg, 1997). Rural people's livelihood methods are often adaptable responses to changes in their circumstances. Furthermore, because the poor directly relies on natural resources, a deteriorated environment can hasten the process of impoverishment. This reduces farmers' production yields and, as a result, the ability of rural people to raise their level of living.

Empirical Review

Reviewing empirical studies is important because it minimizes duplication of effort and expands understanding about the topic under investigation (Griffiee, 2012; Sekaran, 2003). Furthermore, empirical review helps to identify knowledge gaps, introduce multiple research approaches to the study, and contextualizing findings (Griffiee, 2012; Khan, 2014). The empirical research focuses on the population structure of *Pterocarpus Erinaceus* Poir and the minimal felling diameter in dry and semi-arid climate zones of West Africa. The empirical papers that were reviewed include Segla, Rabiou, Adjonou, Moussa, Saley, Radji, and Kokou (2016), Randriamalala and Liu (2010), Ahmed, Oruonye, and Tukura, (2016), Valdez, (2019), and Piabuo, Minang, Tieguhong, Foundjem-Tita, and Nghobuoche, (2021).

Segla, Rabiou, Adjonou, Moussa, Saley, Radji, and Kokou, (2016) studied the population structure and minimal felling of *Pterocarpus Erinaceus* Poir in arid and semi-arid climate zones of West Africa (2016). The study was conducted in Togo, Niger, Burkina Faso all of which are West African countries. Forest inventories were used to acquire the data. The sampling was done using two different methods: a band transect and random sampling.

In Niger, and Burkina Faso, the transect method was utilized, but in Togo's Guinean and Sudanian zones, the random approach was used. The transect method was justified since the vegetation of the Sudan and Sahel zones in Niger, and Burkina Faso have a low density of species, whereas the Guinea and Sudan zones in Togo had a comparatively large concentration of species, therefore random approach was used.

In the first procedure, the transects used were two of 200m perpendicular each. A GPS was used to perform an azimuth procedure in each observation band. Individual species were examined and the diameters taken was at a breast height (DBHs) of less than 10 centimeters. The random technique, on the other hand, was based on 1000m² (40m 2m) sample units at regular intervals of 200m, which was randomly established in *P. Erinaceus*-dominant populations. In Togo, a total of 60 sites were investigated.

The leaves of the species were utilized as fodder in the Sahelian zone, but they were rarely employed as lumber, according to the study. The species was commonly collected for wood, fuel and logs, in the Sudanese and Guinea zones. Furthermore, the study discovered that logging and farming practices in the Sudanian and Guinean zones have an impact on the growth of rosewood and hasten the extinction of matured species trees. The MDEs for the Guinean–Sudanese and Sahelian areas respectively, were 35 cm and 65 cm, according to the authors.

Madagascar rosewood was studied by Randriamalala and Liu in 2010. The study's focus was on democracy and environmental protection. The study looked into how traders avoid paying taxes to the government, the forces that drive the trade, and the socioeconomic and ecological consequences of the illegal rosewood trade in Madagascar. The data for the study was obtained using the survey approach. The research lasted a year, beginning in February 2009.

Both primary and secondary data were used in this investigation. Permits, minutes, statements, and contracts from officials from the MEF, the Customs and Justice services, banks, shipping businesses, and exporters were used to compile preliminary data. Those interviewed for the study included

government officials, woodcutters, visitors to the region, residents of Andapa, Vohemar, Sambav, and two Antalaha exporters.

Fraud was discovered at every stage of the rosewood trade, according to the report. The study discovered, however, that this hurricane did not uproot most trees transported after a cyclone, but rather that they were felled on purpose. In 2009, it was estimated that a total of \$ US 550,000 was lost due to fraud. The Chinese were the primary importers of Madagascar rosewood, according to records. The survey also found that active logging was taking place openly, that wildlife had vanished, and that the forest was nearly naked. According to the findings, additional trees of various types were cut to improve accessibility to the species and aid in the transportation of the valuable timber.

Valdez (2019) investigated the regeneration of *Dalbergia stevensonii* through coppicing in Belize. The research was carried out in the Toledo district. For the observation, the study location was chosen with care. The study was based on an evaluation of the stump and coppicing component of *Dalbergia stevensonii*'s population status in 2014. The information was re-gathered from earlier inventory plots. The data on coppicing was gathered over the course of one week, from October 8 to 12, 2018.

Eight plots were re-evaluated and selected based on stump accessibility. For reassessment, parcels were split into ten subplots. Primary data came from field observations and assessments of stumps resprouts of trees removed in 2014, while secondary data came from population assessment data from the same year. The data was analyzed using IBM SPSS11 Statistics for Windows, Version 25.0.

Although the initial vigor of the resprouts was strong, the study discovered that this did not guarantee the survival of all resprouts. Valdez (2019) also said that there was a significant resprout mortality rate when comparing resprout survival in 2014 and 2018. He also concluded that, while a stump's coppicing vigor is low just after it is felled, resprout growth in numbers may occur later.

Similarly, Ahmed, Oruonye, and Tukura (2016) investigated the environmental effects of increased rosewood logging in Nigeria's Taraba State. The qualitative research method, survey design method, participant observation, and structured questionnaires were all used in the study. Respondents were chosen solely on the basis of their direct or indirect engagement in the activity and were given questionnaires to complete. In this investigation, secondary materials were also used.

The respondents were chosen using a random sample and availability technique. Because the wood producers were not stationed somewhere, the organized interview schedule was given to them wherever they were discovered. The organized interview schedule was created to gather information on tree species, commonly chosen reasons for choice, challenges associated with tree wood felling, shipping, and trading, and methods for achieving sustainability in timber production or otherwise. To get results, descriptive statistics were employed to analyze the data.

About 2,250 stands of *P. Erinaceus* trees were killed weekly, and 132,600 stands were cut annually in one single region, according to the findings (Mayo Kam). Illegal extraction was highlighted as the leading driver of forest degradation around the world. The indiscriminate logging of logs has opened

up large forest areas, particularly on hilltops and along important rivers in the area where these trees grow. Furthermore, the study discovered that, as a result of the fall in the species, extraction activities in the study area had drastically decreased and had been relocated to other parts of the state. The commercial exhaustion of *P. Erinaceus* trees at the local level, according to Ahmed, Oruonye, and Tukura (2016), could focus on other indigenous rosewood species.

In a study on illegal logging and governance, Piabuo, Minang, Tieguhong, Foundjem-Tita, and Nghobuoche (2021) experimentally studied the influence of unlawful logging and governance effectiveness on carbon emissions. The study took a qualitative as well as a quantitative approach. Data was gathered from three time-series datasets spanning the years 2000 to 2016. The data was analyzed using a panel dynamic co-integrated regression model (DOLS) and time series analysis.

Piabuo, Minang, Tieguhong, Foundjem-Tita, and Nghobuoche (2021) discovered that unlawful extraction and governance efficiency had a considerable effect on carbon emissions in the Congo Basin's timber-producing countries. This implies that an increase in unlawful extraction or governance efficiency leads to an increase in carbon emissions. They came to the conclusion that this may be expounded by an increase in unlawful extraction and higher corruption, which are linked to the illegal removal of trees, lowering the forest's carbon sequestration potential and thus increasing carbon emissions. However, the situation in Asia's timber-producing countries is slightly different.

Table 1: Summary of Empirical Reviews

No.	Author (s)	Year of publication	Issue under study	Research area	Research method (s)	Method of sampling	Data collection instruments	Results
1.	Ahmed, Oruonye, and Tukura	2016	Dynamics of Rosewood exploitation in savanna lands	Taraba State Nigeria	Mixed method	random sampling	Survey Participants' observation Structured questionnaires	About 2,250 stands of <i>P. Erinaceus</i> trees are felled weekly and 132,600 stands felled annually in one single location (Mayo Kam)
2.	Segla, Rabiou, Adjonou, Moussa, Saley, Radji, and Kokou	2016	Population structure and minimum felling diameter of <i>Pterocarpus erinaceus</i> Poir in arid and semi-arid climate zones of West Africa.	Burkina Faso, Niger and Togo	Mixed methods	band transect method and the random method.	Observation	The leaves of the species were used as fodder in the Sahelian zone where it is rarely exploited as timber. While in the Sudanian and Guinean zones, the species were frequently harvested for timber, service wood and fuel. Logging and farming practices impact the development of <i>P. erinaceus</i> and accelerate the extinction of large-diameter trees.
3.	Randriamalala and Liu	2010	Rosewood of Madagascar: between democracy and conservation.	Madagascar	Mixed method	Purposive sampling,	Survey guide,	Fraud took place along every step in the rosewood trade. The majority of trees

Table 1 continued

4.	Valdez	2019	Analysis of regeneration by coppicing of <i>Dalbergia stevensonii</i> in Belize	Toledo District	Mixed methods	Purposive sampling	Observation guide	<p>exported following the passage of a cyclone had not been uprooted by this hurricane but rather were intentionally felled. A total amount of US \$550,000 was lost due to fraud in 2009. Although initial resprouting vigor was high, it did not guarantee survival of all the resprouts. W</p> <p>hen comparing resprout survival in 2014 and 2018, it was discovered that there was an increase in resprout mortality. That the Congo Basin timber-producing countries are characterised by increasing trend of illegal logging, poor governance effectiveness and corruption.</p>
5.	Piabuo, Minang, Tieguhong, Foundjem-Tita, and Nghobuoche	2021	Illegal logging, governance effectiveness and carbon dioxide emission in the timber-producing countries of Congo Basin and Asia	Congo Basin and Asia	Mixed methods	purposive simple random sampling survey	Survey guide	

Source: Author's compilation (2018)

Lessons Learnt

The survey approach was mainly adopted, according to the various empirical assessments. The survey method was specifically used to focus on rosewood areas in order to uncover crucial factors impacting rosewood species exploitation within its dominant regions. In addition, descriptive study design was used to investigate the unsustainable extraction rate of rosewood and how it affects the environment and livelihoods, according to the review. Mixed methods research was chosen primarily because it provided a mechanism for gathering, interpreting, and combining qualitative and quantitative data in order to analyze a phenomenon. As a result, adopting this approach in a study can yield all of the information needed to inform theory and practice.

Purposive sampling and simple random sampling were the most commonly used sampling methods, according to the review. Purposive sampling was employed to identify key informants, while simple random sampling was utilized to ensure that all respondents had a chance of being chosen for the research. Interviews and participant observations were revealed to be the most commonly used data gathering methods. These various ways aided in the collecting of data from the impacted areas, which ensured rigorous data collection by overcoming the limits of using a single method. An interview guide, interview schedule, and a field observation guide were among the data gathering instruments used by the majority of the research.

Issues related to the depletion of rosewood due to unsustainable extraction was dominant in the empirical review. This aided in settling on the topic and specific area of interest for the study. The review further informed the

researcher on the issues to look out for in the process of the data collection, hence aided in the development of guidelines for the study.

Because of the diverse character of the issues studied, prior studies used rigorous statistical analysis for quantitative evaluations. IBM SPSS Analysis was one of these statistical analyses. Descriptive statistics, on the other hand, were frequently used. In qualitative research, thematic analysis was commonly employed. This qualitative analysis tool can be used to examine nominal data.

The review further contributed to the construction of the conceptual framework. Because, it was revealed in the empirical review that, the nature of extraction is determined by the drivers of extraction. Also, from the review the drivers may enhance or retard the extraction activities. In effect, the impact on the livelihood is determined by the nature of the extraction.

Conceptual Framework

The study's major variables and the conceptual framework function together (Figure 1). According to this diagram, commercial rosewood extraction has a direct relationship with environmental and livelihood implications. According to the nexuses, commercial rosewood extraction largely provides an enabling environment for particular social circumstances to alter or prosper. The presence of a commercial extraction procedure for rosewood is fueled by a number of challenges.

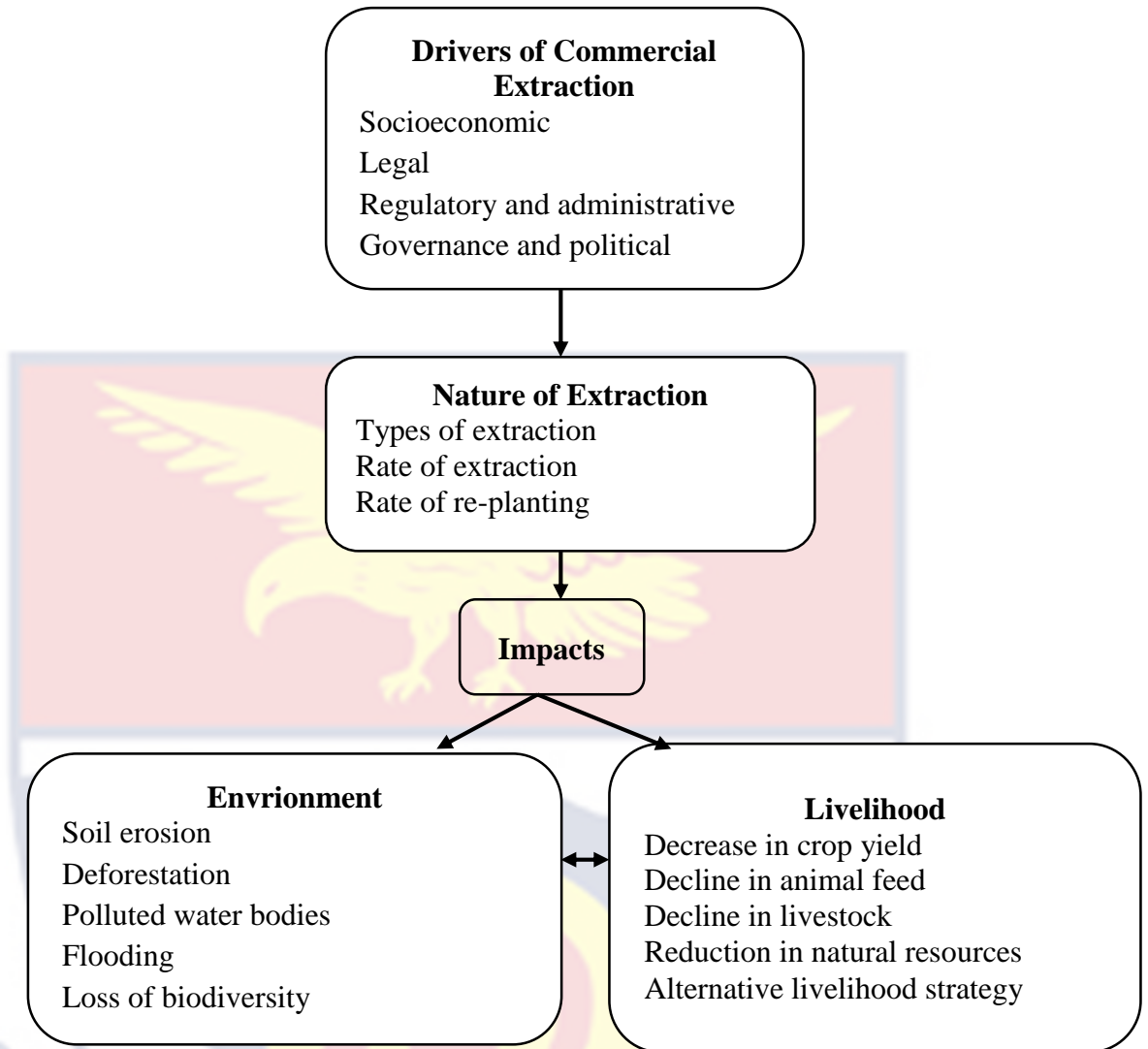


Figure 2: Dynamics for the Extraction of Rosewood and its Implication on the Environment and Livelihood

Source: Author's construct (2020)

Dynamics governing the extraction of Rosewood covers the drivers that account for the extraction and the nature of the extraction industry. The drivers namely, socio economic, legal, regulatory, administrative and governance and political, entail the conditions that structure the industry. However, Institutional framework determines how well these drivers work to either enhance or retard the extraction process in a given context.

This indicates that ineffective government implementation of forest management rules and policies can lead to inefficient extraction techniques, illicit extraction, and over-harvesting. The forest and environmental laws must

be properly enforced. Individuals and businesses will operate in full conformity with the law and act in accordance with forest extraction laws and regulations once these are in place.

High unemployment, poverty, poor income, and an increase in demand for rosewood are socioeconomic drivers. These socioeconomic issues influence how individuals and communities obtain the resources they require to meet their basic human needs. Furthermore, socioeconomic variables such as lower-income households are more inclined to use whatever means at their disposal to gain access to nature, making it simpler to use forest products, which can contribute to increased degradation.

Legal drivers are necessary for defining the rules and obligations of the various players engaged in the creation, administration, and enforcement of social protection systems. These laws are necessary for the administration of environmental legislation. Permits are issued to companies and individuals in the wood logging industry to assist regulate the industry. Governmental and political drivers, on the other hand, are concerned with the functions of governments, political jurisdictions, legislative bodies, and regulatory agencies.

The purpose of government in enforcing environmental laws and policies should be to oppose or reduce unauthorized logging, unsustainable extraction techniques, and their consequences for livelihoods. When government ability is insufficient, poor extraction and unauthorized logging prevail. Traditional rulers and legislators, for example, must make steps to enforce good governance.

The environment is degraded as a result of unsustainable plant extraction, which has an impact on society's ecosystem services. The

degradation of the environment has an impact on people's lives since some people rely on the ecosystem as a source of income. As most resources available to them are endangered by the extraction process, people of society use a variety of coping techniques to make ends meet. In effect, how well the extraction drives can act in a given setting will be determined by a well-established institutional structure.



CHAPTER THREE

RESEARCH METHODOLOGY

Introduction

The strategy to solving a research problem analytically is known as research methodology (Kothari, 2004). The study's research procedures are described in this chapter. The study field, research philosophy and design, and study design are all discussed in this chapter. The target population, sample and sampling method, data gathering tools and instrument, instrument design, and ethical considerations are all discussed. A summary concludes the chapter.

Study Area

The study was carried out in the Wa East District in the Upper West area. The Sissala East district borders Wa East on the north, West Gonja on the southeast, and West Mamprusi on the northwest (GSS, 2014). It has a population of 78,412, with males accounting for 49% (38,422) and females for 51%. (39,990) (Assembly of Wa East District, 2014). The district accounts for around 17.3% of the region's total landmass (18,478.4sq/km²). Because of its isolation from other parts of the region, the district lacks fundamental social and economic infrastructure and services (PHC, 2010).

The geographical vegetation in these areas is characterized by open savannah woodland and is classified as an ecologically dry zone. The rainy and dry seasons are the two seasons that the zone experiences. The rainfall pattern is mono-modal and continues from May to October. Wa East is one of Ghana's most climate-vulnerable regions. In the last 115 years, the district has seen varied of rainfall declines, rainfall variability, and temperature rises (Abbam, Johnson, Dash, Padmadas, 2018). In general, rainfall is moderately

seasonal and irregularly distributed throughout the year. The district's main issues are soil deterioration, recurrent droughts and floods are the district's main issues.

Agriculture is the district's primary source of revenue (GSS, 2012). Livestock farming, grain farming, tree farming, and fish farming are among their main farming operations. According to the Wa East District Assembly (2016), the overall population engaged in agricultural activities was 10,167 in 2014, accounting for 94.4% of the district's entire households (10,8670).

Wa East is one of the most densely forested places with harsh climatic conditions in the region. Rosewood is predominant in this area. The plant is drought resistant, which helps to explain why it can grow in such a harsh climate. Several timber merchants have encroached into the savanna areas of the Wa East district, bringing their chainsaw operators or hiring locals to fell rosewood to serve their trade in the species (Kansanga, Dinko, Nyantakyi-Frimpong, Arku). Most of the district's roads are impassable (Wa East District Assembly, 2015).

THE WA EAST DISTRICT.

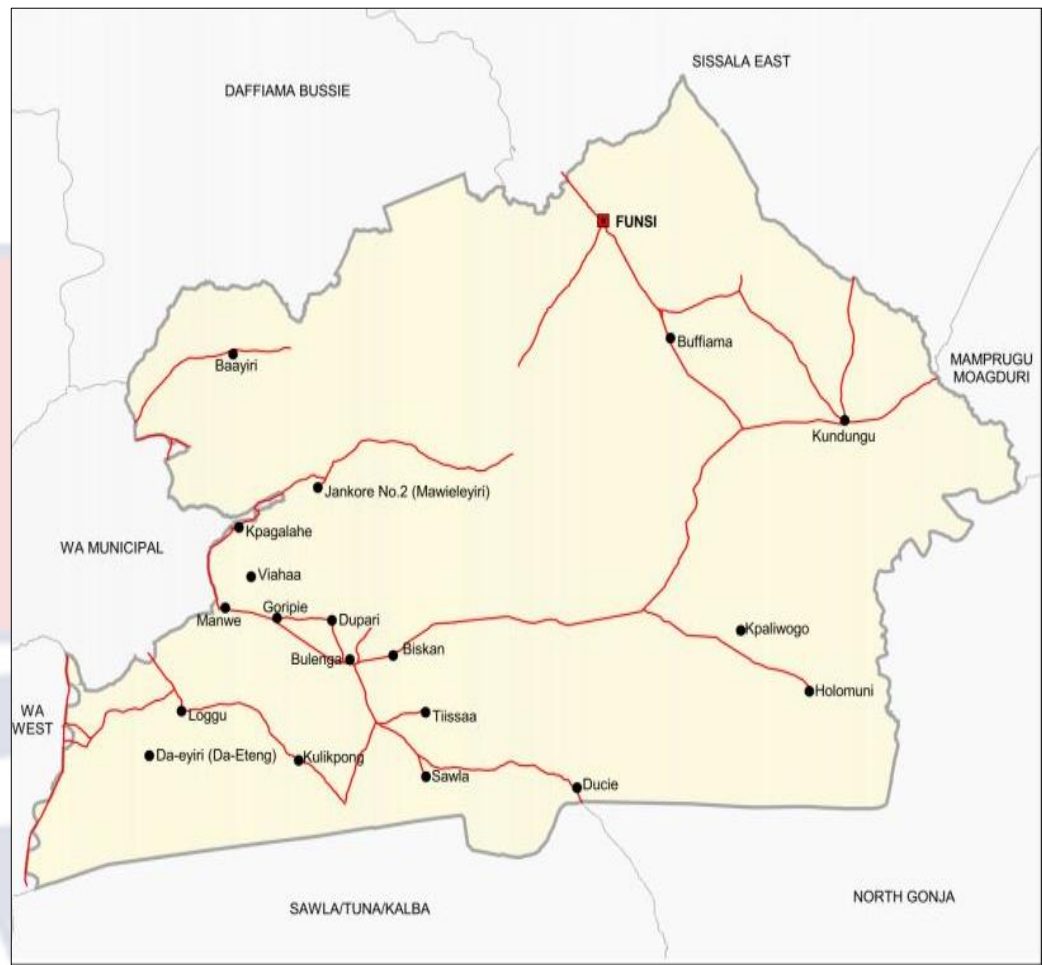


Figure 3: Wa East District Map

Source: GSS (2014)

Philosophy of Research

Philosophical viewpoints continue to have impact on social science research (Sarantakos, 1998). According to Chilisa and Kawulich (2015) and Sarantakos (1998), positivism, interpretivism, and pragmatism are the most influential philosophical worldviews in social scientific research. These paradigms are used to guide the researcher's ontology, epistemology, methodology, and tactics throughout the research process.

The positivist approach in research is a philosophical notion that upholds the concepts of rhetorical impartiality and subjectivity (Johnson &

Onwuegbuzie, 2004). Positivism asserts that when employing scientific methods, there is an objective reality that can be recognized (Bhattacharjee, 2012). Verifiable measurement and exact observation are the foundations of knowledge acquisition in positivist epistemology (Ary, Jacobs, Razavieh, & Sorensen, 2010). Primarily, quantitative research design is used in positivist methodology by using experimental, correlational, survey, or causal-comparative study designs (Bhattacharjee, 2012). In the positivist paradigm, data collection methods include interview schedules, questionnaires, tests, experiments, and observations (Chilisa & Kawulich, 2015).

In contrast, the interpretive paradigm maintains a relativist ontological viewpoint, in which reality is independently generated and differs from one person to the next (Johnson & Onwuegbuzie, 2004; Patel, 2015; Scotland, 2012), resulting in the presence of different facts. Subjectivity underlies the interpretivism epistemology, which is based on the natural world phenomena of human experiences of socially created knowledge (Chilisa & Kawulich, 2015; Ponterotto, 2005). In terms of methodology, interpretivism favors a qualitative purist approach and uses study designs such as phenomenology, case studies, ethnography, hermeneutics, and feminist perspectives to investigate social phenomena (Patel, 2015; Yin, 2003).

In the pragmatic worldview, however, knowledge claims emerging from research results focus on current acts, conditions, and outcomes of inquiry rather than historical circumstances (Baert, 2005)). According to Johnson and Onwuegbuzie (2004), the pragmatic paradigm is not attached to any philosophical system or reality. In the pragmatist viewpoint, truth is defined as what works at a given time (Johnson, Onwuegbuzie, 2004). In this philosophical

perspective, research is conducted utilizing mixed methodologies, allowing researchers to rely on qualitative and quantitative assumptions at will (Yin, 2003; Zachariadis, Scott, & Barrett, 2010).

Given the three philosophical viewpoints of positivism, interpretivism, and pragmatism, this study is more in line with pragmatism's views because the current research focuses on the commercial extraction of rosewood and its impact on the environment and livelihood. This necessitates the collection of qualitative and quantitative information. The pertinent issues in the pragmatic worldview ideas will pave the way for satisfactorily addressing the study's important elements. Because it was accepted by some of the earlier empirical research. Also, this philosophical paradigm helps to analyse issues from a broader perspective. As a result, the pragmatic point of view is adopted as the philosophical paradigm guiding this research.

Research Design

The mixed-methods technique is the best research strategy to use (Tashakkori & Teddlie, 2008). The study used mixed-method methodology, which allows for the gathering and analysis of data using both qualitative and quantitative methodologies. Benefits associated with combining quantitative and qualitative approaches, which allows the researcher to leverage the strengths of the systems while reducing their inherent flaws, inform the process choice. The researcher also addressed the research issues from both qualitative and quantitative viewpoints using a mixed-methods strategy (Dedoose, 2012). Mixed methods research necessitates the gathering, analysis, and interpretation of both quantitative and qualitative data in order to incorporate them into a single study.

Mixed-methods research was chosen for this study to allow the researcher to view the problem from multiple perspectives in order to enhance and enrich the meaning of peculiar viewpoint study (Creswell, Klassen, Clark, & Smith, n.d.), as well as to integrate findings in order to draw inferences from both qualitative and quantitative perspectives (Creswell, Klassen, Clark, & Smith, n.d.). In both quantitative (validation) and qualitative (inquiry) investigations, the researcher will use triangulation, a technique of verification that increases validity by embracing different opinions, methods, and data sources (Dedoose, 2012).

Target Population

The target population is the total number of units for which survey data is used to draw conclusions (Lavrakas, 2008). As a result, the target population identifies the groups to which the survey results should be applied (Asiamah, Mensah, & Oteng-Abayie, 2017). Households, landowners, chiefs and caretakers of the land, Forestry Commission personnel, and assembly members make up the study population. In this study, all of the residents in the Wa East District are eligible to be respondents since they have the common attributes of being District residents.

Table 2: Community Demographic and Household Characteristics

	Population	Males	Females	Number of Households
Bulenga	2,793	1,381	1,412	443
Funsi	3,311	1,602	1,709	558
Kundugu	2,325	1,165	1,160	309
Goripie	2,339	1,168	1,171	325
Total	10,768	5,316	5,452	1,635

Source: GSS (2010)

Sample and Sampling Procedure

Any empirical study in which the purpose is to draw conclusions about a population from a sample must first determine the sample size (Taherdoost, 2017). According to Kadam and Bhalerao (2010), studying an entire population is neither realistic nor viable. As a result, a group of people is chosen from the people who are few yet appropriately reflect the population from which they are drawn, allowing accurate conclusions about the people to be derived from the data. Yamane's (1967) formula for sample size is used to compute the sample size for the research, which has a 5% margin of error and a 95% confidence coefficient. The relationship yields the following formula:

$$n = \frac{N}{1 + Ne^2}$$

Where, n = the sample size, N = the size of the population, and e = the margin of error of 5 per cent.

Given that $N = 1,635$

$e = 0.05$

$$n = \frac{1,635}{1 + 1,635(0.05)^2} = n = \frac{1,635}{5.0875^2} \quad n = 321.37$$

$n = 321$

The calculated sample size for the research is 321. Following that, the sample size will be distributed proportionally among the communities depending on the total household population. Table 2 highlights the proportional distribution of households to the study communities.

Table 3: Household Sample Proportional Distribution

Communities	Household size	Proportion of total household x total sample size (321)	Sample
Bulenga	443	0.209 x 321	87
Funsi	558	0.341 x 321	109
Kundugu	309	0.189 x 321	61
Goripie	325	0.199 x 321	64
Total	1,635		321

Source: Author's Compilation (2020)

Simple random sampling was the adopted process in sampling the household respondents (Yates, Moore, & Starnes, 2008). The sample frame of the houses obtained for the municipal assembly and the respondents was randomly sampled. The landowners, chiefs and custodians of the land, officials from the Forestry Commission and the assembly members were purposively sampled as these are key informants. These respondents had information and knowledge relevant for the study.

Data Collection

Five research assistants were employed to help the researcher with data collection. Native language speakers were hired and instructed on the interview guide's elements and how to interpret them. Primary and secondary data were acquired for the investigation. We gathered data on characteristics that explain the commercial mining of rosewood. Furthermore, information was gathered on

the effect of commercial rosewood extraction on rural livelihoods and natural resources. In addition, information on evolving patterns of livelihoods such as farm, off-farm activities were acquired. Secondary information was sought to examine the rate of extraction and the changes in land cover that accompanied it. Table 3 summarizes the types of data, measurement scales, and analytical processes used.



Table 4: Objectives of the study, Data Types, Variables, Measurement Scales, Data Sources, Target Populations, Methods, and Analytical Methods.

Specific objective	Types of data	Variable	Measurement scale	Source of data	Target population	Methods	Analytical methods
To explore the rate of rosewood depletion and methods of extraction in the Wa East District	Qualitative	Changes in extraction over time	Nominal	Primary data	Chiefs	Interviewing	Thematic analysis
	Quantitative			Secondary data	Affected farmers landowners Assembly members		
To investigate the range of rural livelihoods affected by the commercial exploitation of rosewood in the Wa East District	Qualitative	Soil erosion, Deforestation Polluted water bodies Flooding Loss of biodiversity Animal fodder timber	Nominal	Primary data	Forestry Commission officials	Interviewing observation	Thematic analysis
				Secondary data	Rural folks, chiefs, affected farmers, landowners		
Examine the effects of rosewood extraction on the natural environment in the Wa East District	Quantitative	Farm Off-farm formal Informal livelihood activities Assess assets (social, Financial, physical, human and natural)	Nominal	Primary data	Rural households	Interviewing observation	Thematic analysis
	Qualitative			Secondary data	Landowners		

Source: Author's Construct (2020)

Instruments Design

The data was gathered using semi-structured interviews and interview guides. The semi-structured interviews elicited data from households, while key informants were interviewed using interview guides. The next paragraphs detail the exact design of these instruments.

The use of an interview as a data gathering tool is justified since it allows for observation of respondents' nonverbal behaviors, ensures comprehensiveness, and aids in the collection of holistic data. Furthermore, the majority of the household respondents are uneducated. Earlier research (Ahmed, Oruonye, and Tukura 2016; Valdez, 2019 Piabuo, Mining, Tieguhong, Foundjem-Tita, and Nghobuoche, 2021) into similar issues used a similar tool to collect data. The interview schedule for the houses was created in accordance with the study's four objectives. The interview schedule was divided into five sections, each with closed and open-ended questions. The first section collects information about the respondents' demographics, such as their name, age, educational level, household size, and occupation. The interview guide, on the other hand, includes open-ended questions that allow the researcher and interviewee to interact and dig for a deeper knowledge of the topics at hand.

Ethical Procedures

The research was carried out in accordance with social science research ethics. Informed consent, voluntary involvement, inflicting no harm, privacy, anonymity, and confidentiality of the respondents' data are among the ethical factors, according to Sieber (1998), Sarantakos (2005), Punch (2005). Before beginning the fieldwork, approval was obtained from the Institutional Review Board (IRB) of the University of Cape Coast (UCC). Respondents were asked

for their informed consent by the researcher. Before each interview, a statement on informed consent was made available, and the respondents were asked to sign it. For expert interviews, however, a letter of approval was employed to get the key informants' informed consent.

All respondents were told that if they accepted to engage in the study, their rights would be protected and that participation in the survey was entirely voluntary. The respondents were informed about the research's goal and procedure. All respondents were assured that the study would not affect them in any way. To preserve participant confidentiality and privacy, the researcher employed codes and pseudo names. The respondents were assured that the data they supplied would be kept private and would only be used for academic purposes.

Data Processing and Analysis

The researcher collected both qualitative and quantitative data, demanding both quantitative and qualitative analysis. The quantitative data was edited, coded, inputted into Statistical Product and Service Solutions (SPSS) version 21, and cleaned. The investigations included descriptive statistics, and other statistical approaches. The quantitative data was presented using tables and figures while thematic analysis was used in developing themes for the qualitative data. Texts, tables and figures were used to present the qualitative data.

Chapter Summary

The chapter consists of research methodologies utilized to achieve the study's goals. Only qualitative methodologies were employed. The specific sample technique employed was simple random sampling. The data gathering

methods employed were an interview schedule and an interview guide, followed by theme analysis.



CHAPTER FOUR

RESULTS AND DISCUSSIONS

Introduction

This chapter discusses the outcomes of the issues that address the research objectives. To characterize the study's participants, the chapter begins with their background characteristics. Following that, based on the study's research aims and conceptual framework, the findings and comments are arranged into three important themes. The rate of rosewood depletion and methods of extraction, the range of rural livelihoods affected by the commercial extraction and the effect of rosewood exploitation on the natural environment in the Wa East District are the themes discussed.

Participants Background Characteristics

Age distribution, degree or level of education, participants' occupation, land ownership, length of stay in the community, and access to land were the information gathered as the background data of this study. Three hundred and twenty of the 321 interview schedules administered were valid, resulting in a 99 percent response rate. A response rate of 60% is regarded good, according to Fincham (2008), and should be the researchers' goal. As a result, all of the analyses are based on the 318 respondents who responded within the allowed range. According to Table 4, Bulenga accounted for 27% of the respondents, followed by Fonsi (34%), Kundugu (19%), and Goripie (20%).

Table 5: Research Participants of Study Communities

Community	Number	Percentage
Bulenga	87	27
Funsi	109	34
Kundugu	61	19
Goripie	64	20
Total	321	100

Source: Author's Compilation (2021)

The age of the interviewees was the first background feature assessed. In all of the villages chosen, the respondents were aged 20 and above. Table 5 shows that 33% of respondents were between the ages of 35 and 44, and 25% were between the ages of 25 and 34, 21 % were between ages 25 and 34, and 21 percent were between ages 25 and 34, and 21 percent were between ages of 20 and 24, respectively. This indicates that the majority of the responses were older, and as a result, they may be able to provide specific data about the extraction. For this study, age is crucial since it can help with stories of extraction operations in response to the near-extinction of rosewood which previously served the community members source of income (Yates, Moore & Starnes, 2008). As a result, the elders may well be able to provide vivid accounts of the extraction process as responders. Younger persons under the age of 20 may, on the other hand, have limited expertise of rosewood extraction. Table 6 shows the age distribution of responders.

Table 6: Respondents Age Distribution in Study Communities

Age	No. of respondents	Percentage
20-24	67	21 %
25-34	80	25 %
35-44	105	33 %
45 and above	69	21 %
Total	321	100%

Source: Field Data (2021)

The respondents' occupation was the second factor evaluated in their background. 40 percent of the 321 respondents were simply farmers, 22 percent were minor traders, 17 were teachers, and 10% were both farmers and hunters. As stated in Table 7, the rest were health employees, environmental health workers, and forestry commission officers.

Table 7: Occupations of Household Respondents in the Study Communities

Occupation	No. of Respondents	Percentage
Farmers	130	40
Farmers and hunters	30	10
Teachers	56	17
Health workers	21	7
Forestry commission officials	4	1
Environmental Health workers	10	3
Petty traders	70	22
Total	321	100

Source; Field Data (2021)

The length of stay of the respondents in the various communities was the next background characteristic evaluated by the study; this background variable affected respondents. They should have spent at least five years in the neighborhoods. At the time of the interviews, the respondents had been in the country for 5 years or more. This was useful in determining the patterns of

rosewood extraction in the district. The responders should have stayed longer to learn more about when and how rosewood extraction began in the area. This benefited the responders in providing precise information about rosewood extraction.

Access to land was another characteristic considered in the study. Land within the study area is acquired through inheritance. Lands in the study communities belong to the tendanas and the royal families. Therefore, land is either inherited or permission must be sought from the traditional authorities before usage. As such, land in these communities are not sold. The major source of livelihood of the people was identified as farming and hunting. It was noted that, most of the rural people within these communities were largely engaged in either farming or hunting as a source of livelihood.

The respondents interviewed included chiefs, assembly members, members of households and officials from forestry commission. The role these respondents play in the various communities was considered. The chiefs are the royals and the custodians of the land. They formulate local rules with the tendanas and elders of the community which governs the affairs of the entire community. Also, they deliberate on issues relating to the welfare of the communities. The assembly members are the liaison between the community and the district assembly. The forestry commission officials were in charge of safe guarding the forest reserves within the district. Forestry commission ensure the legality of every activity in the forest. They ensure that the companies are licenced, have permits and proper documents indicating the permission granted them to carry out any activity within the forests.

Dynamics of the Extraction of Rosewood

The study's first goal was to explore the rate of rosewood depletion and methods of extraction in the Wa East District. The dynamics of the extraction of rosewood covers the drivers that account for the extraction and the nature of the extractive industry. The study found that, the main drivers of the rosewood extraction are socioeconomic, legal, regulatory, administrative, governance and political.

From the interviews, it emerged that, the Chinese and some Ghanaian timber companies were the major actors involved in rosewood extraction. It was discovered that, the Chinese were the majority while the Ghanaians were the minority. Accordingly the Chinese and Ghanaian timber companies extracted the rosewood species in large commercial quantities as compared to the rural folks. The rural folks extracted rosewood in smaller quantities purposefully for domestic usage. It was further revealed that, Ghanaian timber companies and Chinese provided the machinery for the extraction and recruit some indigens to aid them in the process of extraction

During the interview, one of the key informant stated that,

‘ The main people involved in the extraction process comprises of Chinese and big Ghanaian timber companies. But, most of them are Chinese. They owned heavy machines for the extraction. This enables them to cut a lot of rosewood within a short time. The rural folks involved do not have such equipments so they mostly use axe and machetes in cutting of rosewood. ’

According to the interviews, the increased demand for rosewood, particularly among the Chinese, prompted most young men, including several chiefs and community leaders, to discreetly enter the rosewood business. The young men, including several chiefs and community leaders, enter the rosewood business discreetly with private companies. According to them, the Chinese allegedly offered "large quantities" of money in return for rosewood. Despite their awareness of the importance of their vegetation, the locals surrender to the company's demands due to their poor economic situation (poverty) and want to improve their lives. For example, over 60% of those polled mentioned how some the community members who took the companies into the forest to extract the rosewood built their own homes and fended for themselves.

Furthermore, illiteracy, poverty, unemployment, a desire to get rich quick, and a rise in the demand for rosewood are all major reasons in the felling and exploitation of rosewood trees in the areas, according to the report. The Chiefs and Tendanas possess the land, as mentioned in the previous section. Access to the lands was restricted until the recent surge in rosewood extraction and the global deployment of cash into rural populations. This resulted in the formation of a "illegal network" of politicians, forestry officials, prominent community leaders, and other community members who operate as conduits for rosewood exploitation.

This can be seen in all of the research communities. The livelihood of the rural population is inextricably related to the environment in which they reside. The majority of the people are uneducated, and, as previously said, they are either subsistence farmers, hunters, or minor traders with irregular sources

of income. As a result, most farmers choose to migrate to cities in search of other economic pursuits that will keep them afloat until the next farming season, when they will return to their communities to farm. Petty merchants also try their hand at multiple business activities in order to make ends meet. As a result, they regard extraction as a method to make quick money to enhance their standard of living without considering the long-term impact of extraction on the environment.

The findings support Hussein and Nelson's (1998) claim that people diversify their livelihoods to ensure and improve their survival. The findings also corroborate the tenets of sustainable livelihood, which say that livelihood diversification often necessitates the presence of certain assets such as financial, physical, human, natural, and social support (De Janvry & Sadoulet, 2000; Devereux & Sabates-Wheeler, 2004). Plate 1 shows rosewood from the Goripie forest that has been extracted.



Plate 1: Extracted Rosewood in Goripe Forest

Source: Field Data, 2021

Environmental Laws, Policies, Rules and Regulations:

The Environmental policy of Ghana in Article 36(9) of the 1992 constitution, requires all Ghanaians and the government to protect and safeguard the environment for posterity. Also the Forestry commission established in 1999, main mandate is to protect and manage forest resources in the interest of the country as well as establishing systems for the protection and harvesting of forest resources. Failure to carry out this mandate, results in the unsustainable usage of these resources.

There are stipulated laws which regulate environmental use in Ghana. These laws include, E&S Protections in the Ghanaian Constitution, Environmental Protection Agency (EPA) Act, 1994 (Act 490), Environmental Assessment Regulations, 1999, LI 1652, Labour Act, 2003, Act 651, Commission on Human Rights and Administrative Justice. On the other hand, Ghana is a member and a signatory to international conventions that address the climate change, the environment and its sustainability. Some of these are the Kyoto Protocol to the United Nations Conventions on Climate Change, Paris Agreement on Climate Change and the Cartagena Protocol on Biosafety.

The interview found that regulatory and enforcement institutions failed to implement environmental laws, policies, administrative rules in the study communities. According to a key informant, Rosewood was not taken for commercial purposes in the past. Rosewood has only recently begun to be commercialized. The only people who were allowed to enter the forest were community members. Rosewood was traditionally employed for domestic

purposes such as roofing, charcoal, and fuel by the rural population. Small-scale charcoal vendors were among the few who extracted it for economic purposes.

Commercial rosewood extraction began roughly 6 to 10 years ago, according to an Assemblymember during an interview.

He said, *'All of a sudden, we saw the presence of Chinese in the community. Then we started seeing huge trucks loaded with rosewood trees leaving the community. We asked questions and even impounded some of the trucks and demanded answers from the various companies and individuals. Some showed us permits issued from Accra and others had nothing to show. Those that had no documents, we did not release their trucks for them. We then set up vigilante forces to watch over the forestry activities'*.

The harvest of rosewood is prohibited, according to forestry officials. However, according to the Forestry Commission of Ghana, the Ministry of Lands and Natural Resources may give licences to private firms to salvage naturally fallen and abandoned logs of commercial worth. Though the volume of rosewood and specific geographic area where the salvaging should occur are often stated in the permits, the companies often show up in the communities without designated areas. Since some of the Chiefs and community leaders are illiterates, they cannot challenge the authenticity of the company's claims that some bribed Forestry Officials sometimes support.

A key informant indicated that, in instances where the companies claims are glaringly unsubstantiated, the locals are bribed to allow them access to the forest illegally. Thus instead of abandoned logs, they end up felling the trees themselves and staying longer in the forests than expected 80% of the

respondents indicated that, the timber companies extracted almost all the matured rosewood species because of the lack of restrictions and resistance from the forestry commission, community members and their chiefs. For instance an informant from Bulenga explained that, there are unsustainable extraction of the rosewood species and that there have been a total decline in the species because the bodies responsible for the protection of the forest have failed in doing so. In quote, he stated that,

'The timber companies have cut all the rosewood trees within the forest. Now its very difficult to come across a matured specie. Its only the younger species remaining which is not even much. The forestry commission officials just say that,the companies have permits to cut them but do not ensure that they cut a few and leave some behind for the locals to use. Now we the community members find it hard to roof our houses. And our chiefs too do little or almost nothing in protecting the forest. There is no enforcement of the laws here. Everybody just watch on as the extraction goes on'.

Because of the ineffectiveness of government policies and legislation connected to forestry management, there has been an increase in the harvest of rosewood, according to the statement. The finding illustrates a portion of the conceptual framework that reveals that the nature and extent of commercial extraction are determined by the drivers of commercial extraction, which include legal, regulatory, governance, and administration. Furthermore, the data support Bandoh (2017)'s assertion that in the wood business, bad management and policies enhance the presence and prevalence of illicit logging.

The finding hints that rosewood species had declined within the study communities over the past 6 to 10 years now.. Therefore, it is vital to know the nature of extraction, which entails the types of extraction, rate of extraction, and re-planting. According to the respondents, companies operate on a large-scale basis. The least the companies could extract within a week was ten trucks. Extraction was done with the use of chainsaw machines. The chainsaw operators were not rural folks. Instead, the companies brought people outside the district to operate the machines. The rural folks were then employed to cut branches from the trees and load the trucks with the wood.

From the interviews, it emerged that, companies were supposed to re-plant 10 rosewood trees in place of extracting a single rosewood tree. This decision was arrived at by a group of chiefs who came together to find solutions to the extraction and fast decline of the rosewood. Contrary to the policy of re-planting within the district, companies violated this rule and did not engage in re-planting of rosewood after extraction. They only extract the trees and move on to different locations once they found out that the species had finished at their current location. This suggests that, companies engaged in and caused deforestation with no plans of afforestation.

The lack of effectiveness of the appropriate authorities in enacting policies and punishing violators was noted by the respondents. Some respondents attributed the refusal to replant to under resourced enforcement personnel, inadequate equipment and corruption. They further stated all these factors accounted for the neglect of this responsibility by the extraction companies. During the interview, respondent clearly stated that,

“Those who engage in the extraction of rosewood do not replant after extraction because, they do not get punished for it. Therefore, they are able to get away with it easily. If they see that the Forestry Commission, chiefs and elders of the communities hold defaulting companies and persons responsible for their irresponsible act, they will engage in replanting after extraction. The extractors have seen that the authorities are not serious.”

The forestry commission had no afforestation program in place, despite the chiefs and elders' request to transplant ten trees instead of harvesting a single tree. As a result, some respondents predicted that if the proper authorities do not act immediately, there will be no rosewood trees in the forest in the next ten years.

The Effects of Rosewood Extraction

The purpose of Rosewood Extraction Implications is to investigate the impact of Rosewood Extraction. When asked about the impact of excessive rosewood extraction, 318 people (or 99 percent) said that it is a serious problem that has negative consequences for the community. Excessive extraction instances provided by respondents are divided into two major categories: environmental implication and implication on rural livelihood.

Implication of Rosewood Extraction on the Environment:

Rosewood trees were harvested by community members for local use, in the past. As a result, the extraction rate was extremely low. However, the responses claim that this has changed as a result of private enterprises (particularly the Chinese) flooding the area with demand for commercial

harvest. This has an influence on the environment as well as people's livelihoods.

Table 8: Implications of Rosewood Extraction

Implication on the Environment

Effect	No. of Respondents	Percentage
Destruction of lands	153	48
Negative effect on climate (High temperature, and rain pattern)	42	13
Destruction of roads	91	28
Destruction of houses	35	11
Total	321	100

Source: Field Data, (2021)

Taking the impact on the environment as an example, 48% of respondents expressed concern about the destruction of lands, with 28% citing the destruction of roads, 13% citing the negative impact on climate change, such as high temperatures and variable rain patterns, and 11% citing the destruction of houses. They said that over-harvesting of trees, especially rosewood, has resulted in rainfall irregularities and a decrease in downpours. As a result, the majority of the community's youth have moved to urban places. As part of the rosewood extraction effects, the damage of roads and residences was also addressed.

Accordingly, 48% of the respondents mentioned the destruction of lands as a major impact of the extraction. This they attributed to the removal of several trees to get to specific locations of rosewood. It was revealed that, the rosewood trees are not clustered at specific areas, hence, several trees are cut leaving the

lands bare. The cutting of these trees leaves the land prone to situations of floods during heavy rains. To further enhance this point, a respondent stated that,

'The people who go into the forest to cut rosewood, end up cutting and destroying lots of trees just to get to the exact locations of rosewood. Rosewood is scattered within the forest and because they use big trucks, its difficult for the vehicles to move in between the trees therefore, they end up cutting plenty trees for easy movement. This has caused the destruction of the lands because the trees serves as a forest cover preventing flooding and soil erosion from happening.'

28% of the respondents cited the destruction of roads as a major effect of rosewood extraction. It emerged from the study that, the rosewood tree served as a forest cover therefore, it prevented the communities from getting flooded during heavy rain storms. Also a key respondent stated that, the constant usage of the road by the heavy trucks and equipments for extraction, caused the further deterioration of the roads. The key respondent clearly stated that,

'Our roads are now in bad shape because of the extraction activities. This is because, the people use big trucks and other machines on the roads everyday. And also, the removal of the rosewood trees loosens the soil making it easier for floods and erosion to occur. As you can see, our roads are not tiered, so the constant movement of these vehicles have spoiled it. This makes it very difficult for the movement of even a bicycle. Some of us are unable to go to our farms when it rains heavily because the roads

are in a bad shape. Cars taking the village people to markets most at times get stuck in the bad making it impossible to go the market.'

Subsequently, 13% of the respondents cited negative effect on climate (high temperature and rain pattern) as an effect of excessive extraction.

Accordingly, the respondents stated that they have experienced irregular rainfall patterns within the study communities due to the excessive extraction of rosewood. They claimed that the destruction of the forest have caused irregular rainfall and high temperature within the communities. A respondent stated that,

'Previously, we use to experience lots of rainfall within the communities but now, one cannot tell when it will rain or not. And when it rains too, lots of things gets destroyed and we experience heavy flooding. Also, when it does not rain, the weather is very hot making it difficult to farm or even sleep at night. This we all know is because our forests have been destroyed due to the extraction activities. Because our grandfathers used to tell us that the forest helps in bringing rain.'

11% stated that the extraction caused the destruction of houses. During the interviews, it was revealed that, some houses got destroyed due to the heavy floods which occurred within the study communities. The respondents stated that, the trees serves as windblocks during heavy rainfalls and storms. But as a result of the extraction, the houses are exposed to the harsh weather conditions. An assembly man stated categorically that,

"The Chinese have destroyed the entire forest cover because of their greed. They cut down any tree at all that is a hinderance to their movement thereby, leaving the forest bare. It was the forest that

used to protect us from the harsh weather conditions, but now when heavy wind blows, our roofs gets destroyed. And also heavy rainfall submerges our houses but there is nothing we can do.”



Plate 2: Flood and Soil Erosion in Funsu

Source: Key Informant Triangulation, 2021



Plate 3: Flood in Funsu

Source: Key Informant Triangulation, 2021

Plate 3 depicts how recent floods in Wa East nearly resulted in the deaths of some passengers and ruined over 4,000 acres of crops. Plate 3. It also shows how floods in Funsu destroyed numerous homes and forced many people

to flee their homes. These were related to the communities' excessive harvest of rosewood. For example, a Forestry Commission representative said that dense forest serves as a cover or protection, but excessive logging eliminates the forest cover. According to him, removing the forest cover exposes the populations to challenging weather and makes them vulnerable. He presented the photos to demonstrate how the rising rate of rosewood exploitation has wreaked havoc on the ecology.

Many of the communities in the region were affected by these factors. According to the research, Funsu used to have a large forest reserve where people could hunt game at close range without having to go far into the forest. Because of the excessive exploitation of rosewood, a substantial amount of that forest has now been destroyed.

According to the data, increased demand for rosewood is mostly evident in excessive rosewood exploitation. This represents a feature of the conceptual framework that illustrates that high extraction rates result in deforestation, biodiversity loss, farmland degradation, and natural resource depletion. The findings support the forest resilience notion, which argues that ecosystem resilience is solely dependent on species persistence, and that the extinction of only one key component species can wipe out the entire forest ecosystem.

Implications of the Commercial Extraction of Rosewood on Rural

Livelihoods

The goal of the study on the effects of commercial rosewood extraction on rural livelihoods was to see how commercial extraction operations might affect livelihoods. Their sources of livelihood depends on the rosewood species. Therefore extraction of the tree have a direct effect on these livelihoods.

The effect on the environment and the effect on livelihood are not mutually exclusive. The effect of the extraction on the environment has a direct implication on the peoples' livelihood. The study found that most of the rural folks within the study area were largely into farming, animal husbandry and charcoal burners. The trees, for example, are a substantial source of living in the communities. Rosewood is a popular choice for fuelwood, charcoal, building materials, and animal fodder. As a result, their overexploitation has a negative impact on access to them for charcoal, construction.



Plate 4: Crops destroyed by flood in Sissala East

Source: Field Data, 2021

Table 9: Implication of Rosewood Extraction on Livelihood

Implication on Livelihood Effect	No. Of Respondents	PERCENTAGE
Negative effect on farmers and traders activities	179	57%
Lead to low farm yields	52	16%
Impacts negatively on the rearing of animals	35	11%
Affects game in the forest	31	9%
Destruction of properties	24	7%

Source: Field Data, (2021)

For effect on livelihood, 52% of the respondents mentioned that rosewood extraction impacted their farms and trading activities in Funsu. They explained that the trees conservancy in the forest helps in nourishing the farms for higher crop yields. According to them, rosewood trees are giant trees, holding the soil from being carried away either by rainfall or heavy wind. And due to their vast nature, it protects the soil from direct sunlight and helps boost the nutrient level of the earth because the soil doesn't get dried up quickly. Thus it aids the farmer to obtain higher yields according to them.

This backs up Pearce and Warford's (1993) claim that "a damaged environment can exacerbate the process of poverty because the poor are directly dependent on natural resources." Scoones (1998) reaffirmed this by asserting that poverty and environmental deterioration are linked. As a result, poverty encourages people to put pressure on or exploit the environment in order to meet their requirements, leading to resource depletion.

9 percent of respondents said they hunt game in addition to farming. They claim that because the forest has been exposed to exploitation, wildlife has felt endangered and has fled owing to the devastation of their diverse habitats. As a result, hunters must venture deeper into the forest in order to catch, which is not always effective. One of the Bulenga responders, for example, stated.

"The extraction activity has made all the wild animals to ran away to different communities, because they have lost their habitats. The trees provide shelter for most of the animals especially the birds and also serves as shadow or a canopy that protect the animals from direct temperature (sunlight). For the destruction of

properties, all the respondents blame the recent floods and its devastating effect on their communities on the excessive extraction of rosewood”.

11 % said the extraction had affected their capacity to raise animals. The reason for this is because rosewood tree leaves are used as animal fodder, and now that the forest reserve has been exhausted, they must carry their animals deep into the forest to feed them. It also has an impact on the game in the woods, according to 7% of respondents.

The extraction of rosewood is blamed by the villagers for their low farm harvests, ruined dwellings and crops, as well as the death of their animals. When the flooding happened and disaster management teams were dispatched to their towns, the unit informed them that rosewood overexploitation was a contributing factor in the disaster. According to several respondents, the team educated them on the consequences of over-harvesting, warning that excessive wood removal might ruin the "forest cover," allowing high winds and heavy rains to create erosion and floods.

Their concerns are consistent with Boyce's (1994) theory that deforestation, habitat degradation, ecosystem damage, and species extinction are all linked to the poor's fight for survival. It also results in a reduction in rural people's economic activity. This means that excessive rosewood harvest degrades grassland, and degraded grassland degrades the table, causing livestock to suffer and money to be lost, hurting livelihoods (Padmanaba & Corlett, 2014). These findings back up Bosu's (2013) research, which claims that chopping down the trees will have an impact on local temperatures, wildlife, habitat loss, soil erosion, and fire intensity.

CHAPTER FIVE

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

Overview

The findings of the investigation are summarized in this chapter. They're offered in response to the study's objectives. "Commercial extraction of rosewood and its effects on the livelihoods of rural populations in the Wa East district," for example, is one of the study's primary findings, and this chapter provides recommendations based on those results.

Summary

The goal of this study was to investigate the effect of commercial extraction of rosewood in the Wa East district on rural communities. In order to accomplish this, the research was guided by three main objectives, 1 To explore the rate of rosewood depletion and methods of extraction in the Wa East District, 2. To investigate the range of rural livelihoods affected by the commercial exploitation of rosewood in the Wa East District, 3. To examine the effects of rosewood extraction on the natural environment in Wa East District.

Mixed method technique was used to conduct the research. The data collection tools included interview schedule and observation. The sample size was 321 and the response rate was 100%. Assembly members, forestry commission officials, chiefs, and households were among those who responded. Following that, the data was analyzed using SPSS and thematic analysis.

Key Results

Objective one of the research was to explore the rate of rosewood depletion and methods of extraction in the Wa East District. The following conclusions were obtained:

The study discovered that rosewood was known in the study communities as Bunnie or cumcomba. Findings from the study indicated that the Chinese and some Ghanaian timber companies were involved in the commercial extraction of rosewood within the study communities. But then the Chinese dominated with a few Ghanaian timber companies.

Rosewood was previously used for firewood, charcoal, and local construction. Usually, this was done on a small scale. As a result of the inflow of Chinese into the study villages, extraction in larger quantities and for commercial purposes increased. The lands were owned by the Chiefs and Tendanas. Until the current rise in rosewood production, access to the forests was extremely difficult. Until the current rise in rosewood production, access to the forests was extremely difficult.

The study also revealed that rosewood was traditionally harvested for domestic uses using an ax or a machete, according to the study. Rosewood trees are being felled using chainsaws and placed into big truck vehicles. The Chinese were the ones who started the commercial extraction and trade of rosewood.

The study discovered that the main drivers of rosewood extraction in all of the study communities were socioeconomic, legal, regulatory, administrative, governance, and political. Illiteracy, poverty, unemployment, a desire to get rich quick, and an increase in the demand for rosewood were recognized as important problems underlying the felling and extraction of rosewood.

The study discovered that the study communities lacked environmental legislation, policies, administrative norms, and regulations. Also the forestry commission whose main mandate is to protect and manage forestry bodies failed in carrying out their responsibility. Without any constraints from the proper authorities, excessive extraction took place. Because of the lack of rules, nearly all matured rosewood species were harvested, according to 80% of the respondents. regarding the exploitation of rosewood, no companies or individuals replanted.

Objective two sought to investigate the range of rural livelihoods affected by the commercial exploitation of rosewood in the Wa East District.

It was revealed that rosewood is a key source of living in the communities, and the rosewood is a preferred specie for fuelwood, charcoal, construction, and animal fodder. As a result, access to them for these purposes is hampered due to their extensive extraction.

Rosewood extraction has a negative influence on the community members' farms and trading activities, according to 57% of respondents. Low farm yields were reported by 16%, animal rearing was cited by 11%, woodland game was cited by 9%, and property loss was cited by 7%.

Objective three sought to examine the effects of rosewood extraction on the natural environment in the Wa East District.

Excessive extraction results in deforestation, biodiversity loss, agriculture degradation, and natural resource depletion, according to research. Rosewood extraction activities resulted in the loss of forest cover, exposing populations to harsh conditions such as flooding. This was especially prevalent in Funsu.

The destruction of lands was noted by 48% of respondents, with 28% noting the damage of roads, 13% claiming the negative effects of climate change, such as high temperatures and variable rain patterns, and 11% mentioning the demolition of houses.

Conclusions

Commercial rosewood extraction in the Wa East area appears to have an impact on rural livelihoods, which was evident in all of the study villages but particularly so in Funsi and Bulenge. Commercial extraction has resulted in deforestation, flooding, lower crop yields, a drop in animal feed, and, most importantly, deforestation, which was visible in all communities.

Commercial extraction increased as a result of the forestry commission's, community leaders', chiefs', and community members' inability to take action against loggers.

Overall, commercial extraction had a negative impact on rural livelihoods in Wa East, resulting in the destruction of farmlands, low farm yields, road destruction, flooding, and property destruction, and as a result, the rosewood species had declined or been threatened with extinction in the district. These problems resulted from rising demand for rosewood, particularly among Chinese consumers, and the resulting over-extraction to suit market demands. As a result, the some rural residents, including some chiefs and forestry officials, became involved in the extraction process to suit their needs.

Recommendations

The following recommendations have been made to the appropriate stakeholders based on the study's key findings and conclusions.

Traditional authorities should,

Engage community members and landowners right away to reach an agreement and put an end to the extraction. This should be done in such a way that no one in the community participates in or appears to be advocating commercial rosewood extraction. This should be imposed on the latter, regardless of who is involved, because it will aid in reducing deforestation and improving land for future crop yields.

For the officials of Forestry Commission, the suggestion is for them to:

Should put an end to all illegal extraction of rosewood within the study community due to the the near depletion of the species immediately.

Begin a re-planting and sensitization project as soon as possible to educate rural residents about the value of rosewood species in their communities. Excessive extraction could be reduced as a result of this.

Ensure that companies are licensed and have the necessary permissions to conduct extraction operations as soon as possible. In addition, the forestry commission should ensure that extraction is done in a sustainable manner, as well as begin enforcing rules and punishing offenders.

Suggestions for Further Studies

Other academics will be encouraged to conduct research in these areas as a result of the study's findings, conclusions, suggestions, and limitations:

1. Determine the influence of commercial rosewood extraction on the development of infrastructure in the research area.
2. Conduct a risk assessment of commercial rosewood extraction in the study region..

3. Examine how rosewood production has resulted in land disputes in the study region.



REFERENCE

- Abbam, T., Johnson, F., A., Dash, J., & Padmas, S. S. (2018). Spatiotemporal variations in rainfall and temperature in Ghana over the twentieth century, 1900-2014. *Earth and Space Science*, 5(4), 120-132
- Abdul-Rahaman, I., Kabanda, J., & Braimah, M. M. (2016). Desertification of the savanna: Illegal logging of rosewood, causes and effects on the people of kabonwule, Northern Region. *Saudi Journal of Humanities and Social Sciences*, 1(2), 48-54. doi: 10.21276/sjhss.2016.1.2.3
- Abrutyn, S., & Lawrence, K. (2010). From chiefdom to state: toward an integrative theory of the evolution of polity. *Sociological Perspectives*, 53(3), 419-442.
- Adams, B. (2019). *Green development: Environment and sustainability in a developing world*. Routledge.
- Adger, W. N., Kelly, P. M., Winkels, A., Huy, L. Q., & Locke, C. (2002). Migration, remittances, livelihood trajectories, and social resilience. *AMBIO: A Journal of the Human Environment*, 31(4), 358-366. Retrieved from <https://bioone.org/journals/AMBIO-A-Journal-of-the-Human-Environment/volume-31/issue-4/0044-7447-31>.
- Adhikari, S., & Ozarska, B. (2018). Minimizing environmental impacts of timber products through the production process “From Sawmill to Final Products”. *Environmental Systems Research*, 7(1), 1-15. Retrieved from <https://environmentalsystemsresearch.springeropen.com>.

Adjonou, K., Ali, N., Kokutse, A. D., & Novigno, S. K. (2010). Etude de la dynamique des peuplements naturels de *Pterocarpus ericaceus* Poir.(Fabaceae) surexploités au Togo. *Bois & Forêts des Tropiques*, 306, 45-55.

AFRICA, C. I. W. Twenty-second meeting of the Plants Committee Tblisi (Georgia), 19-23 October 2015.

Ahmed, Y. M., Oruonye, E. D., & Tukura, E. (2016). Dynamics of Rosewood (*Pterocarpus erinaceus*) exploitation in savanna lands of Taraba State Nigeria. *Sky Journal of Soil Science and Environmental Management*, 5(2), 44-51.

Aleixandre-Benavent, R., Aleixandre-Tudó, J. L., Castelló-Cogollos, L., & Aleixandre, J. L. (2018). Trends in global research in deforestation. A bibliometric analysis. *Land use policy*, 72, 293-302.

Alemu, Z. G. (2012). *Livelihood strategies in rural South Africa: Implications for poverty reduction* (No. 1007-2016-79737, pp. 2-24).

Allen, R.G., & Pruitt, W.O. (1991) FAO-24reference evapotranspiration factors. *Journal of irrigation and drainage engineering*, 117(5), 758-773

Amisah, S., Gyampoh, A. B., Sarfo-Mensah, P., & Quagraine, K. K. (2009). Livelihood trends in response to climate change in forest fringe communities of the Offin Basin in Ghana. *Journal of Applied Sciences and Environmental Management*, 13(2).

Anukwonke, C. C. (2015). Cc_anukwonke@ ansu. edu. ng Department of Environmental Management Chukwuemeka Odumegwu Ojukwu University Formerly Anambra State University.

Aristotle., (1996). *The Nicomachean Ethics*. Trans. Harris Rackham. London: Wordsworth): 203209, 258-273.

Arunkumar, A. N., Warriar, R. R., Kher, M. M., & Teixeira da Silva, J. A. (2021). Indian rosewood (*Dalbergia latifolia* Roxb.): biology, utilisation, and conservation practices. *Trees*, 1-16.

Ary, D., Jacobs, L. C., Razavieh, A., & Sorensen, C. (2010). *Introduction to research in education Belmont. CA: Wadsworth.*

Ascher, W., & Healy, R. G. (1990). *Natural resource policymaking in developing countries: Environment, economic growth, and income distribution*. Duke University Press.

Asiamah, N., Mensah, H. K., & Oteng-Abayie, E. F. (2017). General, target, and Accessible Population: Demystifying the Concepts for Effective Sampling. *The Qualitative Report*, 22(6), 1607-1621. Retrieved from <https://nsuworks.nova.edu/tqr/vol22/iss6/9>.

Assembly, W. E. D. (2015). The composite budget of the Wa east district assembly for the 2016 fiscal year.

Aubréville, A. M. A. (2013). The disappearance of the tropical forests of Africa. *Fire Ecology*, 9(2), 3-13.

Baert, P. (2005). *Philosophy of the social sciences: Towards pragmatism*. Polity.

Bala, I. F. (2017). GEOSPATIAL IMPLICATIONS OF LAND USE CHANGE IN FAGGE LOCAL GOVERNMENT AREA, KANO STATE, NIGERIA. *Federal University of Technology Akure, Akure, Nigeria.*

Bandoh, W. K. N. (2017). *Tissue culture regeneration potential of African rosewood in Ghana: institutional variables and implications for sustainability*. Unpublished Doctoral dissertation, Kwame Nkrumah University of Science and Technology.

Barbier, E., Burgess, J., Aylward, B., & Bishop, J. (1992). Timber trade, trade policies and environmental degradation. London: *London Environmental Economics Centre*.

Barrett, M. A., Brown, J. L., Morikawa, M. K., Labat, J. N., & Yoder, A. D. (2010). CITES designation for endangered rosewood in Madagascar. *Science*, 328(5982), 1109-1110.

Barthel, S., Folke, C., & Colding, J. (2010). Social–ecological memory in urban gardens—Retaining the capacity for management of ecosystem services. *Global environmental change*, 20(2), 255-265.

Beilin, R., & Wilkinson, C. (2015). Introduction: Governing for urban resilience.

Benton, T., Fairweather, D., Graves, A., Harris, J., Jones, A., Lenton, T., ... & Tiffin, R. (2017). Environmental tipping points and food system dynamics: main report.

Berkes, F., & Folke, C. (1998). Linking social and ecological systems for resilience and sustainability. *Linking social and ecological systems: management practices and social mechanisms for building resilience*, 1(4), 4.

Bhattacharjee, A. (2012). Social science research: Principles, methods, and practices.

- Blondel, N. (2014). Forest Governance and Timber Trade Flows Within, to and from Eastern and Southern African Countries: Burundi Study. *Prepared for the European Commission*.
- Bosu, D. (2013). Draft report on the dynamics of harvesting and trade in rosewood (*Pterocarpus erinaceus*) in Bole. *Central, West and North Gonja Districts of the Northern Region*.
- Bosu, P. P., Apetorgbor, M. M., Nkrumah, E. E., & Bandoh, K. P. (2013). The impact of *Broussonetia papyrifera* (L.) Vent. on community characteristics in the forest and forest-savannah transition ecosystems of Ghana. *African Journal of Ecology*, 51(4), 528-535.
- Boyce, J. K. (1994). Inequality as a cause of environmental degradation. *Ecological Economics*, 11(3), 169-178.
- Boyd, E., & Juhola, S. (2015). Adaptive climate change governance for urban resilience. *Urban Studies*, 52(7), 1234-1264.
- Brack, D. (2003). Illegal logging and the illegal trade in forest and timber products. *International Forestry Review*, 5(3), 195-198.
- Brack, D., & Hayman, G. (2001, March). Intergovernmental actions on illegal logging. In *Presentation on the East Asia Forest Law Enforcement and Governance Ministerial Conference*.
- Bromley, D. W. (1992). The commons, common property, and environmental policy. *Environmental and Resource Economics*, 2, 1-17.
- Broughton, J. M. (1994). Declines in mammalian foraging efficiency during the late Holocene, San Francisco Bay, California. *Journal of Anthropological Archaeology*, 13(4), 371-401.
- Bryman, A. (2016). *Social research methods*. Oxford university press.

Burivalova, Z., Wahyudi, B., Boucher, T. M., Ellis, P., Truskinger, A., Towsey, M., ... & Game, E. T. (2019). Using soundscapes to investigate homogenization of tropical forest diversity in selectively logged forests. *Journal of Applied Ecology*, 56(11), 2493-2504.

Carmenates, O. (2010). Honduras rosewood: Its endangerment and subsequent impact on the percussion industry.

Carney, D., Drinkwater, M., Rusinow, T., Neefjes, K., Wanmali, S., & Singh, N. (1999). Livelihoods approaches compared: a brief comparison of the livelihoods approaches of the United Kingdom Department for International Development (DFID), CARE, Oxfam and the United Nations Development Programme (UNDP). *London: DFID*.

Carpenter, S. R., & Gunderson, L. H. (2001). Coping with Collapse: Ecological and Social Dynamics in Ecosystem Management: *Like flight simulators that train would-be aviators, simple models can be used to evoke people's adaptive, forward-thinking behavior, aimed in this instance at sustainability of human–natural systems*. *BioScience*, 51(6), 451-457.

Chambers, R. (1995). Poverty and livelihoods: whose reality counts?. *Environment and urbanization*, 7(1), 173-204.

Chambers, R., & Conway, G. (1992). *Sustainable rural livelihoods: practical concepts for the 21st century*. Institute of Development Studies (UK).

Chapin III, F. S., Kofinas, G. P., & Folke, C. (Eds.). (2009). *Principles of ecosystem stewardship: resilience-based natural resource management in a changing world*. Springer Science & Business Media.

Chase-Dunn, C. K. (2009). World urbanization: The role of settlement systems in human social evolution. *WORLD SYSTEM HISTORY-Volume I, 4*, 231.

Chilisa, B., & Kawulich, B. (2015). Selecting a research approach: Paradigm, methodology and methods.[Online] Available at: https://www.researchgate.net/profile/Barbara_Kawulich/publication/257944787_Selectinga_research_approach_Paradigm_methodology_and_methods/links/56166fc308ae37ce40910fc>Selecting-a-research-approach-Paradigm-methodology-and-methods.pdf [Accessed 2 April 2018].

Choudhary, M. P., Chauhan, G. S., & Kushwah, Y. K. (2015). Environmental degradation: causes, impacts and mitigation. In *National Seminar on Recent Advancements in Protection of Environment and Its Management Issues (NSRAPEM-2015)*.

CITES. (2006). Sixteenth meeting of the Plants Committee & Twenty-second meeting of the Animals Committee. Lima.

CITES. (2015). Analysis of the international trade in *Pterocarpus Erinaceus* and its consequences in West Africa. Georgia.

CITES. (2016). Consideration of proposals for amendment of appendices I and II. South Africa.

Cooper, N., Brady, E., Steen, H., & Bryce, R. (2016). Aesthetic and spiritual values of ecosystems: recognising the ontological and axiological plurality of cultural ecosystem 'services'. *Ecosystem Services*, 21, 218-229.

- Cordell, H. K., Murphy, D., Riitters, K. H., & Harvard, J. E. (2005). The natural ecological value of wilderness. *The multiple values of wilderness*, 205-249.
- Daily, G. C. (1997). Introduction: what are ecosystem services. *Nature's services: Societal dependence on natural ecosystems*, 1(1).
- Damaiyani, J., & Prabowo, H. (2019, November). Conservation strategy of a vulnerable species of 'Rosewood'(Dalbergia latifolia Roxb) by insect pollinator identification. In *Journal of Physics: Conference Series* (Vol. 1363, No. 1, p. 012005). IOP Publishing.
- Day, J. W., Yáñez-Arancibia, A., & Kemp, W. M. (2012). Human impact and management of coastal and estuarine ecosystems. *Estuarine Ecology*, 483-495.
- D'Cruze, N., & Macdonald, D. W. (2016). A review of global trends in CITES live wildlife confiscations. *Nature Conservation*, 15.
- De Janvry, A., & Sadoulet, E. (2000). Rural poverty in Latin America: Determinants and exit paths. *Food policy*, 25(4), 389-409.
- Dedoose, V. (2012). Web application for managing, analyzing, and presenting qualitative and mixed method research data. *Los Angeles: SocioCultural Research Consultants*.
- Devereux, S., & Sabates-Wheeler, R. (2004). Transformative social protection.
- Devineau, J. L. (1999). Rôle du bétail dans le cycle culture-jachère en région soudanienne: la dissémination d'espèces végétales colonisatrices d'espaces ouverts (Bondoukuy, sud-ouest du Burkina Faso). *Revue d'Ecologie, Terre et Vie*, 54(2), 97-121.

DfID (1999). Sustainable Livelihoods Guidance Sheet. Department of International Development (DfID), London.

Duguma, L. A., Atela, J., Minang, P. ., Ayana, A. N., Gizachew, B., Nzyoka, J. M., & Bernard, F. (2019). Deforestation and forest degradation as an environmental behavior: *unpacking realities shaping community actions*. *Land*, 8(2), 26.

Dumenu, W. K. (2019). Assessing the impact of felling/export ban and CITES designation on exploitation of African rosewood (*Pterocarpus Erinaceus*). *Biological conservation*, 236, 124-133. Retrieved from <https://www.sciencedirect.com/science/article/abs/pii/S000632071930117X>.

Dumenu, W. K. (2019). Assessing the impact of felling/export ban and CITES designation on exploitation of African rosewood (*Pterocarpus erinaceus*). *Biological Conservation*, 236,124-133.

Dumenu, W. K., & Bandoh, W. N. (2016). Exploitation of African rosewood (*Pterocarpus erinaceus*) in Ghana: A situation analysis. *Ghana Journal of Forestry*, 32(2016), 1-15..

Dykstra, D. P., & Heinrich, R. (1996). *FAO model code of forest harvesting practice*. FAO.

Ellis, F. (1998). Household strategies and rural livelihood diversification. *The journal of development studies*, 35(1), 1-38.

Emmanuel, A. Y., Jerry, C. S., & Dzigbodi, D. A. (2018). Review of environmental and health impacts of mining in Ghana. *Journal of Health and Pollution*, 8(17), 43-52.

Environmental Investigation Agency. (2019). Ban-boozled how corruption and collusion fuel illegal rosewood trade in Ghana. Washington.

expanding land investments. *Forest Trends Policy Briefs*.

Fagariba, C. J., Song, S., & Soule, S. K. (2018). Livelihood Economic Activities Causing Deforestation in Northern Ghana: Evidence of Sissala West District. *Open Journal of Ecology*, 8(01), 57.

Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C. S., & Walker, B. (2002). Resilience and sustainable development: building adaptive capacity in a world of transformations. *AMBIO: A journal of the human environment*, 31(5), 437-440.

Fontodji, J. K., Atsri, H., Adjonou, K., Radji, A. R., Kokutse, A. D., Nuto, Y., & Kokou, K. (2011). Impact of charcoal production on biodiversity in Togo (West Africa). *The Importance of Biological Interactions in the Study of Biodiversity*, 978-953.

Food and Agriculture Organization. (2004). Globalization of food systems in deleving countries: impact on food security and nutrition. Rome.

Food and Agriculture Organization. (2011). Assessing forest degradation. Towards the development of globally applicable guidelines. Forest Resources Assessment Working Paper.

Food and Agriculture Organization. (2013). Climate change guidelines for forest managers. Food and Agriculture Organization of the United Nations.

Ford-Robertson, F. C. (1971). Terminology of forest science, technology practice and products. Society of American Foresters.

Fraser, E., Landhäuser, S., & Lieffers, V. (2004). The effect of fire severity and salvage logging traffic on regeneration and early growth of aspen suckers in north-central Alberta. *The Forestry Chronicle*, 80(2), 251-256.

Fraver, S., Jain, T., Bradford, J. B., D'amato, A. W., Kastendick, D., Palik, B., ... & Stanovick, J. (2011). The efficacy of salvage logging in reducing subsequent fire severity in conifer-dominated forests of Minnesota, USA. *Ecological Applications*, 21(6), 1895-1901.

Freudenburg, W. R. (1997). Contamination, corrosion and the social order: An overview. *Current Sociology*, 45(3), 19-39.

Freudenburg, W. R., & Frickel, S. (1994). Digging Deeper: Mining-Dependent Regions in Historical Perspective 1. *Rural sociology*, 59(2), 266-288.

Friedman, M. (1971). Government revenue from inflation. *Journal of Political Economy*, 79(4), 846-856.

Gatti, R. C., Castaldi, S., Lindsell, J. A., Coomes, D. A., Marchetti, M., Maesano, M., Di Paola, A., Paparella, F. & Valentini, R. (2015). The impact of selective logging and clearcutting on forest structure, tree diversity and above-ground biomass of African tropical forests. *Ecological research*, 30(1), 119-132.

Ghana Statistical Service, (2010). Population and housing census: Summary report of final results. Accra: Ghana Statistical Service.

Ghana, P. O., & Apaak, C. A. (2017). Statement on illegal felling and harvesting of rosewood and its attendant destruction of the environment in builsa south district.

Ghana. Statistical Service. (2013). *2010 population & housing census: National analytical report*. Ghana Statistics Service.

Ghazoul, J., Burivalova, Z., Garcia-Ulloa, J., & King, L. A. (2015). Conceptualizing forest degradation. *Trends in ecology & evolution*, 30(10), 622-632. Retrieved from Conceptualizing Forest Degradation (psu.edu).

Gitz, V., & Meybeck, A. (2012). Risks, vulnerabilities and resilience in a context of climate change. *Building resilience for adaptation to climate change in the agriculture sector*, 23, 19.

Glèlè Kakai, R., Akpona, T. J. D., Assogbadjo, A. E., Gaoué, O. G., Chakeredza, S., Gnangle, P. C., ... & Sinsin, B. (2011). Ecological adaptation of the shea butter tree (*Vitellaria paradoxa* CF Gaertn.) along climatic gradient in Bénin, West Africa. *African Journal of Ecology*, 49(4), 440-449.

Gordon's, S. (1954). *Advances in Property Rights Based Fisheries Management: An Introduction*.

Griffie, D. T. (2012). An introduction to second language research methods. *TESL-EJ Publications*.

GSS. (2012). 2010 Population and Housing Census, Summary Report of Final Results.

Gunderson, L. H. (2000). Ecological resilience—in theory and application. *Annual review of ecology and systematics*, 31(1), 425-439.

Hammond, A. N. A. (2019). *China's Quest for Resources in Africa and Its Implications for Environmental Security: The Case of Ghana* (Doctoral dissertation, University of Ghana).

- Hansen, C. P., & Treue, T. (2008). Assessing illegal logging in Ghana. *International Forestry Review*, 10(4), 573-590.
- Hardin, G. (1968). *The tragedy of the commons*. science, 162(3859), 1243-1248.
- Hardin, G. (1968). The Tragedy of the Commons.
- Hart, C. (2018). *Doing a literature review: Releasing the research imagination*. Sage.
- Helms, J. A. (2002). Forest, forestry, forester: What do these terms mean?. *Journal of Forestry*, 100(8), 15-19.
- Holling, C. S. (1973). Resilience and stability of ecological systems. *Annual review of ecology and systematics*, 4(1), 1-23.
- Holling, C. S. (1973). Resilience and stability of ecological systems. *Annual review of ecology and systematics*, 4(1), 1-23.
- Holling, C. S., & Meffe, G. K. (1996). Command and control and the pathology of natural resource management. *Conservation biology*, 10(2), 328-337.
- Hornborg, A., & Martinez-Alier, J. (2016). Ecologically unequal exchange and ecological debt. *Journal of Political Ecology*, 23(1), 328-333.
- Hussein, K., & Nelson, J. (1998). *Sustainable livelihoods and livelihood diversification*. Retrieved from <https://vtechworks.lib.vt.edu/bitstream>.
- IFAD (2011). Sustainable Livelihood Framework [Online] Available <http://www.ifad.org/sla/index.htm> (August15, 2012).
- Innes, J. L. (2010). Madagascar rosewood, illegal logging and the tropical timber trade. *Madagascar Conservation & Development*, 5(1), 6-10.
- Johnson, A. W., & Earle, T. K. (2000). *The evolution of human societies: from foraging group to agrarian state*. Stanford University Press.

- Johnson, D. L., Ambrose, S. H., Bassett, T. J., Bowen, M. L., Crummey, D. E., Isaacson, J. S., ... & Winter-Nelson, A. E. (1997). Meanings of environmental terms. *Journal of environmental quality*, 26(3), 581-589.
- Johnson, M. F. (2019). Who governs here? informal resource extraction, state enforcement, and conflict in Ghana. *Global Environmental Change*, 58, 1-11.
- Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational researcher*, 33(7), 14-26.
- Jourgholami, M. (2012). Small-scale timber harvesting: mule logging in Hyrcanian forest. *Small-scale Forestry*, 11(2), 255-262.
- Kadam, P., & Bhalerao, S. (2010). Sample size calculation. *International journal of Ayurveda research*, 1(1), 55.
- Kansanga, M. M., Dinko, D. H., Nyantakyi-Frimpong, H., Arku, G., & Luginaah, I. (2021). Scalar politics and black markets: The political ecology of illegal rosewood logging in Ghana. *Geoforum*, 119, 83-93
- Khan, S. N. (2014). Qualitative research method: Grounded theory. *International journal of business and management*, 9(11), 224-233.
- Khatun, D., & Roy, B. C. (2012). Rural livelihood diversification in West Bengal: determinants and constraints. *Agricultural Economics Research Review*, 25(347-2016-16910), 115-124.

Kossi, A., Towanou, H., Habou, R., Novinyo, S. K., Elikplim, A. K., Nathalie, J. B., ... & Kouami, K. (2019). Challenges of conservation and sustainable management of African rosewood (*Pterocarpus erinaceus*) in West Africa. In *Natural Resources Management and Biological Sciences*. IntechOpen.

Kula, E. (2012). *Economics of natural resources, the environment and policies*. Springer Science & Business Media.

Kyei, K. R. (2017). *Effect of Different Pre-Sowing Treatments on the Germination and Initial Growth of Pterocarpus Erinaceus Seeds* (Doctoral dissertation).

Lai, E. R. (2011). Critical thinking: A literature review. *Pearson's Research Reports*, 6(1), 40-41.

Larsson, M. L. (1957). Legal definitions of the environment and of environmental damage. *Stockholm Institute for Scandinavian Law*, 157.

Lavrakas, P. J. (2008). *Encyclopedia of survey research methods* (Vols. 1-0). Thousand Oaks, CA: Sage Publications, Inc. doi: 10.4135/9781412963947.

Lawrence, K. S., & Abrutyn, S. B. (2015). The degradation of nature and the growth of environmental concern: Toward a theory of the capture and limits of ecological value. *Human Ecology Review*, 21(1), 87-108.

Lawrence, K. S., & Abrutyn, S. B. (2015). The degradation of nature and the growth of environmental concern: Toward a theory of the capture and limits of ecological value. *Human Ecology Review*, 21(1), 87-108.

- Lebret, K., Kritzberg, E. S., Figueroa, R., & Rengefors, K. (2012). Genetic diversity within and genetic differentiation between blooms of a microalgal species. *Environmental Microbiology*, *14*(9), 2395-2404.
- Leggett, T. (2018, January). The rapid rise of rosewood trafficking in west africa. In *Forum on Crime & Society* (Vol. 9).
- Lloyd, W. F. (1833). The Notion of Value. *History of Economic Thought Books*. logging. In *Presentation on the East Asia Forest Law Enforcement and*
- Loorbach, D., & Shiroyama, H. (2016). The challenge of sustainable urban development and transforming cities. In *Governance of urban*
- Lund, H. G. (2002). When is a forest not a forest?. *Journal of Forestry*, *100*(8), 21-28.
- Mackay, J., & Acheson, J. M. (1987). The question of the commons.
- Malloy, R., Brock, J., Floyd, A., Livingston, M., & Webb, R. H. (2013). *Design with the desert: conservation and sustainable development* (620). Taylor & Francis.
- Marfo, E. (2010). Chainsaw milling in Ghana: context, drivers and impacts. *Tropenbos International, Wageningen, Netherland*.
- Marks, E., Aflakpui, G. K. S., Nkem, J., Poch, R. M., Khouma, M., Kokou, K., ... & Sebastià, M. T. (2009). Conservation of soil organic carbon, biodiversity and the provision of other ecosystem services along climatic gradients in West Africa. *Biogeosciences*, *6*(8), 1825-1838.
- Mugerauer, R. (2010). Toward a theory of integrated urban ecology: complementing Pickett et al. *Ecology and Society*, *15*(4).
- Muller, R. A., & Whillans, F. (2008). A common pool resource experiment with a dynamic stock externality. *McMaster University, Hamilton, Ontario*.

Nasi, R., Wunder, S., & Campos, J. J. (2002). *Forest ecosystem services: can they pay our way out of deforestation?*, Tropical Agricultural Research and Higher Education Center: Costa Rica.

Norglo, B. E. (2015). *Negotiating Access to Forests: The interrelation of Property and Authority at the Development Frontier of the West Gonja District in Northern Ghana*. Unpublished doctoral dissertation, Department of Law and Governance, Wageningen University, Netherland.

Nwazi, J., & Debski, J. A. (2020). African perspective to the nature based solutions to climate change. *Sub-Saharan African Journal of Development and Administration*, 6.

Obasi, F. A., Agbo, F. U., & Onyenekwe, C. S. (2015). Environmental and socio-economic effects of timber harvesting in Ebonyi State, Nigeria. *African Journal of Agricultural Research*, 10(11), 1233-1238.

Obiri, D. B., Abukari, H., Oduro, K. A., Quartey, R. K., Dawoe, E. L. K., Twintoh, J. J., & Opuni-Frimpong, E. (2022). Rosewood (*Pterocarpus erinaceus*) as a de facto forest common for local communities in Ghana. *International Journal of Biodiversity and Conservation*, 14(1), 1-13.

Oduro, K. A. (2016). *Ghana's high forests: trends, scenarios and pathways for future developments*. Unpublished doctoral dissertation, Wageningen University, Netherland.

Oduro, K. A., Duah-Gyamfi, A., Acquah, S. B., & Agyeman, V. K. (2012). Ghana forest and wildlife handbook. *Ghana Forest and Wildlife Resources*. Forestry Commission, Ghana.

- Oduro, K. A., Mohren, G. M. J., Affum-Baffoe, K., & Kyereh, B. (2014). Trends in timber production systems in the high forest zone of Ghana. *International Forestry Review*, *16*(3), 289-300.
- Ojeh, V. N., Humshie, A. P., Garba, H. A., Naabil, E., Obiano, E. C., Boyitie, O. P., & Boyiga, K. K. (2020). The Environmental Benefits of Trees in a Changing Climate: A Nigerian Experience. *Journal of Scientific Research and Reports*, *26*(6), 59-75. <https://doi.org/10.9734/jsrr/2020/v26i630272>
- Okoti1, M., Keya, G. A., Esilaba, A. O., & Cheruiyot, H. (2006). Indigenous technical knowledge for resource monitoring in northern Kenya. *Journal of Human Ecology*, *20*(3), 183-189.
- Oldfield, F., & Dearing, J. A. (2003). The role of human activities in past environmental change. In *Paleoclimate, global change and the future* (pp. 143-162). Springer, Berlin, Heidelberg.
- Olorunfemi, I. E., Olufayo, A. A., Fasinmirin, J. T., & Komolafe, A. A. (2022). Dynamics of land use land cover and its impact on carbon stocks in Sub-Saharan Africa: An overview. *Environment, Development and Sustainability*, *24*(1), 40-76.
- Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge university press.
- Ostrom, E. (1992). Community and the endogenous solution of commons problems. *Journal of theoretical politics*, *4*(3), 343-351.

- Ostrom, E. (1999). Design principles and threats to sustainable organizations that manage commons. In *Workshop in Political Theory and Policy Analysis, W99-6. Center for the Study of Institutions, Population, and Environmental Change*. Indiana University, USA.
- Owusu, B., Nketiah, K. S., & Aggrey, J. (2011). Combating unacceptable forest practices in Ghana, Trompenbos International, Ghana. *Policy brief, September*, 1-20.
- Padmanaba, M., & Corlett, R. T. (2014). Minimizing risks of invasive alien plant species in tropical production forest management. *Forests*, 5(8), 1982-1998.
- Patel, E. R. (2007). Logging of rare rosewood and palisandre within Marojejy National Park, Madagascar. *Madagascar Conservation & Development*, 2(1), 11-16.
- Patel, L. (2015). *Decolonizing educational research: From ownership to answerability*. Routledge.
- Pearce, D. W., & Warford, J. J. (1993). *World without end: economics, environment, and sustainable development*. Oxford University Press.
- Peng, J., Pan, Y., Liu, Y., Zhao, H., & Wang, Y. (2018). Linking ecological degradation risk to identify ecological security patterns in a rapidly urbanizing landscape. *Habitat International*, 71, 110-124
- Peters, C. M. (1994). Sustainable harvest of non-timber plant resources in tropical moist forest. *An ecological primer*, 1-48.
- Peterson, G., Allen, C. R., & Holling, C. S. (1998). Ecological resilience, biodiversity, and scale. *Ecosystems*, 1(1), 6-18.

- Piabuo, S. M., Minang, P. A., Tieguhong, C. J., Foundjem-Tita, D., & Nghobuoche, F. (2021). Illegal logging, governance effectiveness and carbon dioxide emission in the timber-producing countries of Congo Basin and Asia. *Environment, Development and Sustainability*, 1-21.
- Pierce, J. C., Budd, W. W., & Lovrich Jr, N. P. (2011). Resilience and sustainability in US urban areas. *Environmental Politics*, 20(4), 566-584.
- Pimm, S. L., & Pimm, S. L. (1991). *The balance of nature?: ecological issues in the conservation of species and communities*. University of Chicago Press. USA.
- Putzel, L., Kelly, A. B., Cerutti, P. O., & Artati, Y. (2015). Formalization as development in land and natural resource policy. *Society & Natural Resources*, 28(5), 453-472.
- Randriamalala, H. (2009). The rosewood chronicles.
- Randriamalala, H., & Liu, Z. (2010). Rosewood of Madagascar: Between democracy and conservation. *Madagascar Conservation & Development*, 5(1), 11-21.
- Rani, S., Ali, R., & Agarwal, A. (2019). Fuzzy inventory model for deteriorating items in a green supply chain with carbon concerned demand. *Opsearch*, 56(1), 91-122.
- Rapport, D. J., Lasley, B. L., Rolston, D. E., Nielsen, N. O., Qualset, C. O., & Damania, A. B. (Eds.). (2002). *Managing for healthy ecosystems*. CRC Press.
- Reboredo, F. (2013). Socio-economic, environmental, and governance impacts of illegal logging. *Environment Systems and Decisions*, 33(2), 295-304.

- Repetto, R., & Holmes, T. (1983). The Role of Population in Resource Depletion in Developing Countries. *Population and Development Review*, 9(4), 609-632.
- Reusch, T. B., Ehlers, A., Hämmerli, A., & Worm, B. (2005). Ecosystem recovery after climatic extremes enhanced by genotypic diversity. *Proceedings of the National Academy of Sciences*, 102(8), 2826-2831
- Reyer, C. P., Rammig, A., Brouwers, N., & Langerwisch, F. (2015). Forest resilience, tipping points and global change processes. *Journal of Ecology*, 1-4.
- Rice, J. (2007). Ecological unequal exchange: Consumption, equity, and unsustainable structural relationships within the global economy. *International Journal of Comparative Sociology*, 48(1), 43-72.
- Sarantakos, S. (1998). Sampling procedures. In *Social research* (pp. 139-164). Palgrave, London.
- Sasaki, N., & Putz, F. E. (2009). Critical need for new definitions of “forest” and “forest degradation” in global climate change agreements. *Conservation Letters*, 2(5), 226-232.
- Scheffer, M., & Carpenter, S. R. (2003). Catastrophic regime shifts in ecosystems: linking theory to observation. *Trends in ecology & evolution*, 18(12), 648-656.
- Scherr, S. J., White, A., & Kaimowitz, D. (2004). *A new agenda for forest conservation and poverty reduction: making forest markets work for low-income producers*. Cifor.

- Schloenhardt, A., & Schloenhardt, A. (2008). *The illegal trade in timber and timber products in the Asia-Pacific region* (No. 89). Canberra: Australian Institute of Criminology.
- Scholz, I. (2018). *Overexploitation or Sustainable Management? Action Patterns of the Tropical Timber Industry: The Case of Para (Brazil) 1960-1997*. Routledge.
- Scoones, I. (1998). Sustainable rural livelihoods: a framework for analysis.5(1) 1-22.
- Sedjo, R. A. (2001). *Forest carbon sequestration: some issues for forest investments* (No. 1318-2016-103352).
- Segla, N. K., Rabiou, H., Adjonou, K., Moussa, B. M., Saley, K., Radji, R. A., ... & Kokou, K. (2016). Population structure and minimum felling diameter of *Pterocarpus erinaceus* Poir in arid and semi-arid climate zones of West Africa. *South African Journal of Botany*, 103, 17-24.
- Sekaran, U. (2003). Towards a guide for novice research on research methodology: Review and proposed methods. *Journal of Cases of Information Technology*, 8(4), 24-35.
- Sharma, S., Rani, S., Kaur, K., Jindal, S., & Garg, S. (2019). Removal of Acid Violet 19 dye from aqueous solution using sawdust of Indian Rosewood (*Dalbergia sissoo*) as adsorbent. *Environ. Int. J. Sci. Technol.*, 14, 49-64.
- Simula, M. (2009). Towards defining forest degradation: comparative analysis of existing definitions. *Forest Resources Assessment Working Paper*, 154, 59.

- Singh, S. P. (1998). Chronic disturbance, a principal cause of environmental degradation in developing countries. *Environmental conservation*, 25(1), 1-2.
- Slingenberg, A., Braat, L., Van Der Windt, H., Rademaekers, K., Eichler, L., & Turner, K. (2009). Study on understanding the causes of biodiversity loss and the policy assessment framework. *European Commission Directorate-General for Environment*, available at http://ec.europa.eu/environment/enveco/biodiversity/pdf/causes_biodiv_loss.pdf.
- Standish, R. J., Hobbs, R. J., Mayfield, M. M., Bestelmeyer, B. T., Suding, K. N., Battaglia, L. L., Eviner, V., Hawkes, C.V., Temperton, V.M., Cramer, V.A & Harris, J. A. (2014). Resilience in ecology: Abstraction, distraction, or where the action is?. *Biological Conservation*, 177, 43-51.
- Taherdoost, H. (2017). Determining sample size; how to calculate survey sample size. *International Journal of Economics and Management Systems*, 237-239.
- Tashakkori, A., & Teddlie, C. (2008). Quality of inferences in mixed methods research: Calling for an integrative framework. *Advances in mixed methods research*, 53(7), 101-119.
- The Forestry Commission of Ghana. (2017, May 4). Rosewood harvesting in Ghana and the way forward. Retrieved from <http://www.fcghana>.
- Thompson, I. (2011). Biodiversity, ecosystem thresholds, resilience and forest degradation. *Unasylva*, 238(62), 25-30.
- Treanor, N. B. (2015). China's hongmu consumption boom. *December. Washington, DC: Forest Trends*.

- Trends, F. (2014). Forest Conversion in Lao PDR: Implications and impacts of expanding land investments. *Forest Trends Policy Briefs*.
- Tuffour, J. K. (2013). Forest depletion in Ghana: An analysis of determinants. *Journal of Sustainable Development Studies*, 5(1).
- Tuokuu, F. X. D., Kpinpuo, S. D., & Hinson, R. E. (2019). Sustainable development in Ghana's gold mines: Clarifying the stakeholder's perspective. *Journal of Sustainable Mining*, 18(2), 77-84.
- Twigg, J. (2001). Sustainable livelihoods and vulnerability to disasters.
- Ugochukwu, A. I., Hobbs, J. E., Phillips, P. W., & Kerr, W. A. (2018). Technological solutions to authenticity issues in international trade: the case of CITES listed endangered species. *Ecological Economics*, 146, 730-739.
- United Nations Environment Programme. (1999). Cultural and Spiritual Values of Biodiversity. London: Intermediate Technology Publications.
- Valdez, M. A. (2019). *Analysis of regeneration by coppicing of Dalbergia stevensonii in Belize*. Unpublished master's thesis, Universidad Internacional de Andalucía.
- Veraart, A. J., Faassen, E. J., Dakos, V., van Nes, E. H., Lürling, M., & Scheffer, M. (2012). Recovery rates reflect distance to a tipping point in a living system. *Nature*, 481(7381), 357-359.
- Villamayor-Tomas, S., Avagyan, M., Firlus, M., Helbing, G., & Kabakova, M. (2016). Hydropower vs. fisheries conservation: a test of institutional design principles for common-pool resource management in the lower Mekong basin social-ecological system. *Ecology and Society*, 21(1).

- Waeber, P. O., Schuurman, D., & Wilmé, L. (2018). *Madagascar's rosewood (Dalbergia spp.) stocks as a political challenge* (No. e27062v1). PeerJ Preprints.
- Waeber, P. O., Schuurman, D., Ramamonjisoa, B., Langrand, M., Barber, C. V., Innes, J. L., ... & Wilmé, L. (2019). Uplisting of Malagasy precious woods critical for their survival. *Biological Conservation*, 235, 89-92.
- Walker, L. R., & Shiels, A. B. (2012). *Landslide ecology*. Cambridge University Press.
- Walljasper, J. (2011). Elinor Ostrom's 8 Principles for Managing A Commons. *On the Commons*.
- Weber, H., & Sciubba, J. D. (2019). The effect of population growth on the environment: Evidence from European regions. *European Journal of Population*, 35(2), 379-402.
- Wilmé, L., Innes, J. L., Schuurman, D., Ramamonjisoa, B., Langrand, M., Barber, C. V., ... & Waeber, P. O. (2019). Management options for addressing the persistent and unresolved CITES issue of Madagascar's rosewood stocks and stockpile. *PeerJ Preprints*, 7, e27889v1.
- Winfield, K., Scott, M., & Graysn, C. (2016, September). Global status of Dalbergia and Pterocarpus rosewood producing species in trade. In *Convention on International Trade in Endangered Species 17th Conference of Parties–Johannesburg..*
- Wright, J. A., DiNicola, A., & Gaitan, E. (2000). Latin American forest plantations: opportunities for carbon sequestration, economic development, and financial returns. *Journal of Forestry*, 98(9), 20-23.

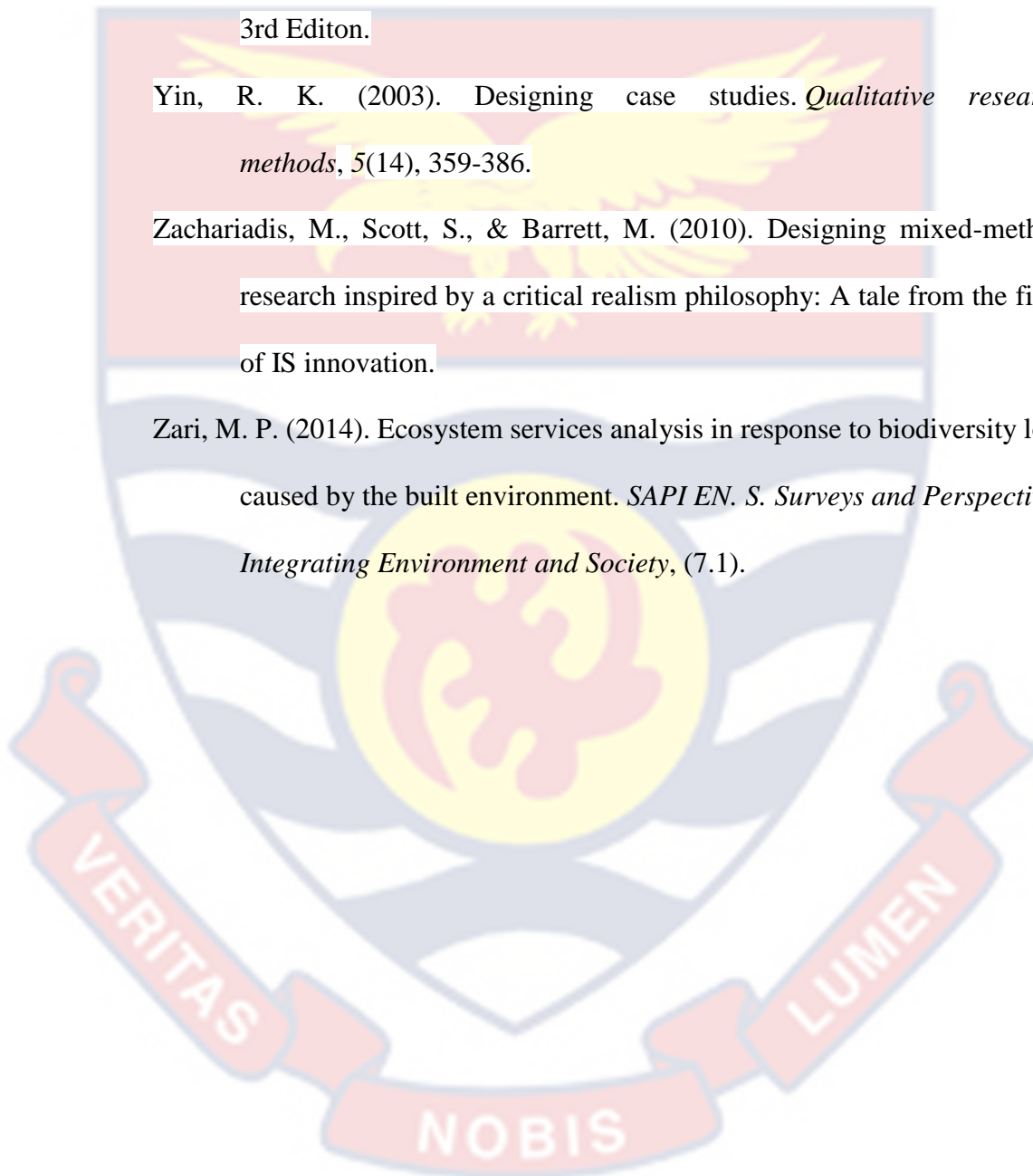
Wright, S. J., & Muller-Landau, H. C. (2006). The Future of Tropical Forest Species 1. *Biotropica: The Journal of Biology and Conservation*, 38(3), 287-301.

Yates, D. S., Moore, D. S., & Starnes, D. S. (2008). *The Practice of Statistics*, 3rd Edition.

Yin, R. K. (2003). Designing case studies. *Qualitative research methods*, 5(14), 359-386.

Zachariadis, M., Scott, S., & Barrett, M. (2010). Designing mixed-method research inspired by a critical realism philosophy: A tale from the field of IS innovation.

Zari, M. P. (2014). Ecosystem services analysis in response to biodiversity loss caused by the built environment. *SAPI EN. S. Surveys and Perspectives Integrating Environment and Society*, (7.1).



APPENDIX A

Interview Guide for Forestry Commission Officials

Objective 1: Dynamics of extraction of rosewood trees

1. Age

- a. 20 to 24 [] b. 25 to 34 [] c. 35 to 44 [] d. 45 or above []

2. Gender

- a. Male [] b. Female []

3. Educational attainment

- a. Yes [] b. N

o []

4. What is the major source of livelihood of the people in the community?

5. What is your role as a forestry commission official in the protection of the forest in the community?

6. Who are the landowners in the community?

7. How is land acquired in the community?

8. Are there rules and regulatory laws governing the usage of the forest?

- a. Yes [] b. No []

9. If yes, what are they?

10. Who makes the rules regarding the forest management within the district?

11. How do people get access to the forest?

12. Who are the people allowed to use the forest?

- a. Only the community members [] b. Government []

c. Community members and government only []

d. Community members, government, and foreigners []

13. What do they use the forest for? Choose as many as applicable.

- a. Farming [] b. Hunting [] c. Firewood [] d. Charcoal []

e. Wood for local construction purpose [] f. Wood for commercial purpose []

14. Rosewood is identified as one of the most popular trees in your community. What do the people use it for?

- a. Firewood [] b. Charcoal [] c. Fodder []

d. Wood for local construction purpose [] e. Wood for commercial purpose []

15. Which people are largely involved in the extraction of rosewood?

a. The community members [] b. Government []

c. Community members and government []

d. Community members, government, and foreigners []

e. Foreigners []

16. What is the rate of rosewood extraction in the community?

a. Low [] b. Relatively high [] c. High []

d. Very high []

17. Are royalties paid to the chiefs and people of the land by the extraction companies?

a. Yes [] b. No []

18. Are the royalties used to help in re-planting rosewood trees in place of the ones felled?

a. Yes [] b. No []

19. If yes, what is the rate of the re-planting? why

a. Low [] b. Relatively high [] c. High []

d. Very high []

20. What is the impact of rosewood extraction on the community?

a. Good [] b. Bad [] c. Very bad []

21. Is the impact of the rosewood extraction related to the environment or the livelihood of the people?

a. The environment [] b. The livelihood of the people []

c. Both Livelihood and the environment []

22. In terms of the environment how has the extraction impacted on it? Choose as many as possible: It has caused

a. Soil erosion Deforestation [] b. Polluted water bodies []

c. Flooding []

d. Loss of biodiversity []

23. In relation to the livelihood of the people, how has the extraction impacted on it? Choose as many as possible: It has caused -

a. Decrease in crop yield [] b. Decline in animal feed []

c. Reduction in natural resources [] d. Reduction in alternative livelihood.

24. What type of forest is in the district?

.....

25. How widespread are these forests in the district?

.....

26. What are types of trees do you have in the forest?

.....

.....

27. What species of rosewood can be found in the forest?

28. What is the trend of exploitation?

.....

29. What is the duration of the commercial extraction of rosewood within the district?

- A. About 1 - 4 years
- B. About 5 – 9 years
- C. more than 10 years

30. How did the commercial extraction of rosewood start in the district?

.....

.....

31. How was the product previously used by the rural people within the district?

.....

.....

.....

Which local people are involved in the extraction of rosewood in your area?

Probe for the role of men

The men are the ones who usually cut the trees and convey them into the trucks

Probe for the role of women

Probe for the role of chiefs

Probe for the role of landlords

Probe for the role of assembly persons

How do they get involved in the extraction of rosewood?

Probe for their role in harvesting

Probe for their role in haulage

Probe for their role in marketing

Do you participate in the commercial extraction of rosewood?

Probe for the nature of exploitation

Probe for dominant areas of extraction

Probe for estimated volume of extraction per annum

Probe for the harvesting process

32. What types of companies are allowed to harvest and export timber?

Probe on the process of permit provision

33. List the names of timber companies involved in the harvesting of timber in the Wa East District.

1.....

2.....

3.....

4.....

34. . Who are the buyers of rosewood products in your area?

35. What management or conservation actions has your institution put in place to preserve the rosewood species?

Probe on natural regeneration,

Probe for domesticating in plantations

Probe for domesticating on form.

36. When were these actions implemented?

37. Which body is responsible for the implementation?

38. How does the body assess or evaluate the effectiveness of the actions?

39. What other stakeholders support these actions?

40. Have there been any forest management given to the rural people?

41. What kind of equipments are used for the extraction of rosewood?

Probe on community participation,

Probe on NGO inclusion

Probe on other groups (personal initiatives)

Objective 2: Implication on the environment

42. How has the extraction of rosewood affected the environment?

Probe for the effect on trees

Probe for the effect on land

Probe for the effect on economic trees

Probe for the effect on vegetation cover

Probe for the effect on wildlife

43. Did the timber harvesting company fulfill verbal and written obligations for such things as road restoration, regeneration of species, and cleaning up trash?
44. Was the timber company careful to avoid damaging other trees and land improvements? A. Yes B. No C. Don't know
45. Did the timber company seem concerned about environmental matters, such as wildlife habitat, water quality, and other concerns? A. yes B. No
46. How has the extraction of rosewood impacted on farming activities in the community?
47. What is the availability of rosewood? A. Has it declined B. It has increased
48. What are the main for the decline or increase in the availability of?
49. *Probe on soil erosion, rainfall patterns, deforestation, pollution on water bodies, flooding and loss of biodiversity.*

Objective 3: Implication on livelihood

50. How has the extraction of rosewood contributed to the new livelihoods adopted by the households?
51. How has the extraction of rosewood impacted on farming activities in the community?
Probe on farming activities, non-farming activities and informal activities
52. How has the extraction of rosewood affected the livelihood assets of the households?
53. How has the extraction of rosewood impacted on the society?

APPENDIX B
Interview Guide for Households

Section 1: Background Data of Respondents

1. Age

- a. 20 to 24 [] b. 25 to 34 [] c. 35 to 44 [] d. 45 or above []

2. Gender

- a. Male [] b. Female []

3. Educational attainment

- a. Yes [] b. No []

4. What do you do for a living?

5. What is the community's principal source of livelihood?

6. What is your role as a forestry official in forest protection?

7. Who are the landowners in the community?

8. How is land acquired in the community?

9. Are there rules and regulatory laws governing the usage of the forest?

- a. Yes [] b. No []

10. If yes, what are they?

11. Who makes the rules regarding the forest management within the district?

13. How do people get access to the forest?

With the permission from the chiefs/traditional authority and forestry commission

12. Who are the people allowed to use the forest?

- a. Only the community members [] b. Government []

c. Community members and government only []

d. Community members, government, and foreigners []

13. What do they use the forest for? Choose as many as applicable.

- a. Farming [] b. Hunting [] c. Firewood [] d. Charcoal []

e. Wood for local construction purpose [] f. Wood for commercial purpose []

14. Rosewood is identified as one of the most popular trees in your community. What do the people use it for?

- a. Firewood [] b. Charcoal [] c. Fodder []

- d. Wood for local construction purpose [] e. Wood for commercial purpose []

15. Which people are largely involved in the extraction of rosewood?

- a. The community members [] b. Government []

c. Community members and government []

d. Community members, government, and foreigners []

e. Foreigners []

16. What is the rate of rosewood extraction in the community?

- a. Low [] b. Relatively high [] c. High []

d. Very high []

17. Are royalties paid to the chiefs and people of the land by the extraction companies?

- a. Yes [] b. No []

18. Are the royalties used to help in re-planting rosewood trees in place of the ones felled?

- a. Yes [] b. No []

19. If yes, what is the rate of the re-planting? why

- a. Low [] b. Relatively high [] c. High []

d. Very high []

20. What is the impact of rosewood extraction on the community?

- a. Good [] b. Bad [] c. Very bad []

21. Is the impact of the rosewood extraction related to the environment or the livelihood of the people?

- a. The environment [] b. The livelihood of the people []

c. Both Livelihood and the environment []

22. In terms of the environment how has the extraction impacted on it? Choose as many as possible: It has caused

- a. Soil erosion Deforestation [] b. Polluted water bodies [] c.

Flooding []

d. Loss of biodiversity []

23. In relation to the livelihood of the people, how has the extraction impacted on it? Choose as many as possible: It has caused -

- a. Decrease in crop yield
- b. Decline in animal feed
- c. Reduction in natural resources
- d. Reduction in alternative livelihood

24. Do you own land within the district? Yes No

25. How many acres do you own? Yes No

26. Has your land been affected by Rosewood logging activities? Yes No

Section 2: Dynamics of extraction of rosewood trees

27. What was rosewood locally used for in the community?

.....
.....

28. How is rosewood currently used in the community?

.....
.....

29. What are the benefits of rosewood to the rural people?

.....
.....

30. How was rosewood previously extracted in the community?

.....
.....

31. What is the present situation of extraction in the district? A. It has increased B. It has declined C. Remained same

.....
.....

32. Which category of people are allowed to extract rosewood in the community?

Section 3: Implications on the environmental

33. What are the implications of the extraction to the environment?.....

.....

34. Does the extraction have an impact on the soil?.....
.....

35. Does the extraction of rosewood have an impact on water bodies?

36. Does the extraction activities impact on the roads?

37. Does extraction activities have an impact on farming? A. Yes B. No

38. If yes, how has it affected farming?.....
.....
.....

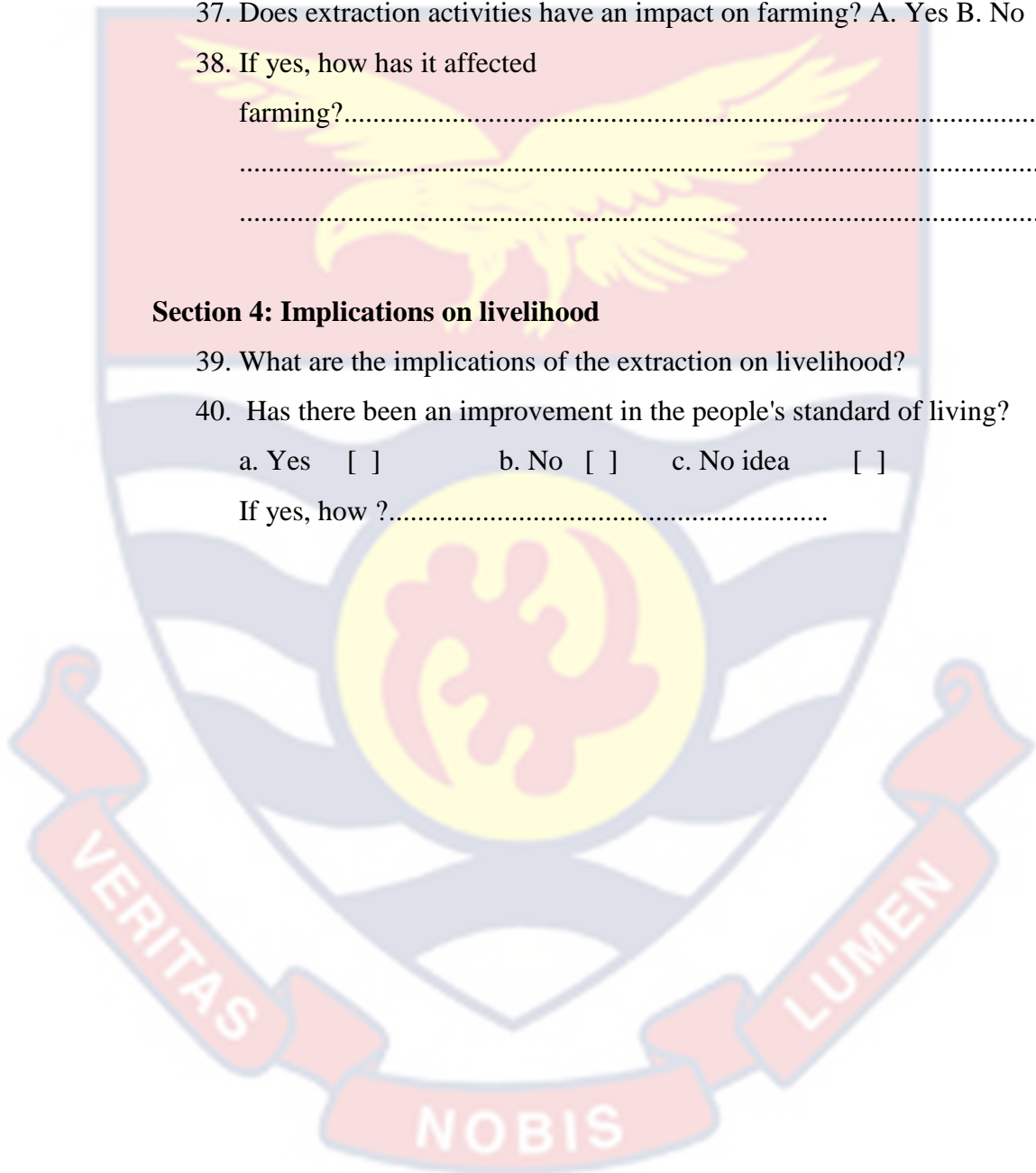
Section 4: Implications on livelihood

39. What are the implications of the extraction on livelihood?

40. Has there been an improvement in the people's standard of living?

a. Yes [] b. No [] c. No idea []

If yes, how ?.....



APPENDIX C
Interview Guide for Chiefs

1. Age
 - a. 20 to 24 []
 - b. 25 to 34 []
 - c. 35 to 44 []
 - d. 45 or above []
2. Gender
 - a. Male []
 - b. Female []
3. Educational attainment
 - a. Yes []
 - b. No []
4. What do you do for a living?
5. What is the community's principal source of revenue?
6. Who are the landowners in the community?
7. How is land acquired in the community?
8. Are there rules and regulatory laws governing the usage of the forest?
 - a. Yes []
 - b. No []
9. If yes, what are they?
10. Who makes the rules regarding the forest management within the district?
11. How do people get access to the forest?
12. Who are the people allowed to use the forest?
 - a. Only the community members []
 - b. Government []
 - c. Community members and government only []
 - d. Community members, government, and foreigners []
13. What do they use the forest for? Choose as many as applicable.
 - a. Farming []
 - b. Hunting []
 - c. Firewood []
 - d. Charcoal []
 - e. Wood for local construction purpose []
 - f. Wood for commercial purpose []

14. Rosewood is identified as one of the most popular trees in your community.

What do the people use it for?

- a. Firewood b. Charcoal c. Fodder
d. Wood for local construction purpose e. Wood for commercial purpose

15. Which people are largely involved in the extraction of rosewood?

- a. The community members b. Government
c. Community members and government
d. Community members, government, and foreigners
e. Foreigners

16. What is the rate of rosewood extraction in the community?

- a. Low b. Relatively high c. High
d. Very high

17. Are royalties paid to the chiefs and people of the land by the extraction companies?

- a. Yes b. No

18. Are the royalties used to help in re-planting rosewood trees in place of the ones felled?

- a. Yes b. No

19. If yes, what is the rate of the re-planting? why

- a. Low b. Relatively high c. High
d. Very high

20. What is the effect of rosewood extraction on the community?

- a. Good b. Bad c. Very bad

21. Is the impact of the rosewood extraction related to the environment or the livelihood of the people?

- a. The environment b. The livelihood of the people
c. Both Livelihood and the environment

22. In terms of the environment how has the extraction affected it? Choose as many as possible: It has caused

- a. Soil erosion Deforestation b. Polluted water bodies
c. Flooding d. Loss of biodiversity

23. In relation to the livelihood of the people, how has the extraction affected it? Choose as many as possible: It has caused -
- a. Decrease in crop yield [] b. Decline in animal feed []
c. Reduction in natural resources [] d. Reduction in alternative livelihood
24. What is the local name of rosewood in the district?
25. Are the rules and laws in place here for using these forests? A.
a. Yes [] b. No [] c. No idea []
26. If yes, what are they.....
27. What are the factors that allow for extraction in the community?
28. How did the extraction of rosewood first come about within the community?
29. Has the extraction of the rosewood impacted on the community? If yes how
a. Yes () b. No ()
30. Has there been a diversification of source of livelihood in the community?
a. Yes () b. No ()
31. If yes, what is the current standard of living of the people? A. Improved B. Deteriorated C. The same
32. Are the rural people in the community happy about the extractive activities? a. Yes () b. No ()
33. What has been the reaction of the people since the extraction started?
34. What has been the reactions of the chiefs due to the extraction?
35. Have the people raised some concerns with regards to the extraction?
a. Yes () b. No ()
36. If yes, what are some of the concerns raised by the people?
37. Have they raised concerns regarding the impact on livelihood?
a. yes () b. No ()
38. Are there concerns regarding the impact on the environment, destruction of species, habitat homes, soil erosion, destruction of roads and water bodies?
a. yes () b. No ()
39. Which authorities have these concerns been directed to?
40. Has the authorities been able to address these issues?
a. yes () b. No () c. not entirely
41. Were the people satisfied with responses of the various authorities?
a. yes () b. No ()

42. What has been the reactions of the chiefs in relation to the extraction?
- a. The chiefs decided to confiscate vehicles of individuals and companies who do not have permits from the forestry commission
 - b. Also if a single rosewood is cut, it amounts to the replanting of 10



APPENDIX D
Interview Guide for Assembly Members

1. Age

- a. 20 to 24 [] b. 25 to 34 [] c. 35 to 44 []
d. 45 or above []

2. Gender

- a. Male [] b. Female []

3. Educational attainment

- a. Yes [] b. No []

4. What do you do for a living?

5. What is the community's principal source of livelihood?

6. What is your role as an assembly member in the community?

7. Who are the landowners in the community?

8. How is land acquired in the community?

9. Are there rules and regulatory laws governing the usage of the forest?

- a. Yes [] b. No []

10. If yes, what are they?

11. Who makes the rules regarding the forest management within the district?

13. How do people get access to the forest?

With the permission from the chiefs/traditional authority and forestry commission

12. Who are the people allowed to use the forest?

- a. Only the community members [] b. Government []
c. Community members and government only []
d. Community members, government, and foreigners []

13. What do they use the forest for? Choose as many as applicable.

- a. Farming [] b. Hunting [] c. Firewood [] d. Charcoal []
e. Wood for local construction purpose [] f. Wood for commercial purpose []

14. Rosewood is identified as one of the most popular trees in your community. What do the people use it for?

- a. Firewood [] b. Charcoal [] c. Fodder []
d. Wood for local construction purpose [] e. Wood for commercial purpose []

15. Which people are largely involved in the extraction of rosewood?

- a. The community members []
- b. Government []
- c. Community members and government []
- d. Community members, government, and foreigners []
- e. Foreigners []

16. What is the rate of rosewood extraction in the community?

- a. Low []
- b. Relatively high []
- c. High []
- d. Very high []

17. Are royalties paid to the chiefs and people of the land by the extraction companies?

- a. Yes []
- b. No []

18. Are the royalties used to help in re-planting rosewood trees in place of the ones felled?

- a. Yes []
- b. No []

19. If yes, what is the rate of the re-planting? why

- a. Low []
- b. Relatively high []
- c. High []
- d. Very high []

20. What is the impact of rosewood extraction on the community?

- a. Good []
- b. Bad []
- c. Very bad []

21. Is the impact of the rosewood extraction related to the environment or the livelihood of the people?

- a. The environment []
- b. The livelihood of the people []
- c. Both Livelihood and the environment []

22. In terms of the environment how has the extraction impacted on it? Choose as many as possible: It has caused

- a. Soil erosion Deforestation []
- b. Polluted water bodies []
- c. Flooding []
- d. Loss of biodiversity []

23. In relation to the livelihood of the people, how has the extraction impacted on it? Choose as many as possible: It has caused -

- a. Decrease in crop yield
- b. Decline in animal feed
- c. Reduction in natural resources
- d. Reduction in alternative livelihood

24. What is your role with regards to the extraction of rosewood in the community?

25. Who are the appropriate authorities in charge of regulating timber extraction?

26. How is access granted for the extraction of rosewood?

27. Are there regulatory measures for extraction?

- a. Yes
- b. No
- c. No idea

28. If yes, what are the regulations involved in the extraction?

A.

B.

C.

29. What do you think is the impact of the extraction on the living standard of the people?

30. What are the reactions of people towards the extraction of rosewood?

