UNIVERSITY OF NAIROBI

ARTISANAL GOLD MINING AND ITS IMPLICATIONS ON ADJACENT LAND USES: A CASE OF ROSTERMAN AND IKOLOMANI SITES, KAKAMEGA COUNTY, KENYA

BY

RACHAEL NAKHANU WAWIRE

B63/37360/2020

A THESIS SUBMITTED IN PARTIAL FULFILMENT FOR THE AWARD OF THE DEGREE OF MASTER OF ARTS IN PLANNING AT THE UNIVERSITY OF NAIROBI

AUGUST 2023

DECLARATION

I declare that this is my original work. To the best of my knowledge; this document has not been presented to this or any other University or institution of higher learning for examination or other purposes.

This work comprises part of the requirements for the award of the degree of Masters in Planning at the University of Nairobi.

Signed _____(Student)

Rachael Nakhanu Wawire

Registration No. B63/37360/2020

This thesis has been submitted for the purpose of examination with our approval as university supervisors.

Signed_____ (Supervisor)

Dr. Silas M Muketha

Signed_____(Supervisor)

Eng. Evans Mairura Omwenga

DEDICATION

I dedicate this thesis to my son Nigel Magero.

ACKNOWLEDGEMENT

I am thankful for my supervisors, Dr Silas Muketha and Pln. Mairura Omwenga for the unwavering advice and supervision they have shown me all through the research period. Your knowledge, patience, and enthusiasm kept me on track from beginning to completing this study. Thank you.

To all the key informants, all the miners and residents of Rosterman and Ikolomani who used their time to respond to the questions. Thank you. To my colleague Ignatuis Mwangi and Georgina Karimi who shared academic knowledge through peer reviews. Thank you.

My deepest gratitude goes to my husband for always being a great support system, my parents, who continuously encouraged, supported, and prayed for me, and my sister, who has always cheered me on to achieve the best. I appreciate you.

All the above is all possible thanks to my God Almighty.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF MAPS

LIST OF ABBREVIATIONS AND ACRONYMS

LSM - Large-Scale Mining

ASM - Artisanal and Small-scale Mining

ASGM - Artisanal and Small-scale Gold Mining

PLUPA - Physical and Land Use Planning Act

SLM - Sustainable Land Management

SD - Sustainable Development

SDG- Sustainable Development Goals

LPLUDP - Local Physical and Land Use Development Plan

IUCN - International Union for the Conservation of Nature and National Resources

WCED - World Commission on Environment and Development

CSD - Centre for Sustainable Development

GDP - Gross Domestic Product

WHO - World Health Organization

EITI - Extractive Industries Transparency Initiative

VOC - Volatile Organic Compounds

KNBS - Kenya National Bureau of Statistics

FGD - Focus Group Discussions

NEMA - National Environment Management Authority

ABSTRACT

Gold mining is an essential driver of economic development. Nevertheless, artisanal gold mining has also been linked to adverse effects on health and the environment, particularly on sustainable land use. Studies have indicated gaps in the effects of artisanal mining activities on sustainable land use. Despite the increased artisanal gold-mining activities, the sector remains informal mainly because it is not included in the mining legislation in Kenya. This research investigated the influences of artisanal gold mining on the adjacent land uses in Ikolomani and Rosterman areas in Kakamega County, Kenya. The study employed a descriptive cross-sectional survey design. The study was cross-sectional as it occurred at a single moment. The study objectives purposed to; determine the effects of artisanal gold mining on adjacent land uses in the study area, examine the factors contributing to the effects of artisanal gold mining on adjacent land uses in the study area, evaluate public and private stakeholders' roles, behavior, and perceptions of artisanal gold mining on adjacent land uses in the study area and to propose strategies that can be employed to ensure sustainable gold mining. Multistage Sampling was used for the Household survey while Purposive sampling was used for the Key Informant Interviews and the Focus Group Discussions. In the study, one hundred and ninety (190) questionnaires were administered using the Kobo Collect application to the respondents living adjacent to the Rosterman and Ikolomani gold mines. Four (4) key Informant interviews were conducted in the Mining Department, Environment Department, NEMA, and Planning Department in Kakamega Government Offices, and two (2) Focus Group Discussions involving the miners and the locals Ikolomani, Lurambi and Shinyalu sub-counties. From the findings, approximately 79.5% of the respondents were artisanal gold miners. However, artisanal gold mining resulted in land degradation, water pollution, noise pollution, agricultural unproductivity, adverse health effects, deforestation, encroachment of ecologically sensitive areas, and instability of physical structures adjacent to the mines. The factors that led to these effects varied from weak gold mining legal and regulatory reforms, inadequate institutions, poor governance, and political and socio-economic factors. The findings also highlighted the actors' actors' roles, behaviors, and perceptions while addressing the proposed planning interventions to curb the adverse effects of the mines. It was found that there was a need to carry out policy and regulatory reforms to formalize the sector and zone the mining areas while incorporating physical infrastructure developments in the gold mining sector.

CHAPTER ONE: INTRODUCTION

1-1 Definitions of Working Terms

Artisanal Gold mining uses informal, manual, and rudimentary procedures to extract gold. (World Bank, 2019).

Sustainability: Fulfilling the needs of current generations without compromising the needs of future generations while ensuring a balance between economic growth, environmental care, and social well-being. (Santander Scholarships)

Sustainable Land Use: Land utilization that incorporates the fair and balanced distribution of land, water, biodiversity, and other environmental resources between the various competing claims, to secure human needs now and in the future. (University in Wageningen, Netherlands, 2023)

Stakeholders: Individuals, groups, organizations, or states with a vested interest, or stake, in the decision-making and activities of a project. (Barney, 2007-2023)

Sustainable Mining: Sustainable mining refers to reducing negative environmental, social, and governance impacts of mining operations. (Sustainable Mining, 2020)

Planning Interventions: becoming intentionally involved in a difficult situation, to improve it or prevent it from worsening. (Cambridge University, 2023)

1-2 Background to the Study

Artisanal gold mining entails techniques of extracting gold from the earth using rudimentary tools and practices. These rudimentary processes are ancient since they commenced way back in the 1800s in 'California gold rush era'. With the discovery of artisanal gold mining came concerns of the effects of artisanal gold mining on the adjoining land uses and on the environment. Studies conducted globally (World Bank, 2019) stated that artisanal gold mining is predominant in developing countries in Africa, Asia, and South America with more than 100 million people depending on it. Moreover, it is characterized by low levels of investment, labor-intensive local production, informality, low levels of mechanization, and low access to the market.

Studies in Africa done in Ghana, Senegal, Tanzania and Mozambique among other African countries (Hilson & Maconachie, 2017) and (Mutemeri et al., 2016), indicate artisanal gold mining has occasioned positive impacts in terms of employment opportunities, fiscal revenues, and foreign currency reserves. However, there are more disadvantages than advantages because artisanal gold mining has instigated environmental degradation, land use conflicts, deforestation, land conversions, influx of migrant workers and depletion of gold reserves social health hazards on the communities living adjacent to the mining sites. (Signé, 2021) further proposed the need to practice sustainable gold mining so as to conserve the environment.

In Kenya, artisanal mining dates back to the 1940s at Kilimapesa mines in Kakamega County and in the 1950s at Macalder mines in Migori County, giving birth to more mines in Kisumu, Turkana, Nandi, Siaya, Vihiga, Narok, West Pokot, and Kericho counties. Artisanal gold mining in Kenya is generally in small-scale and used by communities to satisfy subsistence needs (Jotham & Mulinya, 2020). Artisanal gold mining transpires close to the surface and in the interior of unconsolidated rocks where miners use simple extraction methods such as burrowing in extraction and is often labor-intensive, highly disorganized, informal, and hazardous (Mutono, 2016). Moreover, gold mining has also been linked to adverse effects on health and the environment, particularly on sustainable land use (Leuenberger, et al., 2021).

1-3 Statement of the Problem

Gold mining is often allied to the socio-economic benefits globally (Nguyen et al., 2018). Notwithstanding often-stated socio-economic benefits, communities living near mining sites continue to live in abject poverty amid the attendant adverse effects of mining activities (Mwakesi et al., 2020).

Artisanal gold mining incorporates rudimentary methods and practices to extract minerals risking sustainable use of the land and furthermore affects environmental sustainability. Most artisanal gold miners carry out mining activities to escape from extreme poverty, unemployment because they are socio-economically marginalized (Jotham & Mulinya, 2020). Often than not, majority of these miners lack the skills, expertise, finances and advanced geological technology and hereafter do not factor environmental and land use sustainability as a key factor in the artisanal mining actions. (Mwango, 2013). Recovery of gold through manual crushing and mercury amalgamation is associated with poor gold

recovery a deleterious effect on land and adjacent land uses of the built environment and the adjoining land uses(Mitchell & Palumbo-Roe, 2020). Artisanal gold mining has been linked to harmful effects on soil composition, land quality, and has in the long-run instigated unsustainable land management (Nguyen et al., 2018).

At the same time, artisanal gold mining lacks adequate resources to build capacity in terms of mining institutions and policies and development of a mainstreamed framework to manage and regulate counties' spatial planning (Ministry of Lands, 2018). In the face of these challenges, it is essential to investigate how artisanal gold mining has affected sustainable land use and propose planning interventions to help tackle this land use planning challenge; globally, regionally, nationally and locally.

1-4 Purpose of the Study

To establish the implication of artisanal gold mining on sustainable land use.

1-5 Objectives of the Study

1. To determine the effects of artisanal gold mining on adjacent land uses in the study area.
2. To examine the factors contributing to the effects of artisanal gold mining on adjacent land uses in the study area.
3. To evaluate public and private stakeholders' roles, behavior, and perceptions of artisanal gold mining and adjacent land uses in the study area.
4. To propose planning strategies that can be employed to ensure sustainable gold mining in relation to adjacent land uses.

1-6 Research Questions

1. Are there any effects of artisanal gold mining on adjacent land uses in the Study area?
2. What factors have contributed to the effects of artisanal gold mining on adjacent land uses in the study area?
3. What are public and private stakeholders' roles, behavior, and perceptions concerning artisanal gold mining and adjacent land uses in Rosterman and Ikolomani areas?
4. What planning strategies can ensure sustainable gold mining concerning adjacent land uses?

1-7 Study Assumptions

Artisanal gold mining adversely affects adjacent land uses in the Study area.

1-8 Significance and Justification of the Study

Previous studies on gold mining showed that artisanal gold mining practiced in the Western gold belt was primarily manual, used rudimentary tools, and was not governed by a robust legislative and regulatory framework. The studies further indicated artisanal gold miners used potentially dangerous methods to extract and process minerals, which posed potential effects on the environment and the existing land uses. This study was, therefore, significant to Rosterman and Ikolomani communities and the Mining, Environment, and Physical Planning Departments in Kakamega County. It was essential to carry out this study from a spatial planning perspective, contrary to the previous works done from an environmental perspective. Moreover, no previous studies conducted in Kakamega County, Kenya and in Africa specifically determine the effects of ASGM on the adjacent land uses. With the population increase and the number of people engaging in mining activities to escape poverty, it was essential to propose spatial planning interventions to ensure sustainable gold mining practices. Furthermore, there was a need to assess the land use compatibility of the adjacent land uses neighboring Rosterman and Ikolomani mines to develop land use planning interventions and proposals to ensures sustainable land use in relation to artisanal gold mining.

1-9 Scope of the Study

The geographic scope includes the Rosterman and Ikolomani mines and the adjacent land uses in Kakamega county. The Rosterman mines are located in Lurambi Subcounty which is to the North of Ikolomani Subcounty and to the West of Shinyalu Subcounty. A larger section of the Ikolomani mines is located in Ikolomani Subcounty while the smaller section sprawled over to Shinyalu Subcounty. The variable scope was fixated on artisanal mining in relation to the adjacent land uses in Ikolomani and Rosterman mining sites. The theoretical scope was also limited to determining the effects of the ASGM on the existing adjacent land uses, examining the factors contributing to these effects, and evaluating the stakeholders' roles and perspectives concerning ASGM and adjacent land uses. The study

would further propose planning interventions that could be employed to ensure sustainable gold mining on adjacent land uses at Rosterman and Ikolomani areas in Kakamega County. The respondents would be limited to the area adjacent to the gold mining sites. The study was conducted in April 2023.

1-10 Organization of the Study

The Study is systematized into six chapters. Chapter one involves the study's background, the problem statement, the study's objectives, and the research questions. This chapter also includes the hypotheses of the study, the justification, and the scope of the study. The study further outlines the basic assumptions of the study, the definition of working terms, and the organization of the study. Chapter two handles the literature review critiquing the study variables, theoretical framework, conceptual framework, research gaps, and a general literature summary. The third chapter outlines the research methodology, analytical framework, research design, target population, and sampling design. It also includes objective-based data collection methods and data analysis and presentation procedures. Chapter four describes the geographic study comprising the geographical location and the demographic dynamics. Chapter Five discusses the findings through data analysis, presentation, and interpretation. Chapter Six makes conclusions and recommendations for the study.

CHAPTER TWO: LITERATURE REVIEW

2-1 Introduction

This chapter highlights a critical literature review of existing peer-reviewed research on gold mining globally, gold mining in Kenya, spatial planning, sustainable development and sustainable land use. The chapter extensively reviews the potential impacts of artisanal gold mining on sustainable land use and rural development.

2-2 Definition of Concepts

2-2.1 The Concept of Land Use Planning

According to The Physical and Land Use Planning Act No. 13 of 2019, Land Use Planning is defined as the process of designating, controlling, zoning, evaluating and organizing the present and future use and development of land in all its geographical areas and its resources to secure the physical, economic and social efficiency, health and well-being of urban and rural communities.

On the other hand, Thomas (2011) notes that land use planning is the process by which land is assigned for competing and occasionally conflicting uses to ensure the balanced and orderly development of land, laying the foundation for sustainable human settlements. Land use planning serves two purposes: planning for development and controlling development. Land-use planning not existent in seclusion. Planning for land use is regarded as a vital section of the progression of national development, as the process of land-use planning tries to identify, gratify the basic human wants of a country's population using the obtainable technical and economic resources. It indeed satisfactory since the main objective of planning is meeting current needs while considering future generations' needs. (Thomas, 2011).

Thomas (2011) described human needs to range from food, housing, education, jobs, entertainment, transport, and to basic services such as health care, clean air, water, and electricity. Therefore, land use planning policies seek to meet the basic social needs of the population while also ensuring that land is used in such a way that it can economically be exploited to finance government operations and the population's basic needs. Land-use planning must integrate the needs of a population with a technical and spatial framework. It means that, while example must construct human settlements for a population, there are ecologically sensitive areas such as a swamp where settlement cannot be established

because of vulnerability to natural disasters, land terrain, the inability of the soil quality to support the building's foundation, health dangers, among others (Thomas, 2011).

The definition of land use planning by PLUPA 2019 as the process of designating, evaluating, controlling, zoning, and organizing the present and future use and development of land in all its geographical areas and its resources to secure the physical, economic and social efficiency, health and well-being of urban and rural communities is the upheld definition of this study.

2-2.2 The Concept of Spatial Planning

The Physical and Land Use Planning Act No. 13 of 2019 defines Spatial Planning as the procedure and method used to influence the distribution of people and activities to achieve optimal utilization of physical, economic, and sociocultural resources.

Thomas (2011) notes that land-use planners, who are technical experts, play the role of incorporating a population's social and economic needs into land-use activities in a process called spatial planning, and this is what is translated into land-use plans, policies, and development control. Spatial planning informs integrated development planning, guided by a legal framework for that specific jurisdiction (Thomas, 2011).

According to the "County Spatial Guidelines: Towards Sustainable Development and County Effectiveness (Ministry of Lands, 2018)," the responsibility for spatial planning is vested in both the national government and county government by the 2010 Constitution. Under the Fourth Schedule on the distribution of Functions Part 1 (21) and (32), the National Government is responsible for formulating general principles of land use planning, coordination of planning by the counties, capacity building, and technical assistance to the counties. On the other hand, Part 2(8) allocates the function of county planning and development to County Governments (Ministry of Lands, 2018). The Challenge, however, comes in when the County Government officials and the National Government officials find it difficult to work together in most instances, resulting in poorly implemented plans.

The County Spatial Planning guidelines developed by the Ministry of Lands (2018), enable counties to ensure harmonized and workable development planning and enable a harmonized and standardized planning process. The spatial planning guidelines are evidence-based and guided by inclusivity, flexibility, responsiveness, and simplicity. Further, three main approaches guide spatial planning; strategic focus on significant areas

of spatial planning and difficulties facing counties in undertaking the spatial planning process; a collaboration of the various stakeholders through partnerships; and consultative participation of the public and other stakeholders. (Ministry of Lands, 2018).

The definition of spatial planning by PLUPA 2019 the procedure and method used to influence the distribution of people and activities to achieve optimal utilization of physical, economic, and sociocultural resources is the upheld definition of this study.

2-2.3 The Concept of Sustainable Land Management

The World Bank (2006) defines Sustainable Land Management as "a knowledge-based procedure that helps to integrate land, water, biodiversity, and environmental management to meet rising food and fiber demands while sustaining ecosystem services and livelihoods" There is an emphasis on 'sustainability' which ensures that the needs of the future generations are met by safeguarding the present use of land and its resources.

According to Sessional Paper No. 3 of 2009, sustainable land management is defined as environmental sustainability, social equity, and economic viability in terms of allocation and use of land. This policy indicates the objectives and the course for present and future generations of land in Kenya. The sessional paper contains guidelines to enable optimal utilization and management of land, which direct that; land ought to be managed effectively, the land is a limited resource that ought to be sustainably exploited, members of the society ought to have unbiased access to land for income, and, most importantly, land has cultural significance hence it should be conserved for future generations. The sustainable management of land depends largely on the governing systems which define the relationship between land resources and the people. This statement, however, is contradictory since land management begins at the household level. The sessional paper should give clear sustainable land management measures at the household level to ensure that future generations' needs are met.

The United Nations describes sustainable land management as "the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions". This definition addresses the ever-changing human needs based on the economic carried out over time and the long-term productivity of the land to ensure the sustainability of the environment.

Terr Africa (2005) defines SLM as “the adoption of land-use systems that through appropriate management practices enable land users to maximize the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resources”. Terr Africa (2011) clearly describes sustainable land management practices in detail. The practices aim at; finding solutions to the various land degradation types, developing potential for upscaling in terms of productivity and conservation, capturing local innovation development projects, and striking a balance between prevention, mitigation, and rehabilitation of land degradation.

According to Smyth and Duman Ski (1993), Sustainable Land Management is using land to meet changing human needs while ensuring the land's long-term ecological and socio-economic functions. SLM aims to match the corresponding goals of providing environmental, financial, and social opportunities to the advantage of present and future generations while upholding and enhancing the quality of the land resource. Smyth and Duman Ski added that SLM is concerned with maintaining and enhancing productivity, minimizing production risks, and improving soil capacity to buffer against land degradation.

It is also concerned with protecting the potential of natural resources, preventing soil and water quality degradation, ensuring that land use is economically feasible and socially satisfactory, and assuring convenience to the benefits of improved land management. Sustainable land management is related to the quality of the soil and land. SLM integrates skills, policies, and actions intending to; combine economic principles with environmental concerns to simultaneously maintain or enhance production, reduce production risk, protect the potential of natural resources, and safeguard against soil and water degradation. Sustainable land management affects soil quality and its functionality within natural or controlled ecosystem boundaries to; sustain plant and livestock production, improve water quality, and encourage human health and habitation. And preserve the land quality, that is, the condition of the land relative to human requirements, including agricultural production, forestry, conservation, and environmental management (CIESIN, 2015).

However, Robertson and Swinton (2005) specified that further research needed to be done regarding Sustainable Land Management Systems. To attain Sustainable Land Management, it is vital to minimize land degradation while maximizing land productivity, and that centers on conducting further studies on crops and the biotic and abiotic environment.

Hobbs et al. (2008) gave examples of Land Management Systems, including Agroforestry Systems, Conservation Agriculture, and Precision Agricultural Systems. Food insecurity has been a major challenge facing many regions in Kenya hence Land Management Systems are recommended to tackle the issue of diminishing agricultural productivity caused by a corresponding degradation of land and soil quality. (Peter Motavalli, 2015) Although the land mentioned above management system requires an increased labor requirement, they are considered effective in the long run.

The definition of sustainable land management by Terr Africa (2011) as "the adoption of land-use systems, through appropriate management practices to enable land users to maximize the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resource is the upheld definition of this study."

2-2.4 The Concept of Sustainable Development

The United Nations Kenya (2016) established the Sustainable Development Goals to give an in-depth description of all the aspects of Sustainable Development. The SDGs in Kenya include; No poverty; Good health and well-being; Zero hunger; Quality education; Gender equality; Affordable and clean energy; Decent work and economic growth; Industry innovation and infrastructure; Reduced inequalities; Sustainable cities and communities; Clean water and sanitation Responsible consumption and production; Climate action; Life below water; Life on land; Peace justice and, strong institutions and Partnerships for the goals. The SDGs exhaust all the aspects of development while ensuring that future generations' needs are considered.

The Kenya Vision 2030 is the long-term development blueprint for the country. Its vision is to "*transform Kenya into a newly industrializing, middle-income country providing a high quality of life to all its citizens by 2030 in a clean and secure environment*." It has three pillars, i.e., Economic, social, and political, which are levered towards building sustainable and just economies, promoting food security, urban and rural development, providing energy, conserving and managing the environment, and developing science and technology. This vision, however, is not considered long-term because it has a time frame of fewer than 30 years. For it to be regarded as a sustainable development, the time frame should be longer to cover more generations.

The Global Sustainable Development Report (2019) further explains the interactions between Sustainable Development Goals (SDGs) with Vision 2030 for a better

understanding of Sustainable Development. The report emphasizes the vitality of engaging diverse actors (stakeholders)in the development process. For a development to be considered sustainable, it has to have the ability to adapt to demographic changes by ensuring that there is proper allocation of basic human needs, provision of education and healthcare, provision of social utilities, provision of physical infrastructure and employment opportunities for the population

On the contrary, development is not considered sustainable because it achieves an objective. Barbier (1987) noted that for economic development to be viewed as sustainable, the inception, design, and implementation of plans of projects must complement the needs of the people supposed to benefit from the project. (Barbier, 1987) Moreover, the notion of SD originated from scholarly works in environmental sustainability which were troubled with the limitations and opportunities that nature presents to anthropological activities and how utilization of the said natural resources can impact the physical environment.

Holden et al. (2016) argue that SD ought to be defined as a regularizing value system based on principles and standards aiming to meet human needs, enhance social equity and ensure the environment is conserved and well managed. (Erling Holden, 2016). This knowledge adopts the introductory objectives by WCED (1987). The World Conservation Strategy by the IUCN introduced the term ‘sustainable development’ in 1980 in a presentation. It focused on assisting people experiencing poverty to conduct self-sufficient development within natural resource constraints, promoting profitable development, using suitable know-hows in food manufacture, healthcare provision, housing and water provision, and inspiring social ingenuities.

However, in the presentation by the WCED, the definition was simplified as simply "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987) This is the popular description in literature. WCED (1987) additional expounded that “the main objectives of sustainable development were: reviving growth, changing the quality of growth, meeting essential needs for jobs, food, energy, water, and sanitation, ensuring sustainable population growth, conserving natural resource endowments, reorienting technology and managing risk, incorporating environmental issues in economic decision making, and reorienting international economic decisions” (WCED, 1987). The objectives of WCED fulfill the principles of sustainability, which guarantee the conservation of natural resources even when carrying out future development.

Lele, an author in the 1980s, argued that sustainable development was just a slogan incorporated by both governmental and non-governmental institutions as a new model for advancement. He added that it lacks a fixed theoretical and conceptual framework. Lele referred to sustainable development as advancement that can be constant either indeterminately or for a certain period. However, for advancement to be impactful and sustainable, it needs to include the objectives of the process and the techniques for achieving them.

According to UNDP (2018), sustainable local development is that which; reduces waste, prevents pollution, promotes efficiency, and develops local resources to revitalize the local economy. Sustainable local development focuses on communal rights, management of the environment, economic sustainability, education, and patriotism in national policy processes. This definition concentrates purely on the policy aspect. The Centre for Sustainable Development (CSD) (2018) argued that realizing SD means emphasizing public self-reliance more. CSD emphasizes employment and economic demand management, preservation of the environment, and sustainable managing of resources.

The definition of sustainable development by Global Sustainable Development Report (2019) as the ability to adapt to demographic changes by ensuring that there is proper allocation of basic human needs, provision of education and healthcare, provision of social utilities, provision of physical infrastructure and employment opportunities for the population is the upheld definition of this study.

2-3 Historical Background

2-3.1 Global

The method of obtaining gold from the earth using rudimentary tools and procedures is known as artisanal gold mining, sometimes known as small-scale gold mining. This practice has a long history dating back to ancient times. Because of environmental deterioration and conflicts with other land users, the influence of artisanal gold mining on nearby land uses and the environment has generated concerns over the years.

For ages, artisanal gold mining has been performed, particularly in areas with considerable gold reserves. Gold rushes throughout the nineteenth and twentieth centuries, such as the California Gold Rush (1848-1855) and the Klondike Gold Rush (1896-1899), fueled an increase in small-scale gold mining.

The Implications on Adjacent Land Uses include:

1. Environmental Degradation: One of the main concerns with artisanal gold mining is its impact on the environment. The use of rudimentary techniques, such as panning and sluicing, can lead to soil erosion, sedimentation in rivers, and water pollution due to the use of mercury and cyanide in the gold extraction process. This can negatively affect agricultural lands, water bodies, and nearby ecosystems.
2. Land Conflicts: Artisanal gold mining often occurs in regions where land rights and land tenure systems are not well-defined. This can lead to conflicts with other land uses, such as agriculture, forestry, and conservation. Conflicts may arise between miners and local communities or with larger-scale mining companies that have formal land rights.
3. Deforestation and Land Conversion: In some cases, artisanal gold mining has been associated with deforestation as miners' clear vegetation to access gold-bearing areas. This can lead to loss of biodiversity and disrupt ecosystem services.
4. Social Impacts: Artisanal gold mining can have significant social implications, such as the influx of migrant workers, including child labor, and the potential for exploitation and unsafe working conditions.
5. Economic Dependence: In regions where artisanal gold mining is the primary economic activity, communities may become heavily dependent on this industry. Fluctuations in gold prices or depletion of gold reserves can lead to economic vulnerability for these communities.

2-3.2 Africa

Artisanal gold mining has a long history in Africa, and indigenous communities have used crude ways to harvest gold from the earth for millennia. Artisanal gold mining predates colonial times and has been a significant economic activity in many African civilizations.

Gold was historically mined in numerous places around Africa, and some of the ancient gold mines can still be seen today. The Bambouk region in modern-day Senegal is one of Africa's most famous ancient gold mines, with gold mining dating back to at least the 5th century AD (Mkodzongi & Spiegel, 2018). Similarly, as revealed by the archaeological remains of mining sites in Zimbabwe, the Great Zimbabwe civilization (11th to 15th century AD) had considerable gold mining activity.

During the colonial era, European powers expanded gold mining operations in Africa, particularly in South Africa, Ghana, and Tanzania. Large-scale industrial mining operations were set up to mine gold deposits for export, with substantial social, economic, and environmental consequences for the continent. The implications of gold mining on adjacent land uses have changed over the years and can vary depending on factors such as the scale of mining, mining practices, and the level of government regulation, and can be both positive and negative.

(Hilson & Maconachie, 2017) quantified that the increased ASGM practices spreading through sub-Saharan Africa including a widespread variation of ‘labor-intensive actions short of mechanization’ (Weng et al., 2015) has brought about comprehensive debates addressing the habits of poverty-driven gold mining hysterics which is discernable within theoretical dissertations on rural incomes and development, (Mutemeri et al., 2016). (Hilson & Maconachie, 2017) Contend that an overall letdown of policy-along with scholars to participate in the concerns of societies reliant on ASGM has instigated an unadorned deficiency of institutions for regulating ASGM and a deprived comprehension of small-scale mining and agriculture links in Africa.

Underneath ASGM theoretical arguments, is the larger subject that operational modification and market liberalization have ‘brought momentous redundancy forcing many into illicit artisanal mining for survival (Weng et al., 2015). This has led to the misuse and exhaustion of gold mines and the resource they provide. This has in turn led to adverse effects on surrounding land uses, air pollution, noise, and landslides are some of the issues that have arisen from ASGM. This is a similar occurrence in various countries such as Tanzania, Mozambique, Ghana and Senegal (Fisher et al., 2009), (Persaud et al., 2017) and Weng et al. (2015) perceived that in DRC and Sierra Leone, along with other countries,

artisanal mining is used an additional source of income to diminish poverty. Studies in Ghana and Mali indicate that there are multifaceted linkages between artisanal mining and farming triggering main effects in rural economies caused by the small profit margins in smallholding (Hilson & Garforth, 2012).

As discussed ASGM, has had different impacts on the adjacent land uses some of the positive implications include; Economic benefits: where ASGM has improved the livelihood of miners and the local communities, especially in rural and economically disadvantaged areas. Employment: Mining activities have created jobs and generated income for small-scale miners and their families. Infrastructure development: Mines have driven infrastructure development to different areas as a way of efficiently accessing the gold mined.

The negative implications include; Environmental degradation: Unregulated and poorly managed artisanal gold mining can lead to deforestation, soil erosion, and water pollution, causing damage to the local ecosystem and biodiversity. Land use conflicts: Artisanal mining can lead to conflicts with other land uses, such as agriculture and conservation, as mining encroaches on these areas. Social issues: Health and safety hazards for miners, child labor, and socio-economic disparities can be prevalent in some artisanal mining communities.

2-3.3 Kenya

Artisanal gold mining in Kenya dates back to the early decades of the twentieth century(1900s) where there were some large-scale gold mining investigations commenced in Kilimapesa and Rosterman areas in Kakamega County and in Macalder in Migori County by the European settlers. The two areas constituted a section of the Archaean Tanzanian craton which is famously referred to ‘The gold green belt’. Geographically, the belts cuts through parts of; Turkana, West Pokot, Nandi, Kericho, Kisumu, Siaya, Migori, Vihiga, Kakamega and Narok counties. In the late 1950s to 1960s, there was a steady decrease in gold production which prompted the closure of the largest mines in the country such as Macalder.

Table 2- 1: History of gold mining companies in Kenya

Company	Nationality	Area of Operation
Acacia Mining	Foreign	Siaya and Kakamega Counties

Karebe Gold Mining Ltd	Foreign (Maris Africa)	Nandi County
Kilimapesa Gold Pty Ltd	Foreign (Gold Plat Plc.)	Trans Mara and Narok Counties

According to (Muigua, 2019), the mining subsector in Kenya is considered relatively small. The subsector's contribution to the national GDP is smaller than its expected potential. It is projected that the continued development of the subsector can increase income. There are four main mineral belts in Kenya: the gold, the green belt encompassing Western Kenya towards Tanzania, and the gemstones belt, which runs from central Kenya to Mozambique. The Rift Belt is the source of minerals such as soda ash, diatomite, and fluorspar, and the coastal belt with minerals such as titanium (Muigua, 2019).

Gold mining in Kenya has been carried out for more than 100 years. The primary mining method is artisanal gold mining (Mutono, 2016). Resource analyses show that gold deposits have been found in the remote regions of western Kenya near Lake Victoria. Therefore, the western region is the center for ASGM activities carried out as a source of livelihood.

There are over 250,000 ASGM miners in Kenya, of which 40% are women. Women are increasingly getting involved in artisanal mining to complement farming to increase their source of livelihood (Manga, 2016). They are, however, disadvantaged due to gender inequality, lack of access and control over mining resources, limited information and technology, and exclusion in the decision-making process. Artisanal gold mining supports more than 1 million livelihoods.

A majority of ASGM mining operations are informal. Kenya lacks a robust legal framework for regulating ASGM. At the same time, ASGM miners work under dangerous conditions. Most operations are manual or use technologies suited for micro-scale operations, including toxic substances such as mercury, which pose severe health and environmental risks (PlanetGold, 2021).

2-4 Impact of Artisanal and Small-Scale Gold Mining on Sustainable Land Uses

One of the primary effects of artisanal and small-scale gold mining is the contamination of water and soil resources. Regarding spatial planning, artisanal gold mining causes adverse effects on adjacent residential and agricultural land uses. Various studies have investigated this occurrence in different regions of the world.

2-4.1 Global

According to Donkor, the actual first effects of artisanal gold mining go as far as 700 BC when amalgamation was first practiced in Spain by the Romans. Cases of mercury poisoning were documented in the same year artisanal gold mining began. (A.K. Donkor, 2006). Mercury is a heavy metal considered very poisonous and poses adverse health effects to humans. Artisanal gold mining process results in cyanide and mercury leakage into the environment, poisoning groundwater, farmlands, and water resources that majority of the population rely on for income and survival. (Marcello M. Veiga, 2006) further stated that ASGM has adverse effects on the adjoining land uses such as the cultivated land, water resources and inhabited areas which generally affect the physical environment and the health and wellbeing of the communities residing near the mines.

2-4.2 Africa

Funoh, however, reported that when miners were surveyed in Cameroon, they stated that their mining activities did not negatively affect the environment and the adjacent land uses. The researchers attributed the denial to ignorance or the fear of being accused or prosecuted for destroying the environment. It was especially so because a majority of the miners were operating illegally. Mining was also linked to the destruction of forest swamps and the pollution of water bodies. Mining activities also produced high measures of mud and sand, which, when conveyed downstream, lead to the alluviation of rivers and the destruction of aquatic life. Oil waste and fuel disposal from motorized pumps also polluted water resources, intruded into the riparian reserves and harmed water quality (Funoh, 2014).

Serwajja and Mukwaya (2021) reported that in Uganda, mercury use was responsible for high toxicity levels in soils and water around the Karamoja region. The levels of mercury recorded exceeded the acceptable levels in soil and water. According to WHO, the minimum permissible limit of mercury in the soil is 0.03 mg/kg, and 0.006 mg/l in water. Due to artisanal mining, the Karamoja region also witnessed massive land clearances and landscape deformations. The mining sites had piles of waste and uncovered pits, which exacerbated health and safety concerns for the neighboring residents (Serwajja & Mukwaya, 2021).

2-4.3 Kenya

Nyamai Rhoda researched to investigate environmental implications at Macalder mines in Migori County. Samples of soil and water from River Kuja were collected and analyzed for contamination. Elemental analysis indicated that mercury, lead, and arsenic levels were higher than the tolerable levels World Health Organization (WHO) suggest. Lead and arsenic quantities were 5200 and 7300 times above WHO thresholds. These unacceptable levels of heavy metal contamination were an ever-present occupational risk and subjected miners and the surrounding residents to adverse health outcomes (Mutono, 2016).

Alwanga et al (2020) reported using artisanal gold mining techniques in Rosterman gold mines in Kakamega County, Kenya. ASGM mainly was conducted informally, on a small scale, and had diminishing returns. In addition, the mining activities caused environmental degradation characterized by high noise levels, scanty vegetation, degraded neighboring farmlands, and polluted water sources (Alwanga et al., 2020).

2-5 Impact of Artisanal and Small-Scale Gold Mining on Sustainable Rural Development

2-5.1 Global

In Vietnam, a study found that mining was associated with increased crime rates and substance abuse. Overdependence on mining activities adversely affected communities when mines were temporarily closed. Such temporary closures increased unemployment rates and social ills such as crime. Non-mining communities were more resilient to economic shocks when compared to mining communities because their economic activities were diverse (Nguyen et al., 2018). In Vietnam, however, researchers observed that communities with active mines experienced increased employment, reduced poverty rates, and improved infrastructure (Nguyen et al., 2018).

2-5.2 Africa

A study by Appiah and Reuben (2012) focusing on mining in Ghana noted that the mining industry is often fraught with contradictions in terms of its socio-economic implications. In the study, the researchers sought to document the communities' perceptions of the mining areas and collected data using questionnaires. Using data gathered from 102 households, the findings showed that gold mining had contributed positively to Ghana's economic growth by being a foreign exchange earner, providing employment, and being a source of tax revenue (Appiah & Bauben, 2012).

In Ghana, gold mining was linked to adverse health impacts on the neighboring residents. Mining was associated with short-term health impacts, such as injuries and loss of time, and long-term impacts, including cancers and respiratory conditions. The use of mercury by ASM miners in gold recovery was linked to an increase in kidney diseases. Mercury also affects the respiratory system (Aboka et al., 2018).

According to Appiah and Bauben (2012), Gold mining in Ghana has also been associated with providing social amenities to surrounding communities; however, this is not always enough to satisfy the needs of these communities. For instance, in the Tarkwa gold mining region, it was established that up to 58% of residents did not have access to social amenities such as clean drinking water, health centers, and schools. Further, these gold mining activities did not increase employment. Communities faced high unemployment rates, crime, and prostitution (Appiah & Bauben, 2012).

A survey of the effects of mining in Burkina Faso, Mozambique, and Tanzania, covered nine mining areas and collected data using focus group discussions from 83 groups. The discussions covered the implications of mining on economic indicators, the environment, and the health of mining communities. The findings showed that the implications of mining were primarily negative. Environmental pollution, social disruption, and health risks harmed the well-being of residents. Health implications were associated with negative indicators concerning morbidity, mortality, and well-being (Leuenberger, et al., 2021).

Extractive activities have an impact on social indicators. In a study of ASGM in Tanzania and Mali, researchers sought to establish the influence of mining on health indicators and access to social amenities. Findings in Tanzania showed that gold mining harmed households in the surrounding catchment area. In Mali, however, it was the opposite. Due to proper zoning, gold mining positively affected households in the immediate catchment area (Polat, et al., 2014).

2-5.3 Kenya

Barreto identified economic implications of ASM ranging from job creation, poverty reduction, and infrastructural development to increase tax revenue. In Kenya, mining contributed 0.8% of GDP in 2015, with the government mining policy pointing to upsurge its contribution to 10% by 2030. The mining policy sees value addition as the pathway to increasing the contribution of mining to GDP. In a recent assessment of the contribution of

gold mining, it was established that ASGM employs 40,000 Kenyans. M employs 140,000, with up to 800,000 depending on ASM for their livelihood (Barreto, 2018).

While most studies have indicated a positive economic impact, other researchers note that mining is associated with impoverishing effects. In most countries with rich mineral resources, residents adjacent to the mining sites continue to experience abject poverty. In a study covering 173 households in Taita Taveta County, researchers collected data using focus group discussions to determine the implications of mining on the incomes of communities. The findings showed that mining did not help households acquire assets; however, the income from mining helped them meet daily needs (Mwakesi et al., 2020).

Jotham and Mulinya conducted a study at the Rosterman mines in Kakamega County, Kenya, investigating the economic impact of ASGM in the zone. The research fixated on the impact of gold mining on income. Using a sample of 322 miners and 44 respondents drawn from the County government, the findings established that ASGM activities positively affected miners' income status. However, while respondents noted that the increased incomes had enabled them to take their children to school, an analysis of the school enrolment rates did not find any increase (Jotham & Mulinya, 2020).

2-6 Planning Interventions for Sustainable Land Use Management

Planning Interventions are the strategies that can be employed to guarantee that land resources are utilized in a sustainable manner while putting in consideration the present and future uses.

2-6.1 Policy, Legal and Regulatory Mining Reforms

Globally, there has been a missing link between policy, institutions and artisanal gold mining. In studies carried out in Guyana, a country locates in the north eastern part of South America by (Hook, 2019), stated that institutional and policy reforms were interventions used to confront the effects triggered by artisanal gold mining. Formalization of the sector assisted in tackling of the institutional gaps, land tenure insecurity, forest degradation and loss of green cover in Guyana.

In Africa, one major weakness of ASGM in most developing countries is weak regulatory and legal reform. It has led to policy movements such as the Extractive Industries Transparency Initiative (EITI). The initiative seeks to increase accountability in the natural resource sector. One of EITI's reform initiatives is to increase public disclosure, especially in developing countries, which are the main producers of gold. Accountability also means

the prioritization of anti-corruption to avoid the resource curse, which is often associated with natural resource exploitation in developing countries (Signé, 2021). In an assessment of 34 gold-producing African countries, it was established that these countries generate smaller resource rents. Reforming mining legislation can lay the framework for increasing African countries' revenue from the sector (Gajigo et al., 2012).

In a study in Uganda, in the Karamoja region, the researchers also found that miners were using rudimentary tools for extracting gold. The miners excavated the gold-rich rocks and soil from underground pits, and once brought to the surface, they crushed the soil and rocks into fine powder. The next process involves mixing the fine powder with water in a basin, stirring, and adding mercury to increase the speed of separating the gold from the soil dust (Serwajja & Mukwaya, 2021). The study findings recommended a strong environmental audit and monitoring framework to tackle environmental pollution.

In Kenya, Mwango (2013) stated that artisanal and small-scale mining incorporates small, informal, and mostly unlawful miners who use undeveloped approaches and practices to extract minerals. A majority of these miners are unskilled and underequipped. A majority do not possess advanced mining knowledge and have a minimal appreciation for the need to protect the environment. The use of rudimentary production techniques characterized artisanal and small-scale mining practices, exhibiting the need to review this mining technology used (Mwango, 2013).

Mitchell and Palumbo-Roe conducted a study in Migori County, where they found that gold is produced from the quartz-carbonate reefs in the greenstone belt and recovered using extraction of the ore. The researchers also discovered that the deep shafts were unstable and dangerous. There were frequent cases of mine collapse leading to fatalities. The gold was recovered using manual crushing and mercury amalgamation without protective gear, adversely affecting human health. These techniques are associated with poor gold recovery (Mitchell & Palumbo-Roe, 2020). The study proposed use of advance mining technology to address the rudimentary practices.

Barreto assessed mining in Kenya, demonstrating that formalization could increase the productive output of gold and other gemstones. Formalization increases transparency and accountability in the supply chain. A continuous, coherent, and integrated formalization process must be grounded on legalization. The legal framework should empower vulnerable groups while also ensuring capacity building and the creation of economic

incentives (Barreto, 2018). Formalization and legalization should also include options such as education initiatives, government-sponsored technical assistance to miners, and fair-trade practices (Miriam, 2014). Formalization and legalization can create the mechanisms of certification (Barreto, 2018).

Mwango (2013) specified that ASM is characterized by informality, implying that ASM miners in Rongo Sub-County usually operate without a legal framework. Informal operations are small-scale, use outdated technologies in production, and have unregulated markets. Informality thrives where processes are excessively complex and bureaucratic, are centrally determined and controlled, based on state directives, and lack social significance to the communities in the mining belts. Informality is also associated with social and political marginalization (Mwango, 2013).

According to Alwanga et al. (2020), the informal nature of ASM in developing countries makes it challenging to achieve high performance levels. The researchers note that some artisanal and small-scale miners are licensed in informal operations, while a majority are not. The lack of licensing makes monitoring mining activities or enforcing regulations difficult. Further, mining sites are generally inaccessible because operations are informal and lack proper infrastructure (Alwanga et al., 2020).

An evaluation of mining in Taita Taveta County demonstrated that the county did not have a proper regulatory system. The county had no legal framework to regulates the influx of migrants to the mining sites. The lack of an appropriate regulatory framework also meant that mining sites were poorly rehabilitated, while large-scale mining resulted unproductive farmlands, an aspect which negatively affected food security in the region (Mwakesi et al., 2020). The absence of adequate legislation means that the rights of miners and communities cannot be secured. Underdeveloped governance structures and institutions and the marginalization of mining communities often imply that when serious disputes arise, there are no dispute mechanisms to solve them. The net result is conflict over access to land and land use. Weak laws also encourage human rights violations, such as child labor in the mines.

Kenya has a Mining and Mineral Policy (Sessional Paper No.7 of 2016), which provides the strategic direction for the mining sector. The policy reiterates the need for a robust institutional framework and the need to tackle government issues, operational constraints, environmental protection, value addition, capacity building, and post-mine closure

activities. (Kenya, Republic of, 2016) highlights illegalities such as smuggling, health and safety risks, and tax evasion challenges regulations of the artisanal mining activities. Furthermore, it highlights the need to develop a framework for mainstreaming and formalizing artisanal and small-scale mining in order to support the livelihood of the artisanal gold miners.

The policy engendered the Mining Act of 2016 and regulations under the Act covering dealings in minerals, licensing and permits, state participation, employment, and training (Muigua, 2019). It is important to note that even in the presence of laws and regulations, when regulatory agencies lack the resources to enforce regulations effectively, minimal compliance will persist (Schoneveld et al., 2017). Mining Act 2016 covers the gold mining sector and aims at formalization of the artisanal mining subsector, capacity building in terms of technology, expertise and finances, fair trade of gold by the artisanal miners, formation of legal groups and co-operatives, and land use sustainability.

(Kenya, The Republic of, 2010) in section 60(1) (c) & (e) advocates for sustainable mining while protecting ecologically sensitive areas such as the riparian reserves. Article 62(1)(f) states that all mineral and mineral oils should be classified as public land.

(Kenya, Republic of, 2022) considers artisanal gold mining to be customary and hence emphasizes on the need of planning for the designated artisanal gold mining zones, conducting of Environmental Impact Assessment, provisions for disaster vulnerability profiles for mining sites and organization of miners into groups after vetting them to ascertain capacity to mine in terms of expertise and technology. The abandoned mines are also supposed to rehabilitated so as to remedy land degradation effects.

(Kenya, Republic of, 2019) gives provisions for zoning of mining sites as industrial zones. According to section 46 Kakamega County Government should prepare a Local Physical and Land Use Development Plan (LPLUDP) to spatially categorize various land uses within the county.

(Kenya, Republic of, 2015) ensures mining is done sustainably through management of natural resources, auditing of the value of the mineral resources, protection of ecologically sensitive areas such as riparian reserves through conducting Environmental Impact Assessment.

2-6.2 Spatial Planning Guidelines

Globally, there has been inadequate studies linking artisanal gold mining and land use planning. (Maus, et al., 2022) studies incorporated spatial planning as an intervention to sustainable mining. Gold mining areas were among the mining sites mapped worldwide using satellite imagery. Ground features such as tailings, shafts, open cuts, pond water structures, processing areas and other forms of infrastructure in the mining areas were defined during the identification of the mining sites. Google earth imagery enabled mapping out of physiographic features such as the water resources to give a better understanding of the intervention. Of the mapped countries, Russia, Australia, Brazil, China, Indonesia and Unites States of America accounted for 52% of the mining areas while 21 other countries accounted for 39% and 118 countries accounted for the remaining 9%. This study emphasized the prerequisite for land use planning for the mining sites to ensure sustainable land use.

Esteves and Moreno stated that resource-rich regions expect that local economies will benefit from the extraction of minerals which is not always the case because these regions do not always know how to take advantage of extractive activities to create jobs, develop local businesses, build skills, improve technologies, and generally encourage financial progression and sustainable development (Esteves & Moreno, 2013). There exists a movement aiming at developing policies to regulate resource utilization, encourage industrialization and develop the economy sustainably with the key goal of promoting equity of resource allocation (Acheampong et al., 2016). Spatial planning guidelines lie at the heart of any sustainable land management.

In Africa, studies by (Mhlongo & Akintola, 2021) in Limpopo Province in South Africa associate the impacts of gold mining to environmental sustainability, health and safety risks of miners and residents living adjacent to the mines and land degradation as an outcome of land use unsustainability. Formalization of ASGM activities was the best alternative to minimize the illegalities of the sub-sector and also the unavoidable physical effects to the environments. Conclusively, he suggested mapping of the mining zones so as to strategically implement land reclamation and rehabilitation of the abandoned and active mining areas.

Studies conducted in Ghana by Adu-Baffour et al. (2021), relate artisanal gold mining to rudimentary practices and use of hazardous chemicals adversely affecting adjoining agricultural land use, the physical environment and the neighboring communities (Adu-Baffour et al., 2021). The impacts are caused by improper implementation of mining legal

frameworks, governance challenges and ineffective collaboration of stakeholders in the mining sub-sector. The studies proposed a review of the legal and policy frameworks to tackle issues such as tenure insecurity, unlicensed miners and resource misallocation. Furthermore, the studies proposed a collaborative governance system to enable natural resource management and ensure sustainable land use through involvement of all stakeholders in planning and policy making.

In Kenya, the County governments are in charge of planning and development of the counties under Part 11 Article 8 of the Fourth Schedule of the Constitution. While implementing this mandate, the counties are required to; develop specific policies, guidelines and strategies for the counties, prepare CSPs and urban spatial plans, implement the plans, commission spatial planning studies within assigned area, and take part in the groundwork of regional spatial development plans (Ministry of Lands, 2018).

The Ministry of Lands and Physical Planning developed Spatial planning procedures to handle the problem of varied approaches in spatial planning, insufficient institutional capabilities, insufficient human capacity, insufficient distribution of planning funds, deficient implementation of plans, lack of a proper spatial planning institutional framework, and a lack of harmonization of planning between national and County governments (Ministry of Lands, 2018). However, these guidelines have not fully been operationalized because of the challenge of insufficient resources to enable plan implementation.

2-7 Research Gaps

Globally there has been no research on the implications of artisanal gold mining on the adjacent land uses in the last five years. Nguyen et al. (2018) relates artisanal gold mining to adverse effects the environment and land use management (Nguyen et al., 2018). A study by Donkor (2006) was conducted in Spain to show the influence of artisanal gold mining on the environment highlighting the impacts of unsustainable mining on the residential land use from a socio-economic point of view. The studies showed globally are from an environmental point of view and lack the perspective of land use planning.

In Africa, more than ten studies have been conducted, indicating the effects of ASGM on the environment and the society. However, none of the studies have interlinked gold mining with land use planning in their methodology and the proposed strategy. (Tuokuu et al., 2019) reported that there was a missing linkage between artisanal gold mining and

sustainable development which propositions the concept of land use planning while incorporating the SDGs to ensure there is a sufficient regulatory framework guiding gold mining.

While in Kenya both the national and county governments are responsible for land use planning, the performance of the spatial planning function at the county level has been inefficient as a result of the low adoption of spatial planning by counties, absence of mandatory institutions and resource capacities and a framework guiding spatial planning of the counties. While the Ministry of Lands and the Council of Governors have developed guidelines that offer a mutual and coordinated technique to undertaking spatial planning in counties, the extent to which these guidelines have been adopted remains clear. In the face of artisanal mining activities, it is crucial to investigate how these factors have influenced sustainable land use planning, land management, and rural development.

Studies conducted in Migori County the process of recovering gold through manual crushing and mercury amalgamation is associated with poor gold recovery and deleterious effects on land and adjacent land uses (Mitchell & Palumbo-Roe, 2020). This creates is a need for reforming the mining legislation and regulations in the artisanal mining context to formalize the sector and empower the artisanal miners with information and technology to improve the gold mining revenue.

2-8 Theoretical Background

2-8.1 Normative Theory

Normative theories answer the question of how to generate the best urban environment, or, as Lynch stated it, ‘how to know a good city when you see one’. However, question of values is the what should be asked, along with how cities are conceptualized in terms of their functions (Steinø, 2018). The theory also focuses on the question of ‘why to plan’.

Economically, public planning may be perceived to be at the cost of individual citizens and organizations, which has to be meaningfully justified. In this view, public planning must have an objective, which can be impossible to achieve otherwise, or at least not competently. Irrefutably, planning must be a means for the realization of public policy goals, through interventions.

2-8.2 The Rational Comprehensive Planning Theory

Procedural planning theories are an attempt to refine the planning process so as to produce better plans. Among these Rational Planning Model is considered to be most successful and even used today. Allmendinger (2009) argued that the normative theory was purely sociological and rejected Faludi's rationale point of view.

Andreas Faludi's (1986), rational comprehensive, planning theory on the other hand defined planning theory as normative and focused on the rationale planning process which entailed goal formulation and alternative form of action while planning for land use. Additionally, because it synchronizes written text with maps and policy to physical expression spatially. Sandercock (1998) refers to the rational comprehensive model as 'technocratic planning' due to its prominence on technical know-how and skills and its unfaltering belief that technology and social science can be utilized in solving of society challenges.

This study employed the steps of the rational comprehensive planning model; conception of goals, objectives and targets, collection of data, analysis of data and development of alternatives.

2-8.3 The theory of Spatiology

There exists a number of theories and models which relates theory to planning. "Spatiology" Theory was developed by Lagopoulos (2018) to interlink analytical theory with the normative theories to cover the gap between practice and science in the theories of land use planning. The theory of Spatiology emerges as a remedy to "imprecise, vague, ambiguous, and opaque nature" of key multifaceted and normative notions used in urban planning practice and theory. Taylor contends that a clear discrepancy between concepts is not only theoretical, but also preconditional in describing alternatives of action. Lagopoulos, 2018 states that the normative approach is not necessarily "normative" in nature, in the perspective of outlining the objectives of the intervention, but diagnostic, focusing on comprehension of the present structure of the zone and its predispositions. Comprehension can be achieved empirically however, subject to obscurities since its justification is implied and thus incomplete, and may result in unintelligibility. He postulates that there is need for the planner's work, although applied(technical), to also adopt an analytical(scientific) part, and the latter ought to be explained by the planner.

The main goal was interlinking planning interventions with the prevailing structure of the zone and its tendencies. Centered on Human geography, it focuses on modelling the existing spatial structure and excludes proposal formulations through knowledge obtained. (Lagopoulos, 2018).

2-9.4 Export Base Theory

The Export Base theory is grounded by the demand in exports in perfect elastic supply. It is purely based on policies guiding rural development. Moreover, it assists in estimation of the effect of sector employment and rural development results (Kilkenny & Partridge, 2009).

In the context of economic development, the export base theory and gold mining are linked, particularly for countries that have the potential to develop through the exports of gold produce (Maureen & Mark, 2009). According to the export base idea, focusing on and extending a country's exports (Kenya) can contribute to economic growth and development. In the instance of gold mining, certain governments have used their gold reserves to increase export profits and spur economic growth (Lemma, 2022). The export-based theory will also improve accountability and efficiency in Kenya's and Kakamega's trading systems through

Economic Diversification: This is important when a country increases its export sectors beyond traditional industries and traditional techniques. In Kenya, gold mining can be an important driver of economic diversification and enhance areas with gold mines such as Kakamega and Migori. The country can diversify its revenue streams and minimize its reliance on a limited number of goods or sectors by exporting gold.

Investment and Employment: Gold mining can attract foreign direct investment (FDI) and create employment opportunities, especially in the regions where mining operations are based. Increased investment and employment can have positive spillover effects on other sectors of the economy, driving overall economic growth.

Trade Balance: A successful gold mining sector in Kenya can contribute to improving trade balance by increasing export revenues. A positive trade balance means that Kenya would be exporting more goods and services than it imports, leading to a stronger overall economic position.

2-9.5 Tragedy of the Commons

The Tragedy of the Commons refers to a scenario in which commonly held land is inevitably degraded because everyone in a community is allowed to graze livestock there. It was embraced as a principle by the emerging environmental movement. (Anukwonke, 2015)

Tragedy of the commons states that resources belonging to communities, as a whole, are poorly managed by individuals of the same community, as they care less about others and more about themselves and their ability to maximize utility of the shared resource.

The theory is important as artisanal gold mines are viewed as common resources to be exploited by the host communities. It goes further to highlight the roles, attitudes, behaviors and perspectives of stakeholders in relation to the gold mines especially in the developing world.

2-9.6 Stakeholder Theory

Donaldson and Preston (1995), propose the stakeholder theory which assesses stakeholders' identities and relationships. The stakeholder theory was initially apprehended and extensively practiced in the private sector with a cumulative use of the theory in evaluating the public sector and the government policies (Glauco De Vita, 2016). In examining the effects of mineral extraction by Nortjé (2014), stakeholder analysis does not limit the impacts to the economic implications. Instead, sustainability provisions are integrated into the balanced scorecard by integrating environmental and social measures. Environmental exposure relates to the effect on the environment in terms of emissions, waste, material input, noise and vibrations, waste heat, radiation, and land use.

On the other hand, social exposure relates to the direct and indirect effects on internal stakeholders, such as employees, and external stakeholders, such as customers, suppliers, community, and government. Sustainability performance indicators within the oil and gas industry can be economic, environmental, and social. Economic indicators relate to financial performance. Environmental indicators are the emission of volatile organic compounds (VOC), energy efficiency, logistic incidents, greenhouse gas emissions, and decommissioning. The social indicators are health and safety, sponsorships, training, and community development.

Stakeholder theory in this case is used to enhance our understanding of overall sustainability, from the social, economic and environmental pillar.

2-9.7 Systems Theory

Systems theory is a theoretical framework founded on the principle that the element parts of a system can best be comprehended in the context of the associations with each other and with other systems, instead of in seclusion. Open systems refer to those that interrelate with other systems or the environment outside of the systems, whereas closed systems do not. Open systems usually include biological and social systems, whereas closed systems are mostly mechanical systems. The boundaries of open systems are more flexible than those of closed systems. J. Brian McLoughlin's (1969) systemic planning approach contrary, paired the elements of space i.e., Land uses, and location i.e., physical correspondence, and androgenic actions and their physical counterparts to arrive at his theory of land use planning. This thesis deals with an open system made up of the environment around the mines, communities involved in and/or affected by the mining activities, governmental and non-governmental institutions, the business community involved and the planning aspect of gold mining. The systems approach in this study therefore links all the theories mentioned.

2-9.8 Conclusion to the Theoretical Background

This study methodology is driven by rationale comprehensive theory which is procedural, while the plan proposals are centered on Analytical planning theory and Export Base theory based on the data findings and analysis. According to Faludi, procedural theories are defined as theories of planning that are fixated on the procedure of the planning methodology and the actions of the planner, or the organizational systems of planning processes, and it ought to be the core of planning theory.

2-9 Theoretical Framework

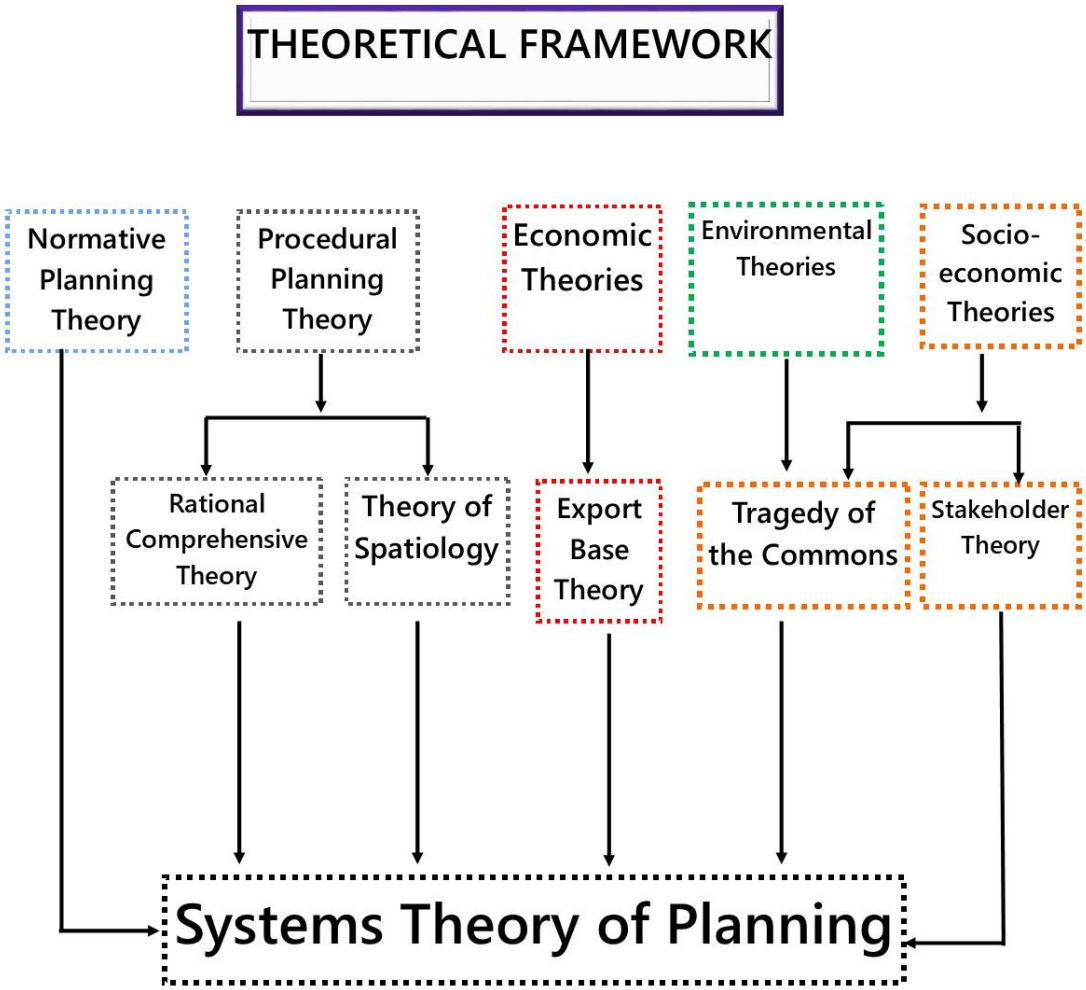


Figure 2- 1: Theoretical framework

2-10 Conceptual Framework

The conceptual framework is a diagrammatic illustration of the affiliation between the dependent and independent variables and all the other variables that affect that relationship. In this study, the independent variable was Artisanal Gold Mining characterized by informality, small scale of mining, low-income levels, diminishing quality and quantity of gold. The Dependent variable is land use planning which is influenced by the effects of artisanal gold mining resulting in unsustainable land use. The Intervening variables which affect the occurrence of unsustainable land uses include; legislation, policy, institutions, governance, politics and socio-economic factors.

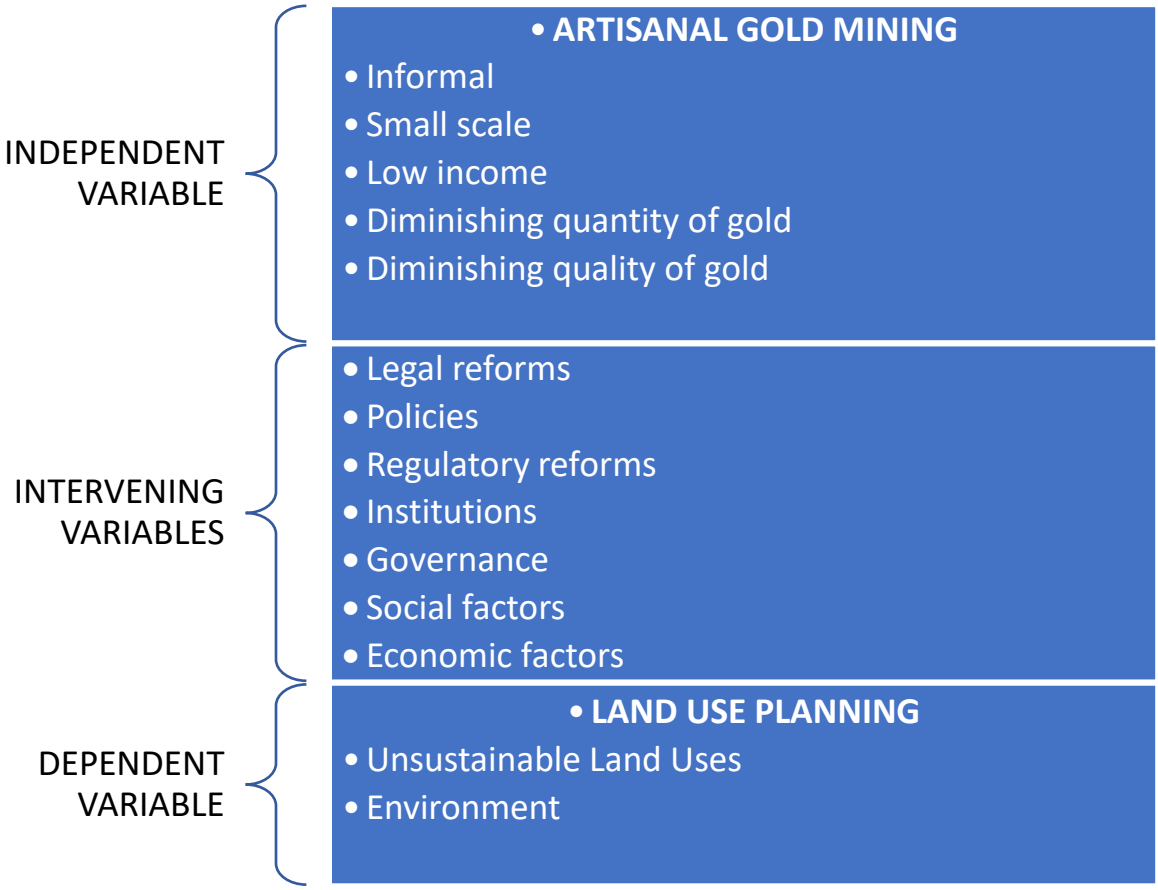


Figure 2- 2: Conceptual framework

CHAPTER THREE: RESEARCH METHODOLOGY

This chapter describes the Research design, the Study area, Study Population, Sampling Design, data collection methods, data analysis, data presentation, expected outputs, quality of research, ethical considerations and the summary of the chapter.

3-1 Research design

A research design refers to the strategy guiding the research process. The research design forms the basis of investigating the research questions as it influences decisions on population and sample size, data collection, and data analysis. The selection of a research design is determined by the nature of the research objectives and questions and constraints such as time and financial resources (Creswell & Creswell, 2017). This study used a descriptive survey design. Descriptive studies are focused on finding out who, what, where, when, and how much. It attempts to measure the types of activities, how often, when, where, and by whom (Mugenda & Mugenda, 2008). The descriptive research design collects quantitative information that could be tabularized and presented numerically to determine causal associations between variables.

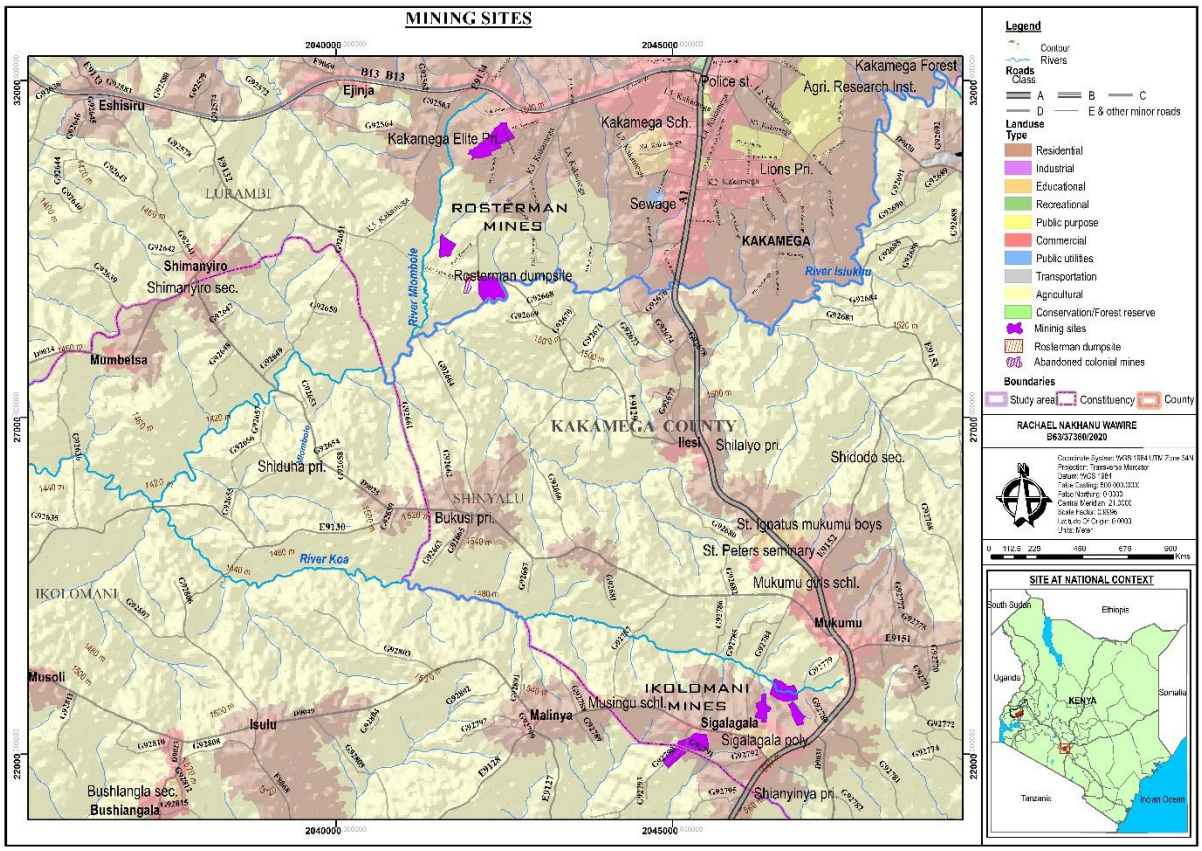
Data is often collected using survey instruments such as questionnaires and interviews. The validation for using descriptive research design stems from it enabling the researcher to establish relationships between variables and examine people's beliefs, opinions, and perceptions on a set of questions under study (Creswell & Creswell, 2017). The specific descriptive research design that was used in this study is the cross-sectional survey. Cross-sectional surveys are concerned with collecting data from respondents at a precise period and using the data from the sample to infer the characteristics of the population.

Key informant interviews and household questionnaires were used involving representatives from NEMA, The County Environment Department, The Mining Department, and the County Planning Department. Descriptive cross-sectional surveys are used when the objective of the research is to reveal relationships and implications of a phenomenon in the population. Cross-sectional surveys allow researchers to describe individual variables and determine relationships between variables (Cooper & Schindler, 2006). This study used a cross-sectional survey to measure the affiliation between artisanal gold mining and adjacent land uses in the Rosterman and Ikolomani areas.

3-2 Description of the Study Area

The research was carried out in Lurambi, Ikolomani, and Shinyalu Sub-counties in Kakamega County. This county is sited Kenya, covering an area of 3,033.8 km^2 and a population of 1,867,579 people. The County borders Vihiga County to the South, Trans Nzoia County to the North, Uasin Gishu County to the East, and Siaya County to the West.

The Rosterman gold mines are located in Lurambi Sub-County in Kakamega, while the Ikolomani mines are situated in Ikolomani Sub County, with part of the mines sprawling over to Shinyalu Sub County. Lurambi Sub-County borders Ikolomani Sub-County to the north and borders Shinyalu Sub-County to the west (Statistics, 2019). The Rosterman gold mine covers the following area.



Map 3- 1: Rosterman and Ikolomani Mining sites

3-3 Population

The population comprised residents of Rosterman mines who lived in Lurambi, Ikolomani, and Shinyalu Sub-counties. According to the 2019 census, it was estimated that Lurambi Sub-County had a population of 297,394, Ikolomani had a population of 111,743, and Shinyalu had a population of 122,475, which resulted in a total of 531,612.

3-3.3 Response Turn-out rates

The data collection process took place between the 17th of April to the 22nd of April 2023. Household questionnaires were issued to Rosterman area residents, focus group discussions were conducted with the Rosterman residents and miners and key informant Interviews conducted with the County Physical Planner, Mining Department Officer, Director of NEMA and Director of Environment Department at the county level.

The study targeted 216 respondents, but 206 responded. Table 1 presents the number of respondents in each suggested class, the expected and available number of respondents and the percentage turnout of the respondents in the Rosterman area.

Table 3- 1: Respondents turn out rates

Class of Respondents	**Expected number of respondents**	**Available number of respondents**	**% turnout of the respondents**
Household Survey/Questionnaire	203	190	93.6%
Key Informants	**4** -Mining Department Officer -County Planning Officer -Environment Officer -NEMA Representative	**4** -Mining Department Officer -County Planning Officer -Director, Environment Department -Director, NEMA	100%
Focus Group Discussions	14	12	85.7%
TOTAL	**216**	**206**	**93.1%**

3-4 Sampling Design

A sample design is a definite plan for obtaining a sample from a given population. It refers to the technique or the procedure the researcher would adopt in selecting items for the

sample. Multi stage sampling approach was used to obtain data from various informants in Ikolomani and Rosterman.

3-4.1 Sampling frame

The sampling frame consisted of a catalogue of all the households in the Lurambi, Ikolomani, and Shinyalu Sub-counties. About the Kenya Population Census in 2019, there are 52,015 households in Lurambi, 26,964 in the study area.

3-4.2 Sample size

A statistical formula for establishing the sample size in a big population (above 10,000 people) will be used to select the appropriate sample size. In this study, there are 108,412 households in both Sub-Counties. The following formula was used to determine the sample size:

Where;

n-the sample size
N -population
e -margin of error

The population for the sub-counties is as follows (KNBS, 2009):

- Lurambi Sub County
- Ikolomani Sub County
- Shinyalu Sub County

Total population for the six sub-counties is 108,412
Assuming a margin of error of 7%:

$$n = \frac{N}{1+Ne} \quad \text{therefore} \quad n = \frac{108,412}{1+(108412\times 0.07^2)}$$

n = 203.69

n = 203

The sample size for the study would be 203 households in the study area, Kakamega County. Therefore, the sample size to be used for each sub-county would be 67.

3-4.3 Sampling technique

The sampling technique is the researcher's method to select the respondents from the population. Sampling techniques ensure that the sample chosen represents the characteristics of the population under study.

Purposive Sampling of the Site

Purposive sampling of the site was conducted based on the annual Gold Production rate according to the National Action Plan for ASGM in Kenya.

Table 3- 2: Gold mining areas and production rates in Kenya

Gold Mining Areas	County	Annual Gold Production (Kg)
Macalder, Kamwango (Rongo), Masara Mikei, Kitere, Osiri, Masaba, Kuria- Transmara, and Kehancha	Migori	1,947.78
Nyamasare, Ligega, Bar Kalare and Wagusu villages	Siaya	523.98
Lurambi (Rosterman area), Ikolomani and Shinyalu	Kakamega	1,406.46
Kilimapesa, Masurura, Blure, Got, Kabongo, Nyakigile and Teng in Lolgorian town.	Narok County	1,520.46
Chemase and Kapsaos	Nandi County	80.10
Vyalo, Shaviringa and Mbale	Vihiga County	1,385.04

Naduat	Turkana County	-

Gold mines in Migori and Narok Counties highest and second highest gold production in the country, however, they been the subject of recent studies such as those done by (Mitchell & Palumbo-Roe, 2020) and (Mutono, 2016) who researched on Migori while (Chepkwony, 2018) conducted a research in Narok County on gold mining. In third place were the mines in Kakamega such as Rosterman and Ikolomani that had the third highest level of artisanal gold production in 2016 (Kenya, Republic of, 2017), while also having no history of research work.

The study was thus limited to Kakamega County. Within the county, Rosterman is the oldest artisanal gold mine dating back to the 1930s, which then drove the development of Ikolomani gold mines. This informed the selection of Rosterman and Ikolomani mines as the study sites.

The two mines are located in Lurambi, Ikolomani, and Shinyalu Sub-Counties. In reference to the 2019 KNBS census, Lurambi Sub-County had a population of 297,394 people and 52,015 households. Ikolomani Sub County had a population of 111,743. The target population, therefore, was the estimated number of households in both sub-counties, according to the 2019 national population census, totaling 108,412.

Purposive Sampling of Key Informants

Through purposive sampling, key informants were chosen. Purposive sampling is a non-probability means of sampling that allows the researcher to select the sample grounded by the key informant and the focus group's knowledge, skills, and experience. The key informants comprised of; a Kakamega County Planner, a representative of the National Environment and Management Association (NEMA), a representative from the Mining Department and a representative from the County Environment Department.

Cluster Sampling of All Respondents

Clusters were selected based on their geographical location within the region. These clusters were made up of the three sub-counties where Ikolomani and Rosterman are located. These are: Lurambi Ikolomani and Shinyalu sub-counties.

Stratified Sampling of Respondents

Under stratified sampling the population is categorized into several sub-populations that are independently more standardized than the total population (the diverse sub-populations are referred to as ‘strata’) and then we select items from each stratum to institute a sample (Kothari, 2004). Stratified sampling was done within the clusters to collect separate data between the households from the focus group discussions.

Purposive Sampling of Focus Groups

Purposive sampling was employed to come up with focus groups composed of miners within the three clusters.

Simple Random Sampling of Households

In simple random sampling, every sample has an equal chance of being selected, hence dealing with the problem of biased representation (Cooper & Schindler, 2006). Adult miners and residents were then simple randomly sampled due to the scattered nature of the settlements and their corresponding mines.

3-5 Effects of artisanal gold mining on adjacent land uses

This section contains the data collection methods of determining the effects of artisanal gold mining on the adjacent land uses in the study area.

- ❖ Household questionnaires

The researcher collected data using questionnaires. Questionnaires were the preferred data collection instrument because they were economical, ensured anonymity, permitted standardized questions, ensured uniform procedures, provided time for subjects to think about a response, and were easy to administer and score. Questionnaires also eliminate uncertainties and ambiguities that may arise from irrelevant answers.

Mugenda and Mugenda (2003) recommended a pre-test study sample of at least 10% of the sample size. Therefore, from the sample of 203, 10% (40 respondents) would be selected for the pre-test. The questionnaires were to be self-administered with the help of the Kobo collect Application installed on the researcher's and research assistants' mobile phones. The responses were entered into IBM SPSS statistical software for reliability analysis. Questions that were not clear and vague would be rationalized to eliminate vagueness and

advance clarity. All glitches encountered in the pre-test were talked, and the questionnaire was refined before the final data collection.

The validity of the questionnaire was to be determined by exposing the questionnaire to a board of professionals and academic scholars to determine whether the constructs represent what is being measured. The validity of a questionnaire is the extent to which it measures what it purports to measure. The test fixated on investigating the face validity and the content validity. Peer appraisal was used to gather responses to the questionnaire, which was then used to advance it before final administration. For construct validity, which measures what the premeditated construct scores mean are and whether they could be comprehensive, associations would be used to verify the relevance of the questions.

In the grounds of the responses from the questionnaire administration during the pre-test, reliability would be recognized by establishing the internal uniformity of items used in lieu of each paradigm using the Cronbach Alpha coefficients. Scores above 0.7 would be judged as acceptable.

The interviewer-assisted strategy was used to administer the questionnaire. While the self-assisted questionnaire administration method was usually used to administer questionnaires to highly literate populations, that assumption could not be made for households involved in artisanal and small-scale gold mining at the mines. Therefore, the researcher and research assistants traveled from household to household and assisted respondents in completing the questionnaire by asking questions in the language they understood best and marking the answers given on the questionnaire.

3-6 Factors contributing to effects of Artisanal gold mining on adjacent land uses

This section contains the data collection methods of examining the factors contributing to the effects of artisanal gold mining on adjacent land uses.

- ❖ Focus Group Discussions with the Miners and Villagers

Focus group discussions can also be used to stimulate discussions that generate more information than one on one interviews. They can be used to clarify the respondents' thought processes and terminology, ensuring that the main survey questionnaire is relevant to the respondents and that misinterpretations are minimized (Creswell, 2015).

In exploratory studies, focus groups are comprised of four to eight individuals, and each group can deal with a specific dimension of the phenomenon under study. Further, focus

groups are run by a moderator, also called a facilitator, who explains the purpose of the FGDs, asks questions and manages the group. The moderator must be an excellent communicator and a good listener. They must also be strong and decisive enough to keep order, insist that one participant speaks one at a time, and moderate verbose people from dominating the group discussion while ensuring everyone adheres to a schedule interviewed Hill et al., (2007). The Researcher conducted two Focus Group Discussions with a group of miners and a group of villagers from each Sub-County i.e., Rosterman and Ikolomani area.

- ❖ Key Informant Interviews with Kakamega County Representatives

Key Informant Interview schedules were developed to collect information. A Key Informant Interview was conducted with respondents selected from National Environmental Management Authority (NEMA) office, the Mining Department office, the County Environment Department office, and the County Planning office. They all gave an in-depth description of the effects of the mines on the adjacent land uses.

3-7 Roles, behavior, and perceptions of the stakeholders in relation to ASGM and adjacent land uses

This section contains the data collection methods of evaluating the roles and the perceptions of public and private stakeholders in relation to ASGM and adjacent land uses.

Miners' Focus Discussion Groups, Household Questionnaires, and the Key informants' responses were compiled and used to explain the roles, behavior, and perceptions of both the public and the private stakeholders in relation to the implications of artisanal gold mining on adjacent land uses. In addition, the researcher observed the stakeholders' behavior during data collection to complement the responses acquired.

3-8 Planning interventions/strategies to ensure sustainable gold mining and adjacent land uses

This section contains the data collection methods of proposing planning interventions to ensure sustainable gold mining in the Study area.

- ❖ Key informant Interviews

The responses gathered from all key informant interviews informed the researcher on the planning interventions to be used to ensure sustainable gold mining from an expert's point

of view. The County Planners' responses were quite detailed and steered the study to a spatial planning perspective that solved the problem.

- ❖ Observation

The observation schedule was used to document the state of things at the Rosterman gold mines and the adjacent land uses based on the researcher's firsthand experience. The researcher used photography and written notes to document artisanal mining activities and their implications on the existing land uses.

- ❖ Household Questionnaire Survey

The Household questionnaire responses included suggestions from the residents on what planning strategies to apply to ensure sustainable gold mining in Kakamega County.

3-9 Data Analysis and Presentation

All quantitative and qualitative data congregated using questionnaires, FGDs, key informant interviews, and observation were recorded and analyzed using appropriate statistical methods.

Quantitative Data Analysis

All answered questionnaires were encrypted and disseminated into an Excel sheet for cleaning, and then introduced into IBM SPSS statistical software for analysis. The responses were analyzed for descriptive statistics with the aim to summarize the data into, percentages, mean frequencies, and standard deviation for all dependent and independent variables. Subsequently, the findings were presented using tables, charts, and graphs.

Spatial Analysis

Spatial analysis is a technique in which problems are modeled geographically to acquire results through computer processing, which the researcher can examine. The spatial analysis was used to represent the various land uses adjacent to Rosterman gold mines and the specific sub-counties in which the research is being carried out. The researcher used GIS (ArcMap) software to enable the analysis. Maps were used to present Rosterman spatially and Ikolomani mines and the land uses in Rosterman. The soils, geology, land

cover, and land uses were analyzed using GIS. This data was then assigned weights using the weighted overlay method to get the most suitable sites.

Factor Analysis

Factor analysis is particularly suitable for extracting a few factors from a large number of related variables to a more manageable number before using them in other analyses, such as multiple regression or multivariate analysis of variance. It can be beneficial in developing a questionnaire. Sometimes adding more statements to the questionnaire fails to understand the variables clearly. Use of factor analysis ensures subtraction of extraneous questions from the final questionnaire. This study introduced factor analysis to identify the factors underlying the variables of a questionnaire which enabled the researcher to assess the implications of artisanal gold mining on the adjacent land uses in Rosterman, Kakamega County (Shrestha, 2021)

Qualitative Data Analysis

Data collected using focus group discussions, key informant interviews, and observations were analyzed using qualitative data analysis methods. Content analysis was used as the qualitative data analysis method. Content analysis is a systematic technique researchers use to analyze message content. It can be applied to determine how the messages answer the questions posed in the research.

Data from focus group discussions, key informant interviews, and observations were afterward transcribed and coded to capture the themes under this investigation, notably: Implications of artisanal gold mining to the adjacent land uses in Rosterman and Ikolomani sub-counties in Kakamega County. A narrative description was used to present the results from qualitative data analysis.

3-10 Expected Outputs

Reports, Statistical charts, descriptions, zoning map and a part development plan.

3-11 Data Needs Matrix

The data needs matrix summaries the information that needs to be collected, their sources, methods of collection, analysis and presentation as per the research objectives. Table 3-3 illustrates the data needs matrix for Ikolomani and Rosterman.

Table 3- 3: Data Needs Matrix

	Objective	Data Needs	Data Types	Data Sources	Data Collection methods	Analysis Method	Presentation Method
1.	To determine the effects of artisanal gold mining on adjacent land uses in Rosterman and Ikolomani areas.	Rural households Key Informants Miners Rural Land Uses	Quantitative Qualitative Descriptive Spatial	Maps Spatial data	Household questionnaire Key Informant interviews FGDs Observation Landsat Image	SPSS ArcGIS	Statistical charts Maps
2.	To examine the factors that have contributed to the effects of ASGM on adjacent land uses.	Rural households Key Informants Miners	Quantitative Qualitative Descriptive	Document review Field visit	Household questionnaire Key Informant interviews FGDs Observation	SPSS	Statistical charts
3.	To evaluate the roles, behavior, and perceptions of public and private stakeholders concerning ASGM and adjacent land uses in	Rural households Key Informants Miners	Quantitative Qualitative Descriptive	Field Visit	Household questionnaire Key Informant interviews FGDs	SPSS	Statistical charts

	Rosterman and Ikolomani areas.				Observation		
4.	To propose planning interventions/strategies that can be employed to ensure sustainable gold mining concerning adjacent land uses.	Policies Legislations Regulations	Quantitative Qualitative Descriptive Spatial	Field visit	Household questionnaire Key Informant interviews FGDs Observation Landsat Image	SPSS ArcGIS	Statistical charts Maps

3-12 Quality of Research

Table 3- 4: Quality of Research

Indicators	**Relevant techniques**	**Examples within the study**
Construct validity: measures the compatibility of the identified indicators in relation to the themes highlighted.	Use of evidence-based sources during data collection. Creation of thematic evidences during data collection. Assessment of draft case study reports while in the report writing phase.	Triangulation method by using various data sources; interviews, surveys and focus group discussions Proper citing of all the data acquired from the various data collection methods All recorded data will be dispersed to respondents for data verification.
Internal validity: attempting to measure the relationship between the variables.	Presentation of graphical and visual techniques in the data analysis stage to explain the findings. The concepts and findings are connected in a constant manner.	The whole study would entail numerous explanations using visuals such as images, statistical charts and maps. The findings are listed in relation to the objectives.

External validity: defining the extent to which the findings of a study can be comprehended.	Characterization of the scope and limitation of the research during the research design chapter. Comparison of the findings and the existing literature in the data analysis stage.	Research design is covered in Chapter three. Additions and deductions would be made after comparison of the obtained data based and the previous related studies in literature review.
Reliability: proving that the events of the study can be replicated with the same results	Provide a detailed record of theories and concepts for each research phase. Assurance of consistency between research problems and study design features during the research design phase. Keep as detailed a record of the findings and activities as possible. Use of devices to record and store data from interviews and focus group discussions. Development of a case study strategy towards the end of the data collection stage to provide a methodology for organization and documentation of the massive amount of collected data. Assurance of substantial correspondence in findings across all the data sources. Conducting peer reviews.	Theoretical and conceptual framework included in Chapter three. Highlighted methodological techniques in chapter three based on the objectives. Recording of all interviews and focus group discussion using a video recorder and audio recorder. Necessary in reporting stage for sequential organization of all collected data. The conceptual framework will be used to collect all data, interviews, focus group discussion and documents. Proposal and half-time peer seminars.

3-13 Ethical Considerations

According to previous ethical studies, researchers must conduct their studies guided by moral norms from conception to conclusion to encourage research objectives such as facts, truth, and error evasion. Prohibitions of falsifying research data minimize errors and promote the truth. (Gajjar, 2013). Ethical standards promote collaboration by establishing transparency, trust, and mutual respect. For example, many ethical standards such as copyright, data sharing policies, and confidentiality in peer review protect intellectual

property from theft while encouraging collaboration. Moreover, many of the ethical norms assist in ensuring that the researcher is held accountable to the stakeholders and the public in general by ensuring that there are no research misconducts and conflicts of interest. The researcher should ensure the participants are safe from harm exposure (Marcelle, 2015).

The following ethical principles will guide this study;

- Honesty in reporting findings, methods and procedures, and publications.
- Objectivity in experimental design, data analysis, interpretation and presentation, and peer review.
- Integrity in delivering all the inputs of all the stakeholders in the research.
- Respect for all intellectual property encountered during research.
- Openness to criticism after sharing of data with the relevant parties.
- Confidentiality with sensitive information provided in the study.
- Competence and professionalism throughout my education and learning period.
- Legality through obeying all the government laws, policies and institutions.

3-14 Chapter Summary

This chapter has covered the methodology, the next chapter is the background to the study area.

CHAPTER FOUR: THE STUDY AREA

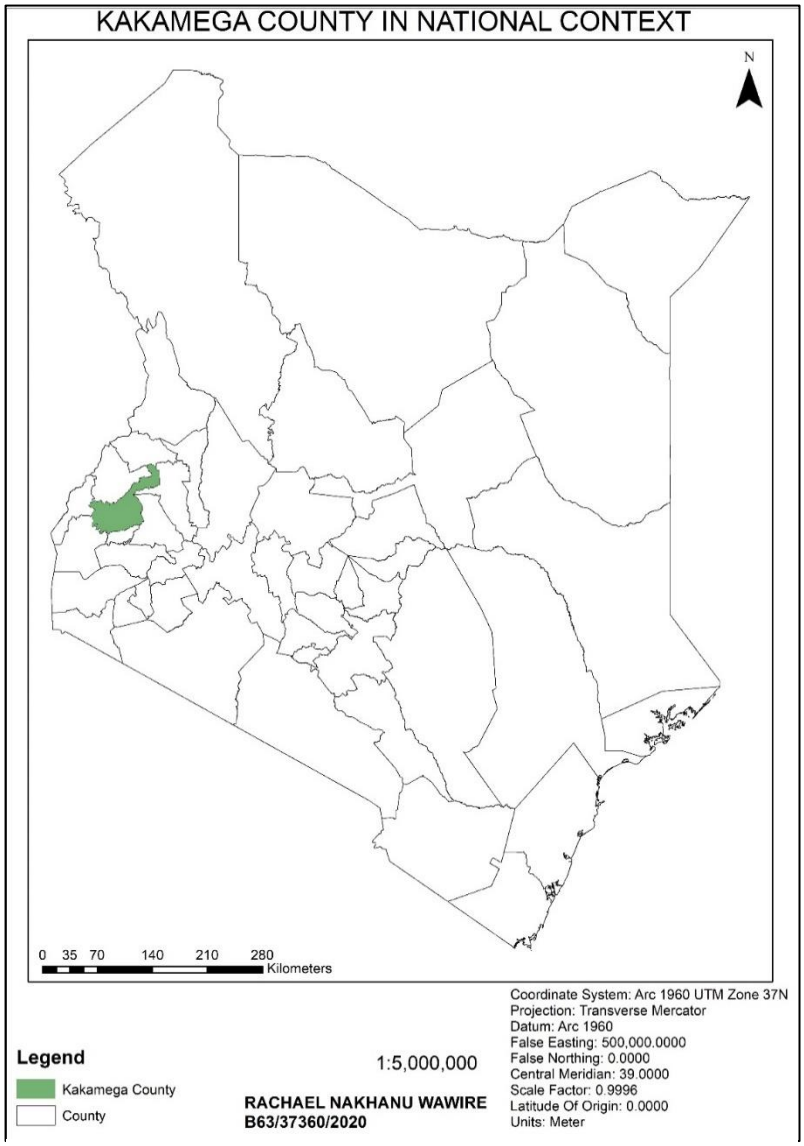
This chapter describes the geographical location and the thematic areas of the study area including; demographical & socio-cultural features, physiographical features, physical infrastructure, land use and tenure, rural economy and, Institutions and governance.

4-1 Introduction

Kakamega County is the fourth most populous county after Nairobi in Kenya. The history of Kakamega County is dated back in 1903, when British settlers settled in the area due to the presence of fertile soils. It resulted in an establishment of an administrative post in Kakamega. The town's growth was accredited to the 'colonial gold rush' at the beginning of 1930s, fueled by geologist Albert Ernest Kitson's reports. Kitson suggested in his account, that there existed massive deposits of gold in Kakamega which was mainly wasted through unprofessional mining methods. As a result, the Rosterman Mining Company was commenced by the colonialists. In the 1940s, the mines were abandoned due to the low production of gold. In 1970 Kakamega was made the headquarters of the newly established Western Province. In 1979, the construction of the Golf Hotel by the Kenya Tourist Development Corporation began, while the construction of the Kakamega airstrip began in 1981 (Kakamega, County Government of, 2023).

4-2 Geographical Location of the Study area

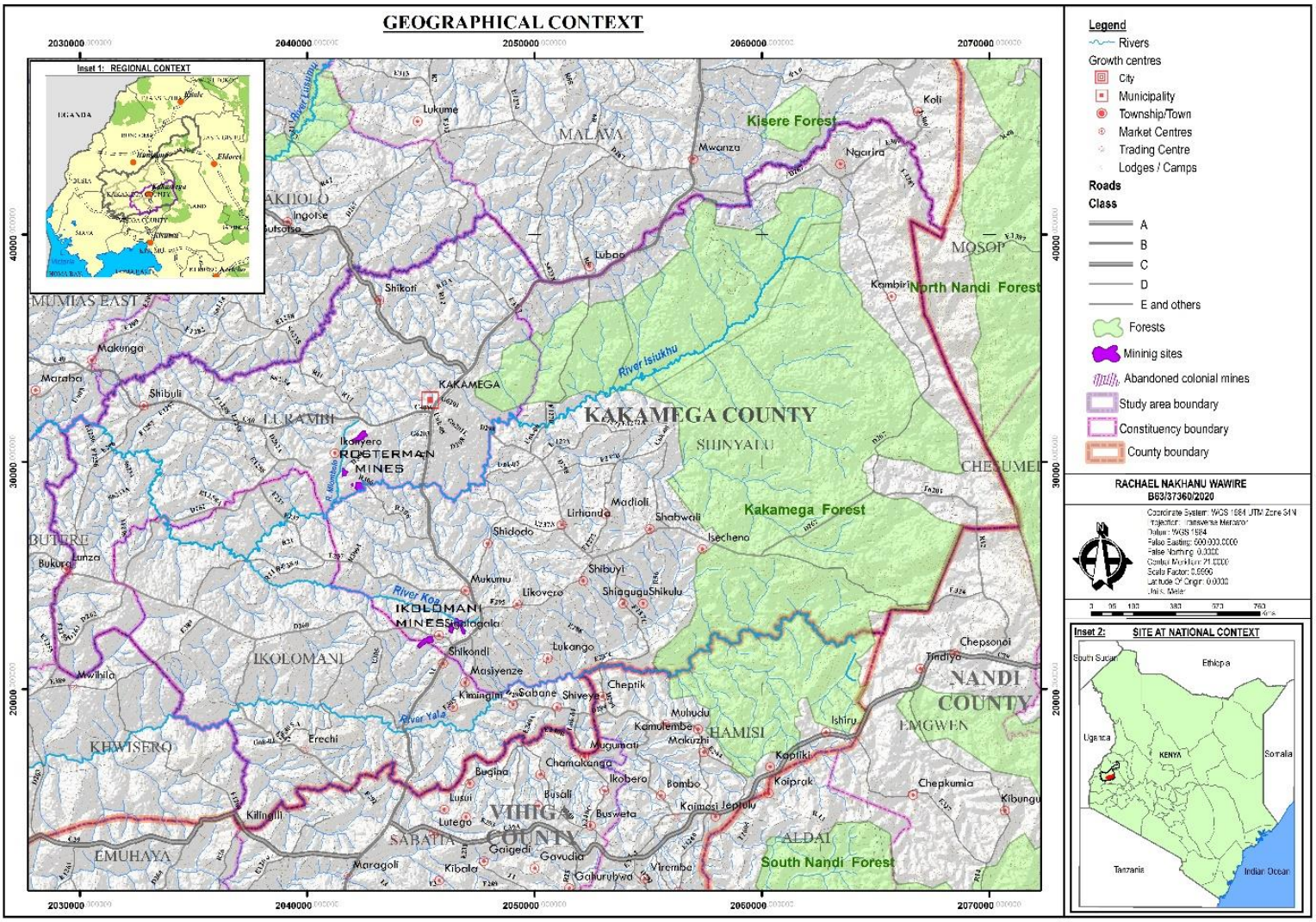
Kakamega County is a county in Kenya which covers an area of 3,033.8 km^2 and has a population of 1,867,579 people. Kakamega is located along longitude: 34.7518631 and latitude: 0.2827307. It has an altitude range from 1,240 meters to 2,000 meters above sea level, totaling an average elevation of 1,535 meters (Encyclopedia Britannica, 2012). The County borders Vihiga County to the South, Trans Nzoia County to the North, Uasin Gishu County to the East, and Siaya County to the West. Kakamega County has 12 Sub-Counties: Lukuyani, Lugari, Ikolomani, Malava, Navakholo, Lurambi, Mumias East, Mumias West, Matungu, Khwisero, Butere and Shinyalu. The study was carried out in Ikolomani, Shinyalu, and Lurambi Sub-counties which lie along the Gold green belt in Western Kenya.



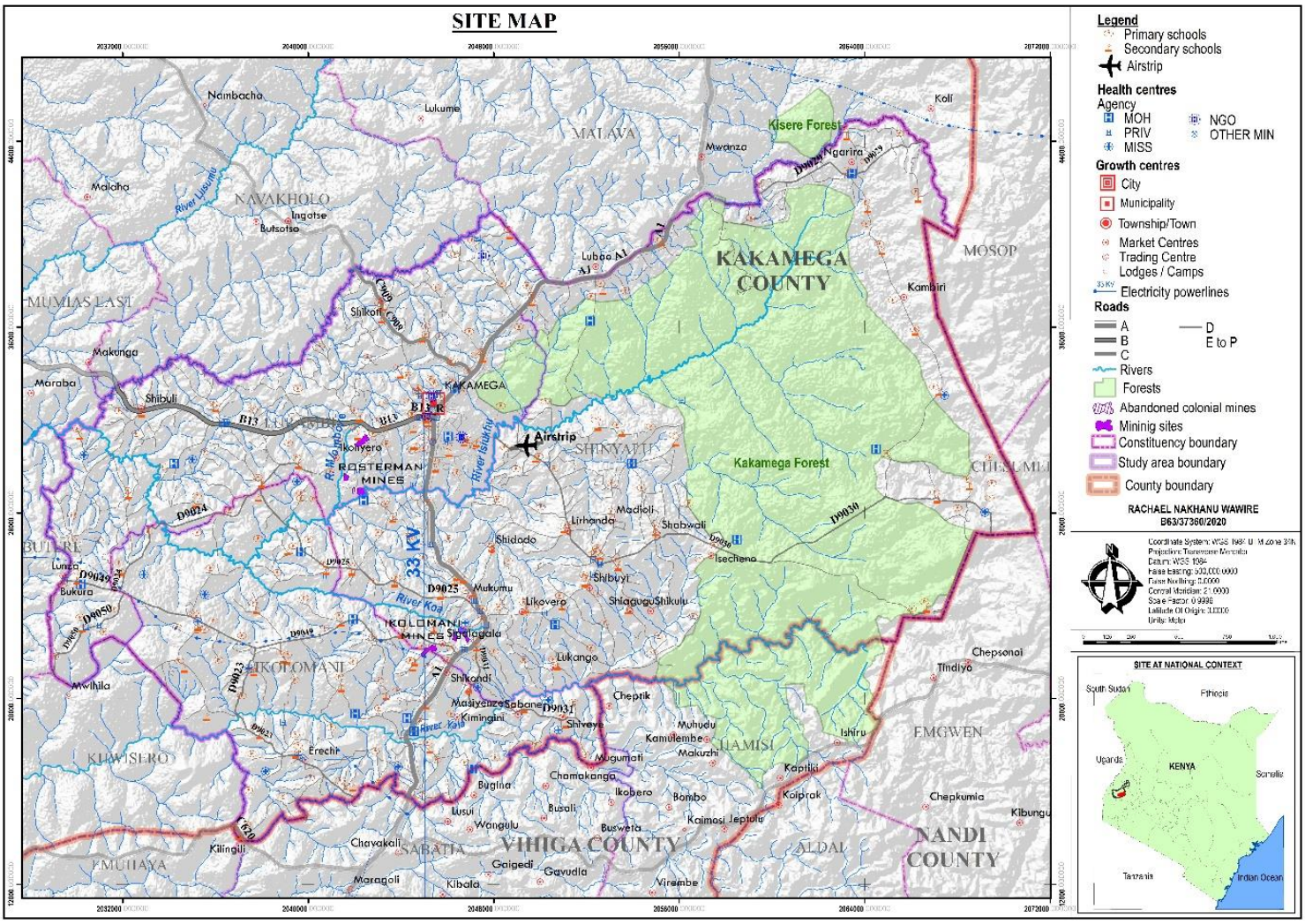
Map 4- 1: Kakamega County national context

Map 4- 2: Lurambi Ikolomani and Shinyalu Sub Counties in Kakamega County

The Study will be carried out in the areas adjacent to Ikolomani and Rosterman mining sites.



Map 4- 3: Geographical Context of the Study Area



Map 4- 4: Site map

4-3 Economy of the Study Area

The backbone of the economy of the study area is mainly agricultural, artisanal gold mining, and commercial. The main crops cultivate in the area include maize, and sugarcane grown commercially while sweet potatoes, arrow roots, cassava, groundnuts and vegetables. The livestock reared in the Study area include; cattle, poultry, goats and pigs. The commercial activities compose of trading enterprises such as retail shops, hardware, salons, grocery stalls and Mpesa shops. The artisanal gold mining comprises of miners and other casual laborers who conduct mining activities as a source of livelihood.

4-4 Socio-cultural features

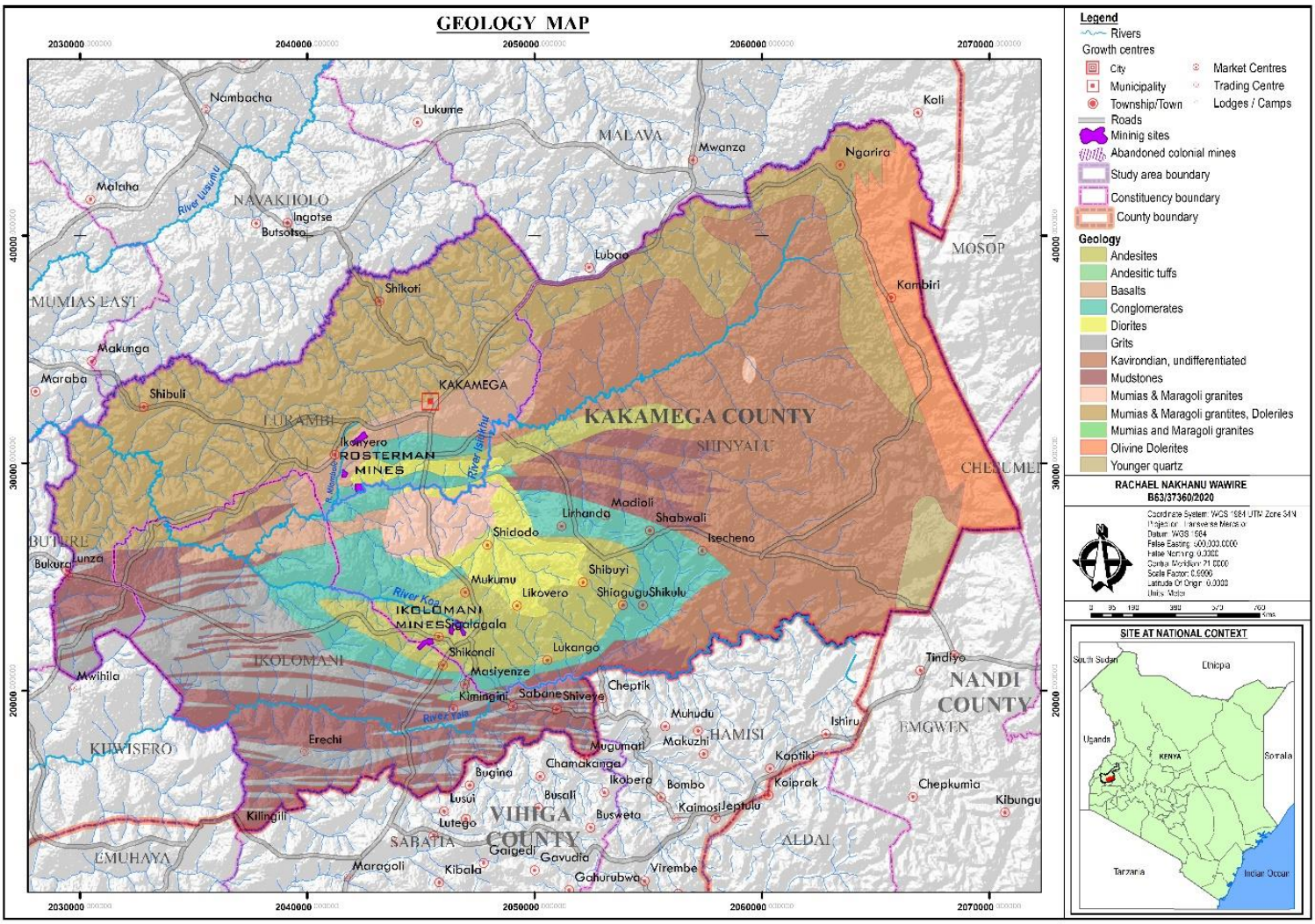
According to the KNBS Census (2019) report, Kakamega County's population was 1,867,579 comprising of 897,133 males and 970,406 females. Kakamega county reported a population growth rate of 1.7% and a population projection of 2,072,565 in the year 2025.

Lurambi County and Ikolomani have a population of 188,212 and 111,743, respectively. While Shinyalu has a population of 122,475. The residents in the Study area have adopted communal living in which several households reside on the same parcel of land.

Immigration of the miners from other counties such as Siaya and Migori to Rosterman and Ikolomani mining sites has given rise to the adoption of the rudimentary gold mining methods in Kakamega County. The unemployment and high poverty levels are at the core of the widespread rudimentary mining methods in the Study area.

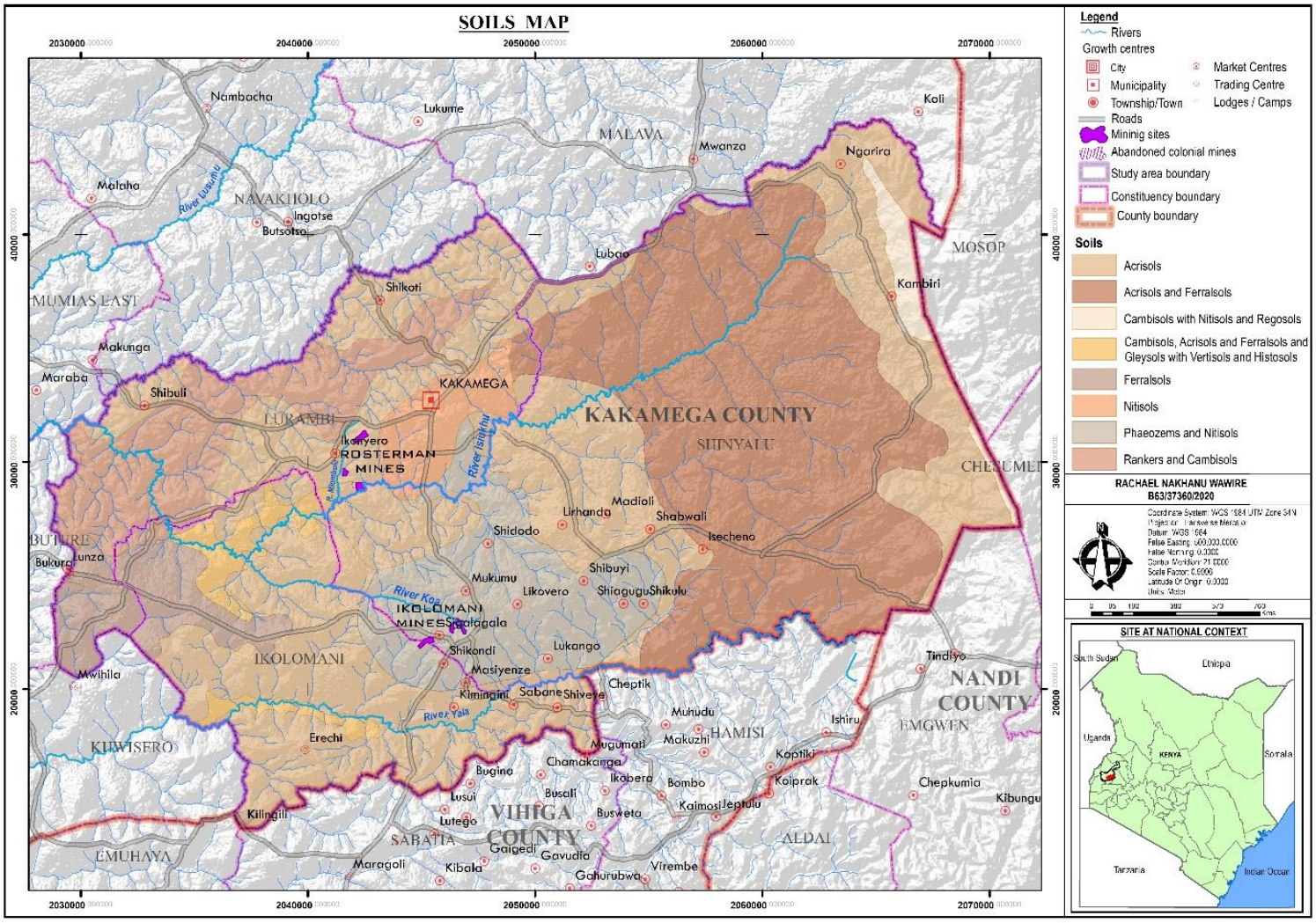
Social amenities such as police stations are lacking hence need for developing the area in terms of social infrastructure.

4-5 Physiographical features



Map 4- 5: Geology of the study area.

The Geology of this study area consists of Andesites, Andesitic tuffs, Basalts, Conglomerates, Diorites, Grits, Kavirondian, Mudstones, Mumias and Maragoli granites, Dolerites, Olivine Dolerites, and younger quartz. The Gold-bearing rocks present on the mining sites as indicated on map 7 are Andesites, Basalts, and Diorites. The mining sites more often than not, crop up in areas with the gold bearing rocks.



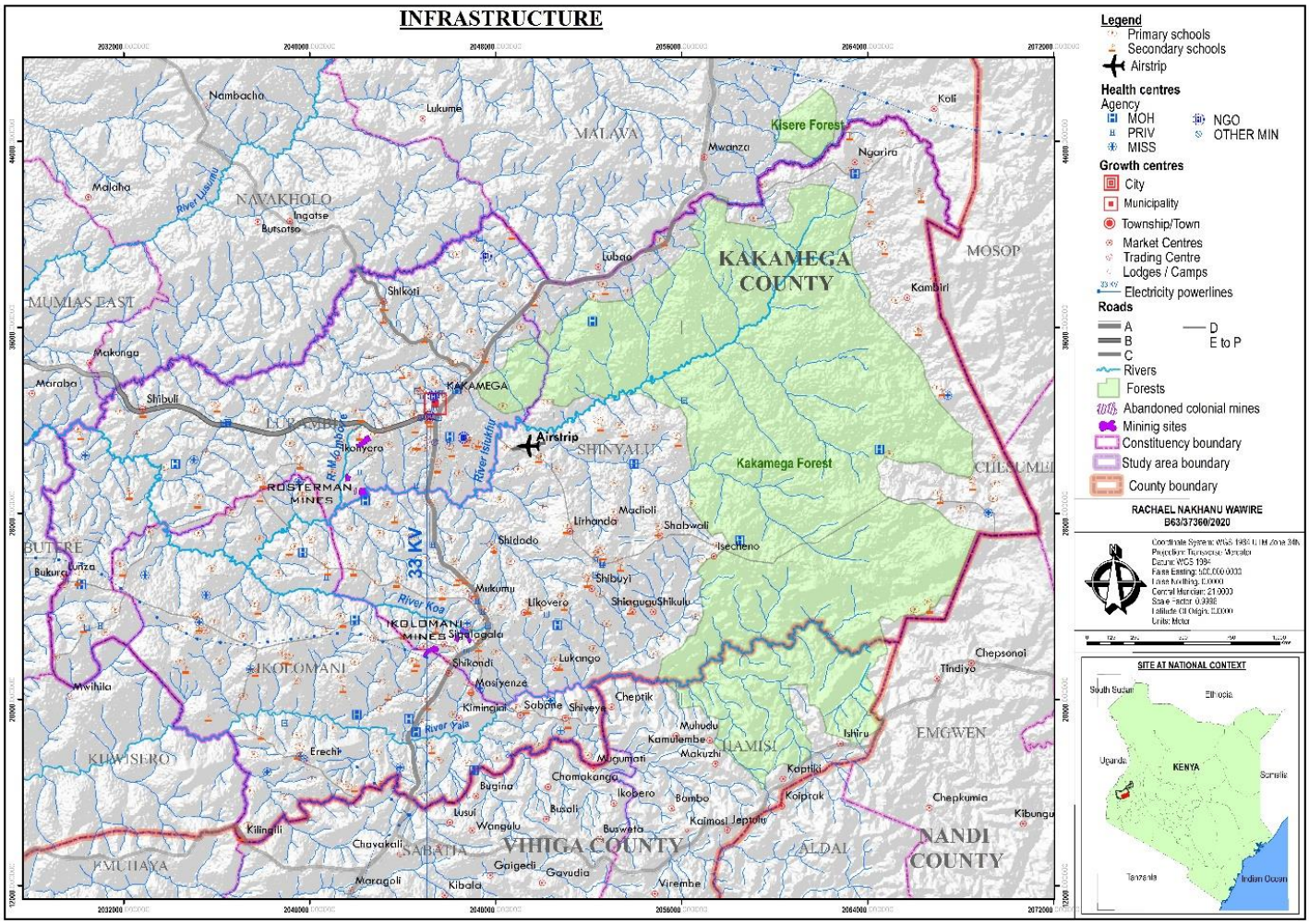
Map 4- 6: Soils in the study area

The soils in this study area include; Acrisols, Cambisols, Ferralsols, Nitisols, Phaeozems, Gleysols, Vertisols, and Histosols. The soils in the Rosterman area are Acrisols while those in Ikolomani are Phaeozomes and Nitisols.

4-6 Hydrology of the Study Area

The Study area consists of 3 rivers within the Study area; Isiukhu and Mlombole passing through the Rosterman mines and River Koa passing through the Ikolomani mines. Alluvial mining practically takes place along the rivers within the riparian reserves causing sedimentation and pollution by the heavy metals used in gold extraction.

4-7 Physical Infrastructure



Map 4- 7: Infrastructure map

4-7.1 Physical Infrastructure

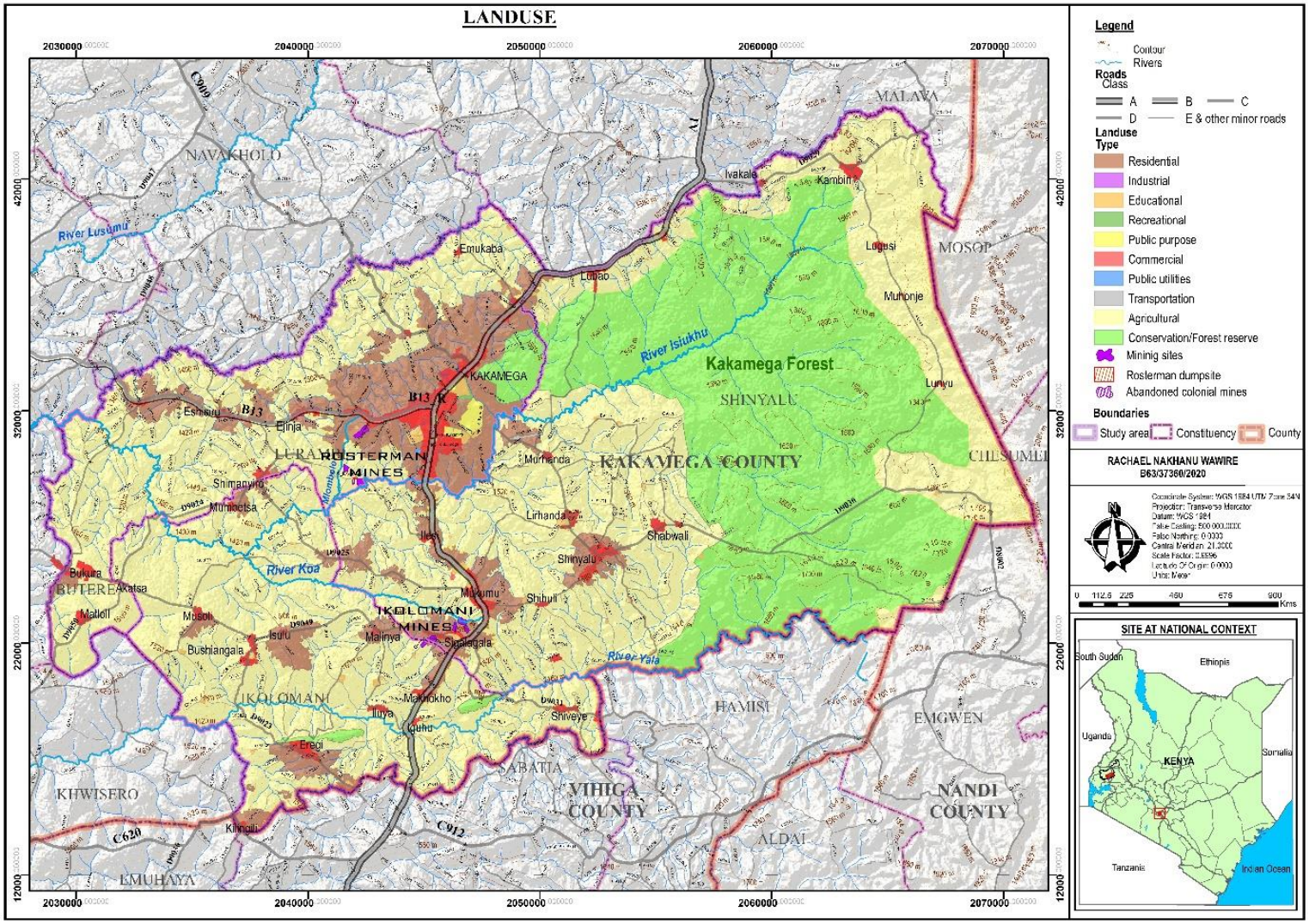
Transport infrastructures consists of Class A-P roads in Kakamega County. The roads in the Study area are still undergoing developments such as tarmacking of the Lurambi-Shinyalu Road and main bridge which is envisioned to be a linkage between Lurambi and Shinyalu Sub-County. Majority of the roads are murram and earth roads which need to be developed for accessibility purposes. Additionally, there are also electrical powerlines present in the Study area indicating accessibility to electricity.

Telecommunication infrastructure is underdeveloped in the area being characterized by poor network and very few masts. There is need to develop the area in the in terms of telecommunication in the area which will enable technological advancements in the mining sites.

4-7.2 Social infrastructure

The social infrastructure consists of educational and health amenities. Educational infrastructure neighboring the mining sites include; 21 primary and 10 secondary schools. Health amenities comprises of government hospitals, private hospitals, missionary healthcare centers and dispensaries. There are 11 medical centers located near the mines which within the access of the residents residing adjacent to the mines.

4-8 Land Use and Tenure



Map 4- 8: Existing land uses in the study area.

The existing land uses in the study area include; Residential, Industrial, Public purpose, and Educational. Commercial, Public Utility, Transportation, Agricultural, Conservation, and Mining. From the above map, the mining sites developments have not been controlled

hence overlapping with other land uses such as agricultural, commercial, residential and the ecological sensitive areas.

The land tenancy in the Study area is mainly leasehold since most of the mining sites are leased by individuals and miners' groups. Part of the land is owned by the residences while a small section is public land. Majority of the individual owners lack freehold land titles with a few possessing deed plans as ownership documents. Land subdivision is not frequent in the Study area since the immigrants from other counties prefer leasing the land for a given duration and abandon the land once the mines are depleted.

4-9 Institutions and Governance

Mining Act 2016 covers the gold mining sector and aims at formalization of the artisanal mining subsector, capacity building in terms of technology, expertise and finances, fair trade of gold by the artisanal miners, formation of legal groups and co-operatives, and land use sustainability.

(Kenya, The Republic of, 2010) in section 60(1) (c) & (e) advocates for sustainable mining while protecting ecologically sensitive areas such as the riparian reserves. Article 62(1)(f) states that all mineral and mineral oils should be classified as public land.

(Kenya, Republic of, 2016) highlights illegalities such as smuggling, health and safety risks, and tax evasion challenges regulations of the artisanal mining activities. Furthermore, it highlights the need to establish a framework for monitoring, evaluating and validating artisanal and small-scale mining so as to promote the livelihood of the artisanal gold miners.

(Kenya, Republic of, 2022) considers artisanal gold mining to be customary and hence emphasizes on the need of planning for the designated artisanal gold mining zones, conducting of Environmental Impact Assessment, provisions for disaster vulnerability profiles for mining sites and organization of miners into groups after vetting them to ascertain capacity to mine in terms of expertise and technology. The abandoned mines are also supposed to rehabilitated so as to remedy land degradation effects.

(Kenya, Republic of, 2019) gives provisions for zoning of mining sites as industrial zones. According to section 46 Kakamega County Government should prepare a LPLUDP to spatially categorize all the current land uses in the county.

(Kenya, Republic of, 2015) ensures mining is done sustainably through conservation of natural resources, auditing of the value of the mineral resources, protection of ecologically

sensitive areas such as riparian reserves through conducting Environmental Impact Assessment.

The Government departments which are in charge of executing the relevant legislation and policy of the mining sun sector are indicated on the table 4-1.

Table 4- 1: Institutions and Governance in Kakamega County

NATIONAL OFFICES	COUNTY OFFICES
1. Mining Department (2 Officers)	2. Physical Planning (4 Officers)
	3. Environment (4 Officers)
	4. National Environment and Management Authority (3 Officers)

CHAPTER FIVE: RESEARCH FINDINGS AND DISCUSSION

5-1 Overview

The chapter concerns data presentation, analysis, interpretation and discussion of the study findings. The chapter commences by describing the summary of response turn-out rates then proceeds to present, analyze, interpret and discuss the findings grounded by the study objectives.

5-2 Summary of response turn-out rates

The study targeted 216 respondents, but 206 responded (93.1%). The researcher gathered 190 of the 203 issued questionnaires (93.6%), 4 key informant interviews (100%) and 2 sets FGDs with a total of 12 people (85.7). The household survey had a 93.6% turnout because of co-operation from the respondents but the heavy rainy weather in the afternoon disrupted the household survey process hindering the 100% turn-out rate. The Focus group discussions had a turnout of 85.7% because two members were busy working at the mines and, as a result, failed to show up last minute.

5-3 Determination of the effects of artisanal gold mining on adjacent land uses

To achieve this objective, the public and the private stakeholders of the mining sub-sector were asked to react to several statements intended to determine the effects of artisanal gold mining on adjacent land use. Data on this objective was analyzed under the hypothesis "ASGM has adverse effects on adjacent land use in the study area." The household questionnaire responses were summarized using a Likert scale of 1-5 as shown in Table 5-1 and 5-2 below.

Table 5- 1: Likert scale

Value	Response
1	Strongly Agree
2	Agree
3	Neutral
4	Disagree
5	Strongly Disagree

Table 5- 2: Summary of findings

Value	1	2	3	4	5
Variable					
Artisanal gold mining activities have contributed to land degradation.	18.95%	71.58%	4.21%	4.74 %	0.53%.
Artisanal gold mining activities have contributed to the unproductivity of farmlands.	18.95%	63.68%	5.26%	11.58 %	0.53%
Artisanal gold mining activities have contributed to soil erosion on adjacent land uses.	14.74%	72.11%	7.37%.	5.79 %	-
Artisanal gold mining activities have contributed to increased land subdivision in the area.	17.89%	65.26%	10.53%	5.79%	0.53%
Artisanal gold mining activities have contributed to increased land fragmentation in the area.	16.32%	71.05%	6.84%	5.79%	-
Artisanal gold mining activities have led to increased heaps of waste in Rosterman dumpsite	15.26%	47.37%	13.16%	22.11%	2.11%
Artisanal gold mining activities have contributed to the pollution of Rivers caused by amalgamation while extracting gold.	34.74%	52.11%	5.26%	6.84%	1.05%

Artisanal gold mining activities have contributed to soil pollution causing soil degradation	15.26%	69.47%	5.79%	7.37%	2.11%
Artisanal gold mining activities have contributed to air pollution through the roasting of mercury during gold extraction	27.89%	48.42%	8.42%	14.21%	1.06%
Artisanal gold mining activities have contributed to noise pollution in adjacent residential areas.	23.16%	48.42%	15.26%	13.16%	-

5-3.1 Effects of Artisanal Gold Mining on Agricultural Land Use

The main effects of artisanal gold mining in Ikolomani and Rosterman were found to be increased land degradation, unproductivity of farmlands, soil erosion, increased land fragmentation and increased land subdivision. A Likert scale was used to establish the level that residents found mining had affected these aspects as indicated in figure 5-1.

(1= Strongly Agree, 2 = Agree, 3 = Neutral, 4 = Disagree and 5 = Strongly Disagree)

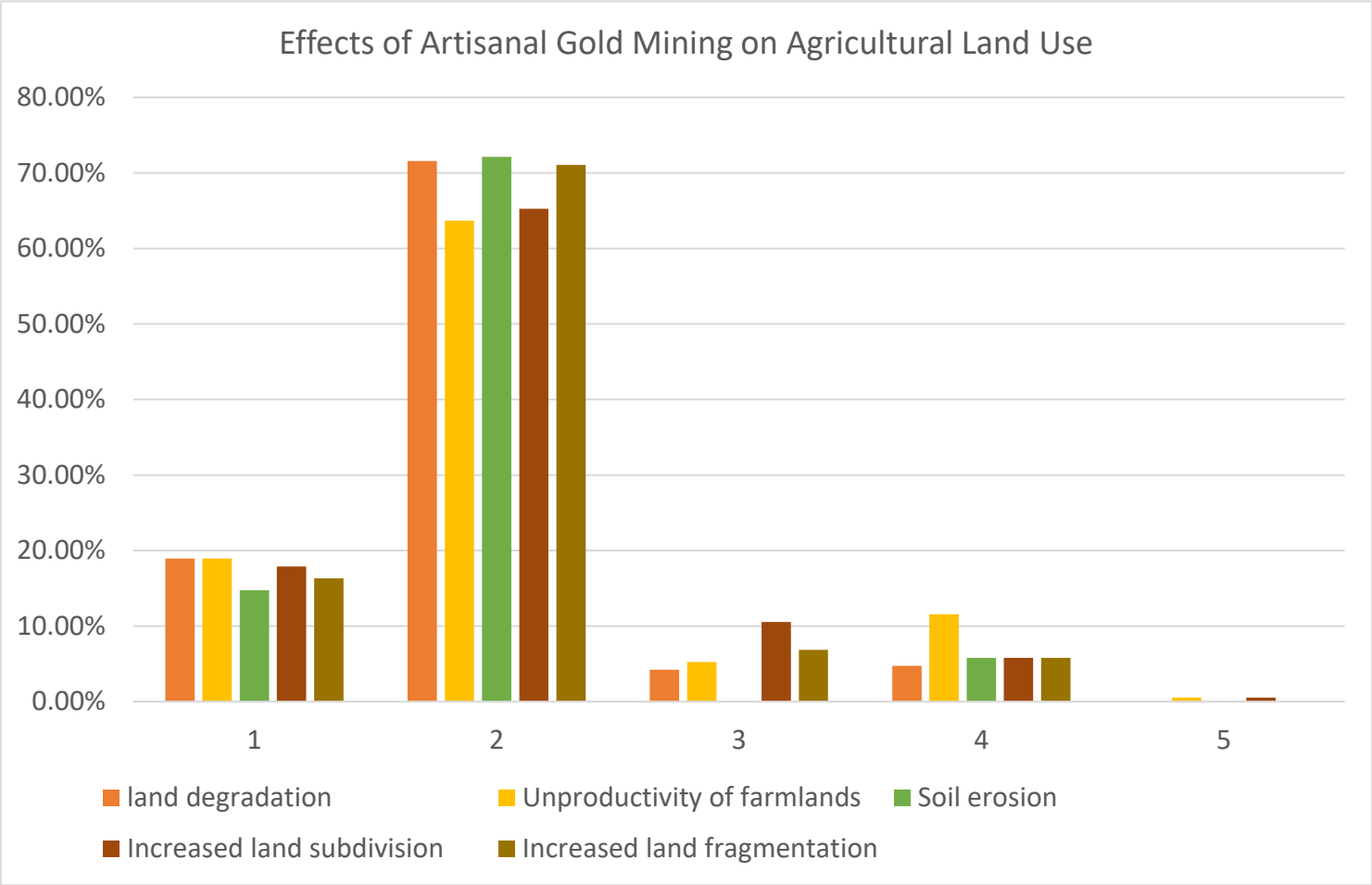


Figure 5- 1: Effects of Artisanal Gold Mining on Agricultural Land Use in Ikolomani and Rosterman

Nearly, 86.85% of residents stated that that artisanal gold mining has led to soil erosion, this can be broken down to 14.74% agreeing and 72.11% strongly agreeing. 5.79% of residents do not think that ASM has any impact on soil erosion.

About 90.53% of residents found that artisanal gold mining led to land degradation, with 71.58% agreeing and 18.95% strongly agreeing. Only 4.74% did not find a relationship between mining and land degradation.

Artisanal gold mining has led to the increase in unproductive farming land, with 82.63% stating that gold mining has a negative impact on farm lands in Ikolomani and Rosterman. 63.68% agreed while 18.95% strongly agreed that artisanal gold mining has instigated

unproductivity of farming land. Only 12% did not see any impact of gold mining on the productivity of farming land.

Land degradation among the effects caused by the excavation and the disturbance of the soil profile and structure. There has been low agricultural productivity in the adjacent farmlands fueled by the decline in the soil quality. Moreover, the residents are converting agricultural land into mining sites, causing in a noticeable labor shift from agriculture into mining and further instigating overlapping land uses withing the Study area. The findings confirm agreements with the findings of Kitula (2006) who reported cases on soil erosion from the heaps of tailings dumped adjacent to the artisanal mines which left the land prone to soil erosion causing land degradation which eventually resulted in unsustainability in agricultural land use.

Figure 5- 2: Heaps of tailings in Ikolomani area

Based on the household survey, 82.63% of the respondents stated that artisanal gold mining contributed to unproductive farmlands which confirm study findings by Alwanga et al., (2020) where artisanal mining occasioned degraded farmlands lowering agricultural productivity in the adjacent areas.

The findings from the key informants confirmed agreements with artisanal mining resulting in unproductive farmlands. The mining officer explained that there was low agricultural Productivity in areas adjacent to the mines because of the degraded land and lowered soil quality. In addition, the shafts drilled to facilitate the mining process interfered with surface and underground water, affecting both agricultural and residential land uses.

The County Environmental officer explained that artisanal gold mining resulted in land degradation and dumping waste on land that would have otherwise been used for agricultural activities. The popularity of artisanal gold mining activities had invaded the agricultural zones in the quest to quench the 'gold rush' thirst. Land previously used for crop production and animal husbandry was slowly being converted to mining sites. These series of activities had, in turn, led to the decline in agricultural productivity in the Study area. The NEMA representative further confirmed that, during the extraction, underground shafts were drilled, affecting the underground water resources. The miners pumped out water from the shafts using large electric water pumps, which destructively affected the water ecosystem, which was vital in facilitating agricultural activities. The pits carried a lot of soil and stones when it rained, causing an imbalance in the soil structure, and directly affecting agricultural productivity by lowering the yield.

Most miners in the focus group discussion, however believed that the artisanal gold mining process had no effect on the adjacent Agricultural land use. They stated that their mining methods had no adverse effects on the environment which indicated the level of ignorance and bias they had in terms of artisanal gold mining and its impact on adjacent land use.

About 83.15% of residents stated that ASGM has driven the rate of land subdivision within Ikolomani and Rosterman, with. 6.32% stated that ASGM has no impact on the rate of land subdivision. To confirm this 87.37% of the respondents stated that ASGM led to the increase in land fragmentation in Ikolomani and Rosterman areas. The land tenure in the Study area is mainly leasehold hence encouraging the occurrence of land fragmentation and minimizing the occurrence of land subdivision.

The County Planner however, argued that land subdivision and fragmentation were not influenced by artisanal gold mining. He explained that there were no frequent land subdivisions in the Rosterman area because most of the land is under leasehold ownership. The private firms who invested in mining avoided buying land on freehold terms because they knew that gold was not a renewable natural resource. Land fragmentation in the Study

area occurred where there was a road tarmacking project contrary to gold mining reasons. (Urban roads) Urbanization led to the development of ring roads and fringe roads in the Study area and the neighboring environs. This raises the issue of tenure insecurity which entirely lies entirely on the government institutions.

5-3.2 Environmental Effects of Artisanal Gold Mining on other land uses

Environmental contributions of artisanal mining in Ikolomani and Rosterman were found to include: increased solid waste dumping, increased air pollution, increased water pollution, increased noise and increased soil pollution. A Likert scale was used to establish the level that residents found mining had affected these aspects as indicated in figure 5-3.

(1= Strongly Agree, 2 = Agree, 3 = Neutral, 4 = Disagree and 5 = Strongly Disagree)

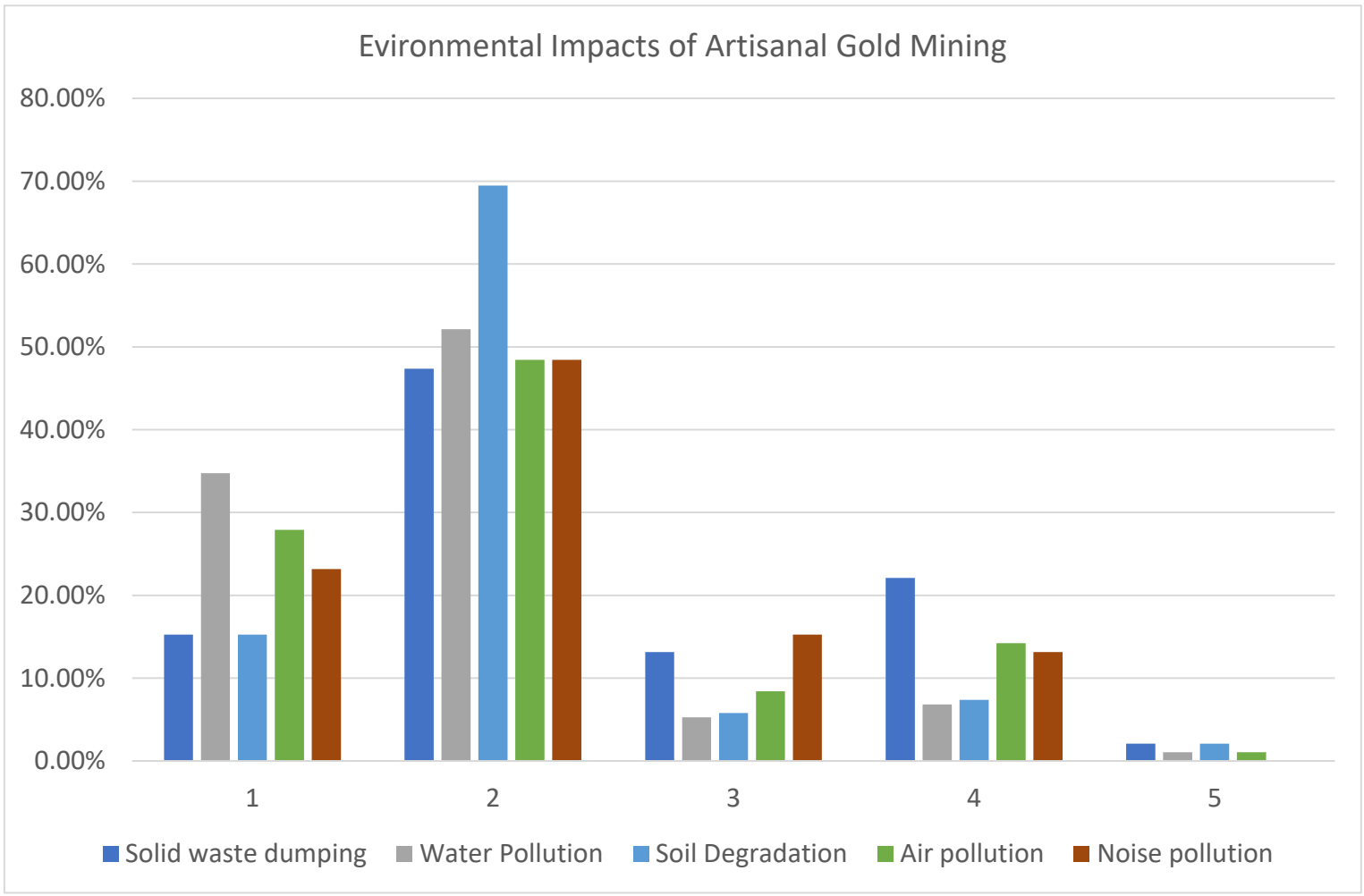


Figure 5- 3: Environmental Impacts of Artisanal Gold Mining in Ikolomani and Rosterman

About 62.63% of residents found that artisanal gold mining triggered an upsurge in solid waste dumping, with 47.37% agreeing and 15.26% strongly agreeing however, 24.22% did not the impacts of ASGM on increased dumping of solid waste. The tailings from the processed ore were reported to have traces of mercury (through the amalgamation method), which is eroded to the surface water and the underground water resulting in health risks to Rosterman area residents. Study findings by Serwajja and Mukwaya (2021) confirm that in Karamoja region in Uganda, they witnessed massive land clearances and landscape deformations. The mining sites had piles of waste and uncovered pits, which exacerbated health and safety concerns for the neighboring residents

Soil pollution was seen to be an impact of ASGM by 84.73% of residents, 69.47% agreed to this while 15.26% strongly agreed. 9.48% did not state this to be an issue caused by ASM. Soil pollution is as a result of the improper disposal of the tailings containing traces of mercury and cyanide which deteriorates the soil quality. Study findings by Serwajja and Mukwaya (2021) confirm that in Uganda, mercury use was responsible for high toxicity levels in soils and water around the Karamoja region. The levels of mercury recorded exceeded the acceptable levels by WHO in soil which is limited at is 0.03 mg/kg.

Approximately 76.31% found that ASGM has led to the increase in air pollution, while 15.27% found that it had no such impact. This was represented as 48.42% agreeing, 27.48% strongly agreeing, 14.21% disagreeing and 1.06% strongly disagreeing. Roughly 86.85% of residents found that ASM led to water pollution, while 7.89% did not agree to this statement. This includes 34.74% strongly agreeing and 52.11% agreeing that ASGM has triggered pollution of water resources.

Based on majority of the household questionnaire responses, artisanal mining activities such as amalgamation and leaching on the rivers resulted in water pollution. The FGDs responses further confirmed the effects further detailed that there was no water waste treatment before they discharged it into the environment. The discharged water contained heavy metals such as mercury and cyanide, which are soil and water pollutants. For example, in Khwisero, they used alluvial mining in gold extraction, instigating the siltation of the river water.

Figure 5- 4: Alluvial gold mining

One of the key informants specified that the miners utilized the tailings by leaching them using cyanide near the Mlombole stream, which drains into River Isiukhu, causing water pollution. In Rosterman area, the shaft method of gold mining in employed mercury in the extraction process, which was drained in the separating pond water without treatment and infiltrated into the ground, causing underground water pollution.

Figure 5- 5: Shaft gold mining method

Almost 86.85% of the respondents in the questionnaire survey were in agreement that artisanal gold mining instigated water pollution. This is similar to study findings by Marcello M Veiga (2006) who reported cases of water pollution and poisoning of ground water and water resources due to use of mercury and cyanide. Since the mines are located adjacent to the River Isiukhu, Mlombole and Koa, they have slowly intruded into the ecologically sensitive ecosystem of the riparian reserve. Study findings by Funoh (2014) also highlighted destruction of forests, forest swamps, and pollution of water bodies as effects of artisanal gold mining. Among the many effects was environmental pollution

brought about by the wastes from the mines; heavy metals from the extraction and petroleum wastes from crushers are released to the environment without treatment. The areas lack proper water treatment strategies to address the water pollution and institutional reforms to enforce laws against intrusion of the riparian reserves.

Almost, 71.58% of residents claimed that ASGM had led to noise pollution in Ikolomani and Rosterman, this includes 48.42% agreeing and 23.16% strongly agreeing. Only 13.16% did not find this to be an issue caused by artisanal gold mining.

Noise pollution is a major effect which negatively affects the residential land use. The Crusher machines used to grind the gold deposits day and night, produced a lot of noise disrupting the neighboring residential area. Nearly, 76.31% of the respondents stated that there was frequent noise pollution in the Study area. Similar studies by Alwanga et al., (2020) reported cases of noise pollution caused by artisanal mining in Kakamega County. Continuous blasting of rocks and pumping of water from aquifers day and night triggered further noise pollution. Moreover, the structural integrity of the buildings in the adjacent residential area were compromised. Irrefutably, water pumping from aquifers made them unstable and affected the underground and surface water ecosystem.

Figure 5- 6: Images of gold crushers

The built-up area comprises physical structures such as settlements, commercial buildings, and road transportation. The shaft gold mining method incorporated horizontal burrowing of tunnels, which caused cracks in the adjacent physical structures resulting in the instability of story buildings which interferes with residential and commercial land uses. The residents living adjacent to the mines were hence displaced forcing them to relocate to other areas away from the mining sites. There were also cracks on story buildings in the areas adjacent to the mines, e.g., in Sigalagala, which contributed to the relocation of households to other areas away from the mines. Horizontal digging of the mines intruded into adjacent residential areas, causing building cracks. For example, there was an

incidence in 2022 in Sigalagala where a building was condemned due to safety risks caused by the cracks that developed due to the artisanal gold mining activities as shown in figure 5-7 below.

Figure 5- 7: Cracks on a residential structure

Land conflicts had also risen in the area due to miners burrowing beneath people's property without consent. The mining sites are dusty, risking the miners' and residents' health from respiratory infections. In addition, using mercury and cyanide in the extraction process without protective gear endangers the miners' health with chronic illnesses such as cancer. Using a lot of timber to reinforce the pits resulted in deforestation due to the cutting down of trees. Deforestation leaves the land exposed and susceptible to stormwater erosion, contributing to land degradation. Deforestation, caused by logging activities done to provide raw materials for the construction of shafts tremendously reduced the tree cover and green space within the study area adversely affecting the environment ecosystem.

Conclusively, there is a planning challenge in the areas as a result of the competing land uses instigated by artisanal gold mining. It is only right finding a spatial solution to compliment natural resource management and address the unsustainable use on land challenge within the Study area.

The Tragedy of the commons is significant in explaining this effect since the artisanal mines conduct rudimentary mining practices without concerning themselves with conservation, management and the overall sustainability of the shared mining resources. Continuous unplanned artisanal mining activities will have long-term effects on sustainable land use and natural resource management. The findings the effect of artisanal mining on adjacent land uses must be taken account in preparation and implementation of land use plans and policy reforms

5-4 Factors contributing to the effects of artisanal gold mining on adjacent land uses

To achieve this objective, the public and the private stakeholders of the mining sub-sector were asked to react to several statements intended to describe factors contributing to the effects of artisanal gold mining on adjacent land use. Data on this objective was analyzed under the hypothesis "There are factors contributing to the effects of artisanal gold mining on adjacent land uses." The household questionnaire responses were summarized using a Likert scale of 1-5 as indicated in Table 5-3 and 5-4 below.

The household survey responses were analyzed using a Likert scale of 1-5 as shown below.

Table 5- 3: Likert scale

Value	Response
1	Strongly Agree
2	Agree
3	Neutral
4	Disagree
5	Strongly Disagree

Table 5- 4: Summary of findings

Value	**1**	**2**	**3**	**4**	**5**
Variable					
Miners are not organized into groups that are registered and legally recognized.	13.16%	49.47%	18.42%	18.42%	0.53%

Miners do not have access to appropriate technology for clean production of gold	35.26%	55.79%	6.32%	2.63%	-
Miners do not have access to formal funding sources to support their mining activities	37.37%	52.63%	3.68%	5.26%	1.05%
Miners lack formal training in geological exploration, ore reserve estimation, mining and concentration techniques, water reclamation, and safety issues among others	37.89%	54.21%	4.21%	2.63%	1.05%
There are no clear procedures for obtaining legal permits for mining activities	17.37%	55.26%	18.42%	5.26%	3.68%
There are inadequate social amenities, such as healthcare services in Rosterman and Ikolomani areas	32.63%	52.63%	6.84%	6.32%	1.58%
Mining activities have degraded agricultural land and destroyed alternative livelihoods	13.68%	74.21%	4.21%	7.37%	0.53%
There is poor road infrastructure in Rosterman and Ikolomani areas	33.16%	44.74%	6.84%	14.21%	1.05%
There is a weak environmental audit and monitoring framework in Kakamega County	27.37%	52.63%	12.63%	6.84%	0.53%
Miners do not have access to a formal market for gold trading	29.47%	46.84%	14.21%	7.37%	2.11%
Politics has a negative impact on artisanal gold mining in Rosterman and Ikolomani areas	11.58%	40.53%	24.21%	20%	3.68%
There are no institutional or legal frameworks guiding gold mining in Rosterman and Ikolomani areas	22.11%	59.47%	11.05%	6.84%	0.53%
There is no financial or technical support offered to miners by the County government	38.95%	51.05%	5.26%	3.68%	1.06%

a. Institutional Frameworks

Some of the institutional issues contributing to the effects of ASGM on adjacent land uses include;

i. Miners lacking organized and registered groups that are legally recognized.

ii. Miners lack formal training in geological exploration, ore reserve estimation, mining and concentration techniques, water reclamation, and safety issues among others

iii. There are no clear procedures for obtaining legal permits for mining activities, thus artisanal gold miners operate illegally.

iv. There is a weak environmental audit and monitoring framework in Kakamega County.

v. Miners do not have access to a formal market for gold trading.

vi. There are no institutional or legal frameworks guiding gold mining in Rosterman and Ikolomani areas.

These factors have been represented in the Likert scale in figure 5-8;

(1= Strongly Agree, 2 = Agree, 3 = Neutral, 4 = Disagree and 5 = Strongly Disagree)

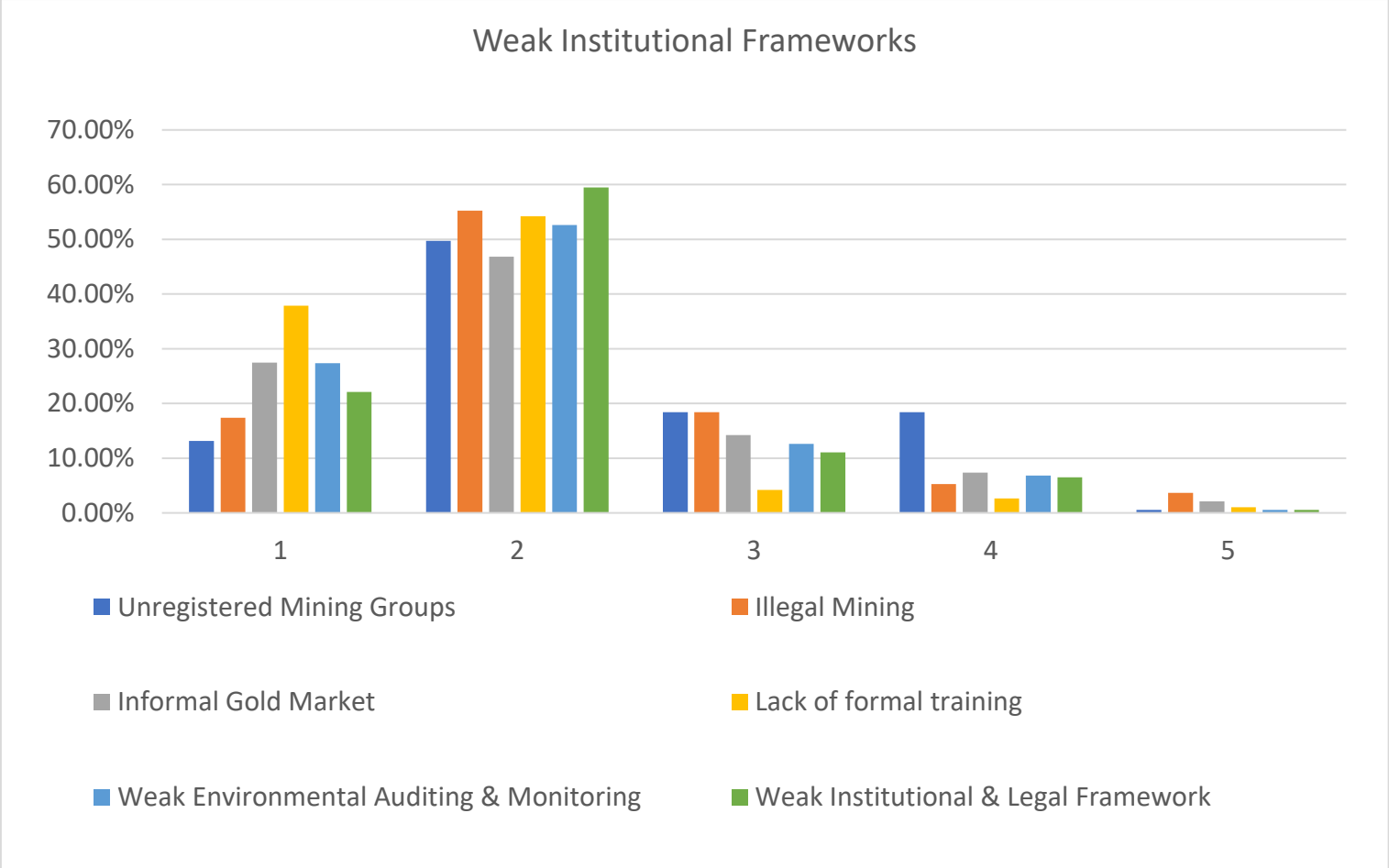


Figure 5- 8: Weak institutional factors affecting the relationship between ASGM and land uses

Lack of legally recognized and registered groups for miners

About 62.63% of residents found that lack of organization of miners into registered and legally recognized group contributed to the effects of ASGM on adjacent land uses in Ikolomani and Rosterman. Only 18.95% were in contradiction to this statement. The Kakamega County Environment Department Representative stated that there was a Committee at the County level with a chairman and 3 representatives from Lurambi, Ikolomani and Khwisero. The miners worked in groups that formed a Sacco. Every group of miners had a leader who oversaw about 5 shafts in the mining site. There was an on-going proposal for a mining co-operative to assist the miners which had not yet been implemented.

Lack of formal training of miners

Lack formal training in geological exploration, ore reserve estimation, mining and concentration techniques, water reclamation, and safety issues among others was found to contribute to the effects of ASGM on land uses in Ikolomani and Rosterman by 92.1% of residents, while 3.68% stated that lack of training had no contributions to the effects of ASGM on adjacent land uses.

About 72.26% of residents found the lack of clear procedures for obtaining legal permits for mining activities had contributed to the effects of ASGM on adjacent land uses in Ikolomani and Rosterman however, 8.94% disagreed. The Mining Department of Kakamega concluded that the fact that the sector was informal and consequently lacked regulations made it very easy for the Rosterman residents to be miners without any mining enforcement restricting their activities.

Lack of institutional or legal frameworks guiding gold mining

61.58% of residents found that that the lack of institutional or legal frameworks guiding gold mining in Rosterman and Ikolomani areas has facilitated the effects of ASGM on adjacent land uses, while 7.37% did not find this to be a contributing factor. The Mining Department of Kakamega stated that they faced a significant challenge when enforcing the mining laws due to inadequate resource allocation by the National Government. Mining Department is not yet devolved; hence it's a National Government function. The NEMA representative concluded that there was a gap in the legislation of artisanal gold mining. The legislations that governed mining in Kakamega County were; The Mining Act 2016, The EMCA, The County Environmental Policy, and the County Environmental Act. Artisanal gold mining was not formalized hence it was not legally recognized. Ninety percent of artisanal gold miners lacked permits, so there was no revenue and taxes accountability. The major challenge was the capacity to formalize the sector.

The Artisanal Mining Committees were formed, and they had never been facilitated, yet their role was to issue gold mining permits to the artisanal miners. The representative went on to state that the poor implementation of the occupational safety regulations led to health problems of the miners who are the residents of the Rosterman area. In addition, there was a lack of resources to regulate artisanal gold mining activities. For instance, Kakamega County had 200,000 artisanal miners and only two mining officers who lacked a vehicle to facilitate regulation of the mining activities. From the NEMA representative it was clear

that there was inadequate capacity of technical staff to enforce mining activities. Only one regional geologist inspector was governing Kakamega, Busia, and Vihiga counties, while there were over 300,000 miners in the region. Furthermore, guidelines for decommissioning Environmental Rights regarding mining were yet to be implemented.

From the focus group discussions, the miners mentioned that they lacked individual permits and were unsure whether their employers had permits. Some miners knew that the employers needed permits to carry out gold mining activities, but most didn't possess mining permits. The sector was mainly informal.

According to the respondents, there was no artisanal gold mining legislation and regulations regarding mining because of a lack of enforcement of safety measures. It was evident by untreated wastewater directed to River Mlombole and River Isiukhu and the naked/uninsulated electric cables connected to the shafts to assist the submissive pumps in removing excess underground water.

The reports of a miner who died from an electric shock from one of the cables were futile since the enforcement officers never came to address the issue. In addition, the miners lacked safety gear such as helmets, air-masks, boots, aprons, and gloves because the grinding places were open, and they emitted dust and fumes while grounding the gold stones. The miners were prone to health hazards such as respiratory diseases. The Rosterman residents had raised the safety measures issue, but the County government had not taken any action. Some human rights activists tried to fight for the miners' rights, but they all got arrested by the police.

Shortly before the study, the miners invited the D.O. to address the abovementioned mining issues, but nothing was done. The invite was also fueled by a leaching incident in River Isiukhu and resulted in the death of many fish in the river. Since River Isiukhu drains to Lake Victoria further extends the adverse ecological effects to the lake. They concluded there were very weak legislation and regulatory framework in the artisanal mining sector if they existed.

Study findings by Mwango (2013) confirmed that ASM is characterized by informality, implying that ASM miners in Rongo Sub-County usually operate without a county legal framework. Informal operations were small-scale, they used outdated technologies in production, and had unregulated markets.

Weak environmental audit and monitoring framework in Kakamega

Roughly 80% of residents in the study area stated that there is a weak environmental audit and monitoring framework in Kakamega County that contributes to the effects of ASGM on adjacent land uses, while 7.37% stated that the weak environmental audit and monitoring framework did not contribute to the effects of ASGM on adjacent land uses in Ikolomani and Rosterman. Poor governance was a significant factor that contributed to the adverse effects of artisanal mining. The Mining Officer specified that there were insufficient resources to facilitate inspections and enforcement by the government officers in the mining department. The Artisanal Mining Committee, which was in charge of issuing licenses to the artisanal gold miners, had insufficient operational resources. Study findings by Mwakesi et al. (2020) in Taita Taveta, Kenya confirmed a lack of a proper environmental framework and poor land rehabilitation as a factor leading to the artisanal mining effects in the area.

Weak legal and policy framework in Kakamega

The Mining Department of Kakamega stated that the legislation governing mining is the Mining Act 2016, the health and safety act, the EMCA, and Water Act. The Mining department mostly abides by the Mining Act but does not supersede the other laws. There was a gap when it came to the legislation and the regulations in the Rosterman area. The Mining Laws mostly handled noise pollution, yet they neglected the inspection of the mining process and the mining sites. The Artisanal Mining Committee was formed at the county level to deal with the issuing of permits, but it had not operationalized. Furthermore, the Mining Act 2016 does not recognize gold mining as a formal sector for revenue collection.

The Kakamega County Environment Department Representative stated that there lacked a County Legal Framework guiding and regulating artisanal gold mining in Kakamega County. The County only regulated artisanal mining of the low-value minerals i.e., murram, clay, sand, ballast, and stones. The fact that mining was not devolved gave the county inspection officers a challenge in enforcing the artisanal mining regulations as in the Rosterman area since it is not a County Function. The Mining Act states that there has to be an artisanal mining committee in charge of issuing licenses. The challenge was that the committees were poorly funded, leading to irregularities in the sector.

Lack of a formal gold market

Lack of a formal gold market was stated to have contributed to the effects of ASGM on adjacent land uses by 76.31% of residents, while 9.48% stated that lack of a formal gold market has no contributions to the effects of ASGM on adjacent land uses.

b. Social Factors

Social factors that were found to contribute to the effects of ASGM on adjacent land uses include:

i. Miners lack access to appropriate technology for clean production of gold.

ii. Miners do not have access to formal funding sources to support their mining activities.

iii. There is no financial or technical support offered to miners by the County government.

The Likert Scale in figure 5-9 shows the level residents agreed to the contributions of ASGM on adjacent land uses in Ikolomani and Rosterman.

(1= Strongly Agree, 2 = Agree, 3 = Neutral, 4 = Disagree and 5 = Strongly Disagree)

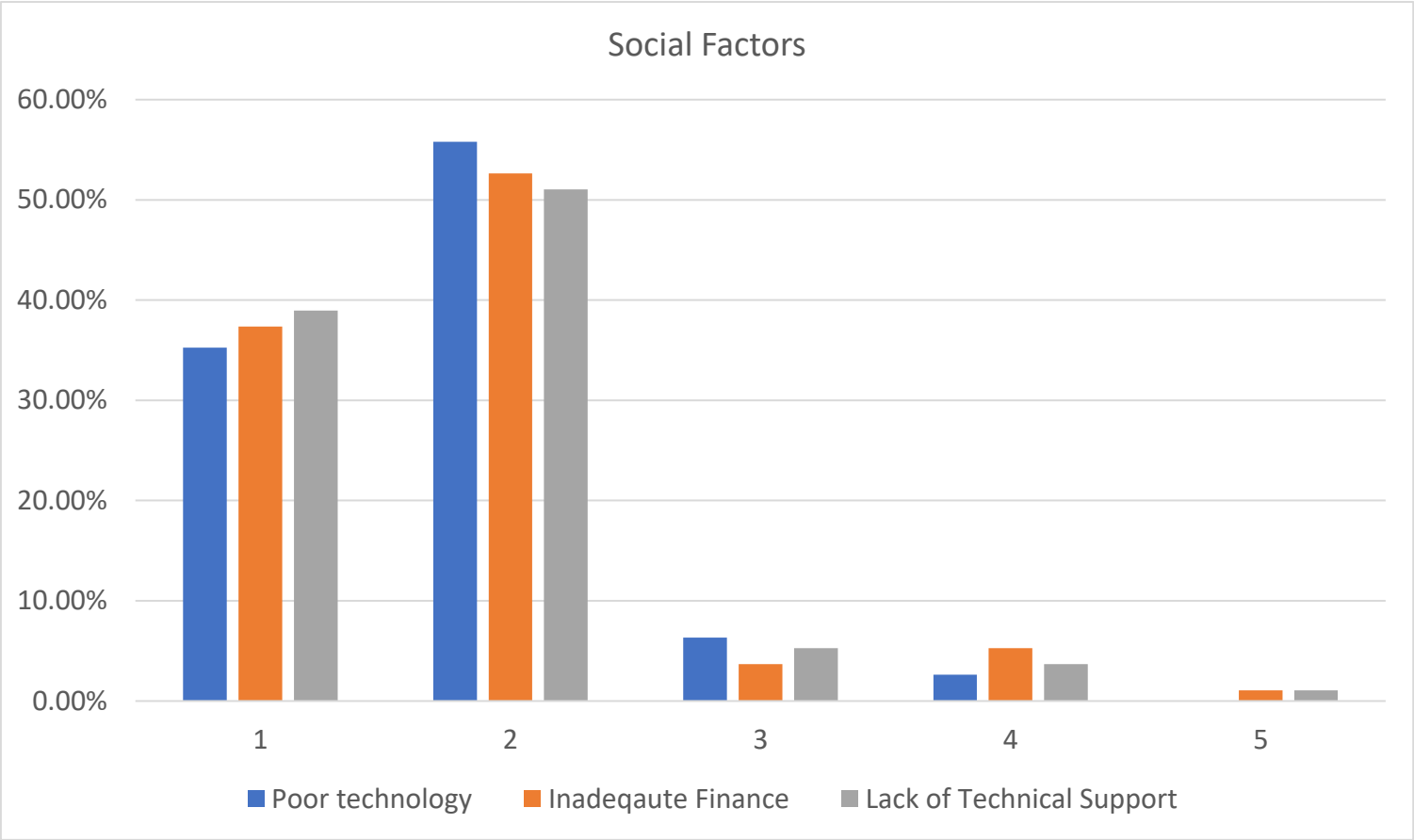


Figure 5- 9: Social factors contributing to the effects of ASGM on adjacent land uses

Lack of support from the County Government

57.58% of residents stated that the lack of financial or technical support from the County Government of Kakamega has contributed to the effects of ASGM on adjacent land uses in Ikolomani and Rosterman. About 4.74% disagreed with the statement and found no link between ASGM and lack of support from the County Government.

Lack of access to appropriate technology

Lack of access to appropriate technology for clean production of gold in Ikolomani and Rosterman was found to contribute to the effects of ASGM on adjacent land uses by 91.05% of residents while, only 2.63% did not see any contributions of the lack of appropriate technology to the effects of ASGM on adjacent land uses. The NEMA representative stated that the lack of new technology in terms of sustainability was another socio-economic

factor. There were no training institutions, research institutions or even colleges in Kakamega County to train the miners on safety measures and advanced mining techniques.

Poverty and Education Levels

Poverty is the main factor contributing to the artisanal gold mining activities in the Rosterman area. Lack of formal funding sources to support mining activities in Ikolomani and Rosterman was seen to contribute to the effects of ASGM on adjacent land uses by 90% of residents while 6.31% were of contrary opinion.

The financial constraints of residents in the area can be attributed to the fact that residents were primarily illiterate and unemployed, hence opted to venture into artisanal gold mining as an easy alternative to livelihood.

Table 5- 5: Level of education characteristics

Value	Frequency	Percentage
Secondary school	90	47.37
Primary school	66	34.74
College education	25	13.16
University education	5	2.63
No formal education	4	2.11

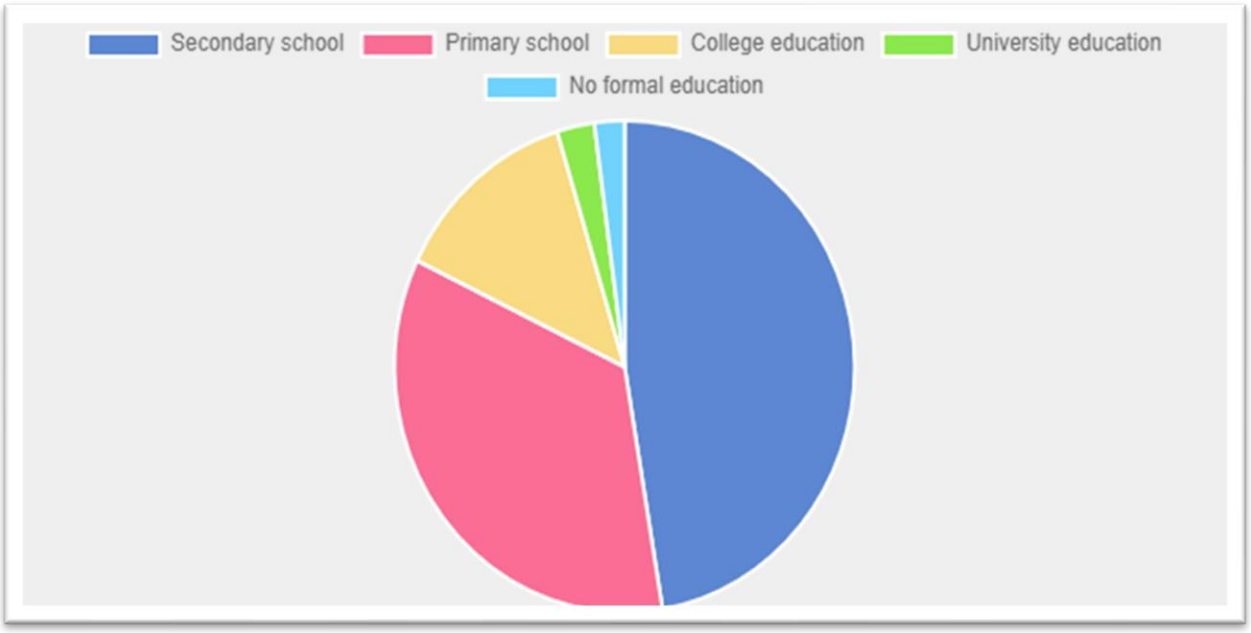


Figure 5- 10: Level of education of the respondents

From the above figure, the majority of the respondents have attained secondary school level (47.37%), followed by those with primary school education (34.74%), and then those who have acquired college education (13.16%). A few respondents have attained university education (2.63%), and those without formal education (2.11%) are the least. It indicates that most of the population have not exceeded secondary school (84.22%), and only a small group has received tertiary education (15.78%).

Study findings by (Jotham & Mulinya, 2020) at the Rosterman mines in Kakamega County, investigating the economic impact of ASGM in the county fixated on the impact of gold mining on income. Using a sample of 322 miners and 44 respondents drawn from the County government, the findings confirmed that ASGM activities positively affected miners' income status. However, while respondents noted that the increased incomes had enabled them to take their children to school, an analysis of the school enrolment rates did not find any increase (Jotham & Mulinya, 2020).

From the NEMA representative, it was evident that the high poverty levels in Rosterman area forced most residents to venture into laboring in the artisanal mining sector. They preferred gold mining over other alternative forms of livelihood, such as agriculture. The desire for more money triggered the preference. The labor fee for gold mining was KSH 500 compared to the labor farming fee, which was KSH. 200 per day. The table below shows the education levels of the respondents. The high unemployment rate in the area also

contributed to them opting to venture into gold mining as a source of livelihood as indicated in the figure below.

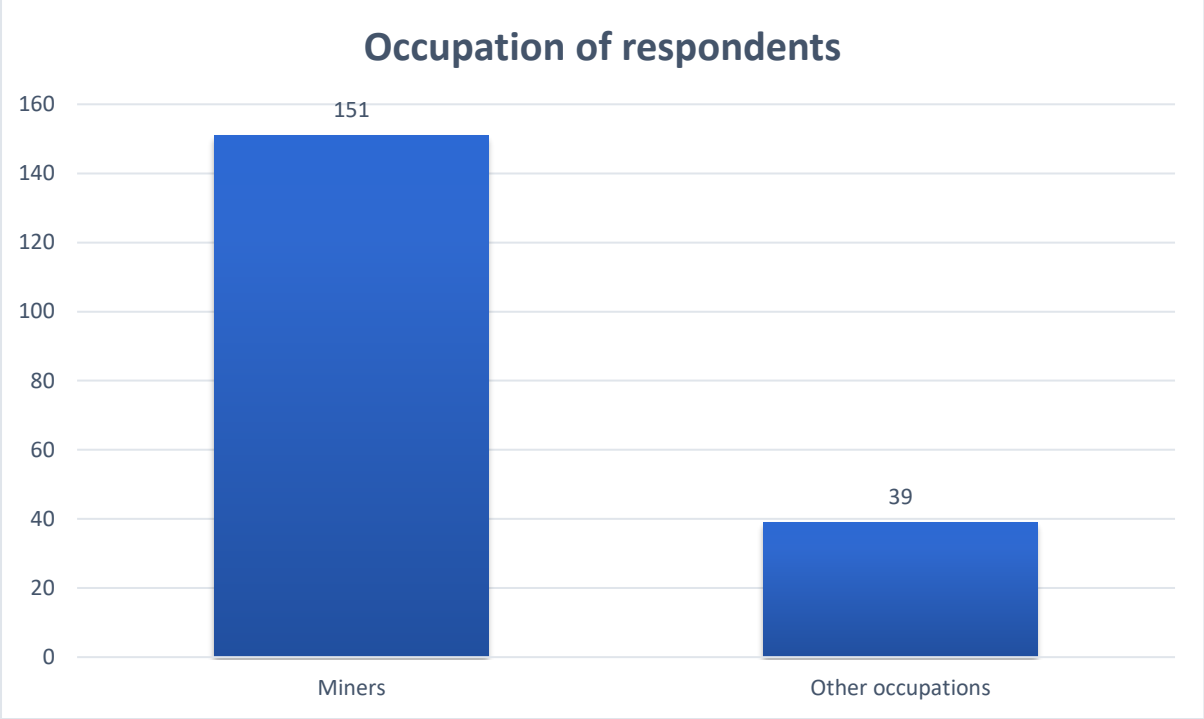


Figure 5- 11: Occupation of the respondents

Information on the other occupations of the respondents is indicated on the figure below. Based on the responses, the other alternative forms of livelihood include; casual labor, crop farming, trading, livestock farming, office employment, fish farming, poultry farming and sports activities.

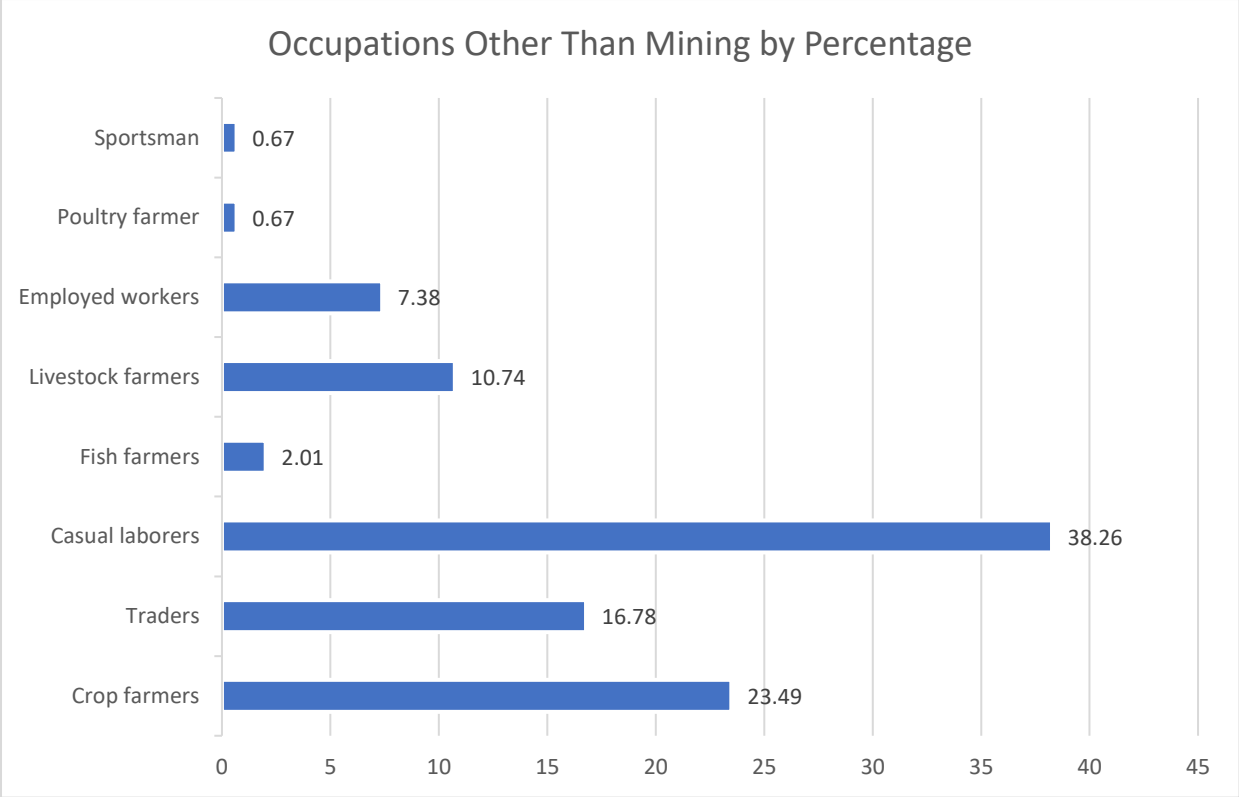


Figure 5- 12: Other sources of livelihood apart from mining

Among other occupations, the majority of the household representatives are casual laborers (38.26%), followed by crop farmers (23.49) and livestock farmers (10.74). This implies that the other occupation categories complement the mining occupation in the respective households.

Marital status

Marital status is another socio-economic factor. Majority of the respondents in the Household survey were married and also the breadwinners in their households as indicated in the figure below.

Of the 190 respondents, 81.05% are married, 16.32% are single, 1.05% are separated, 1.02% are divorced, and 0.53% are widowed. It implies that most of the household heads are married, with the single groups being the minority, as illustrated in the figure 5-35 below.

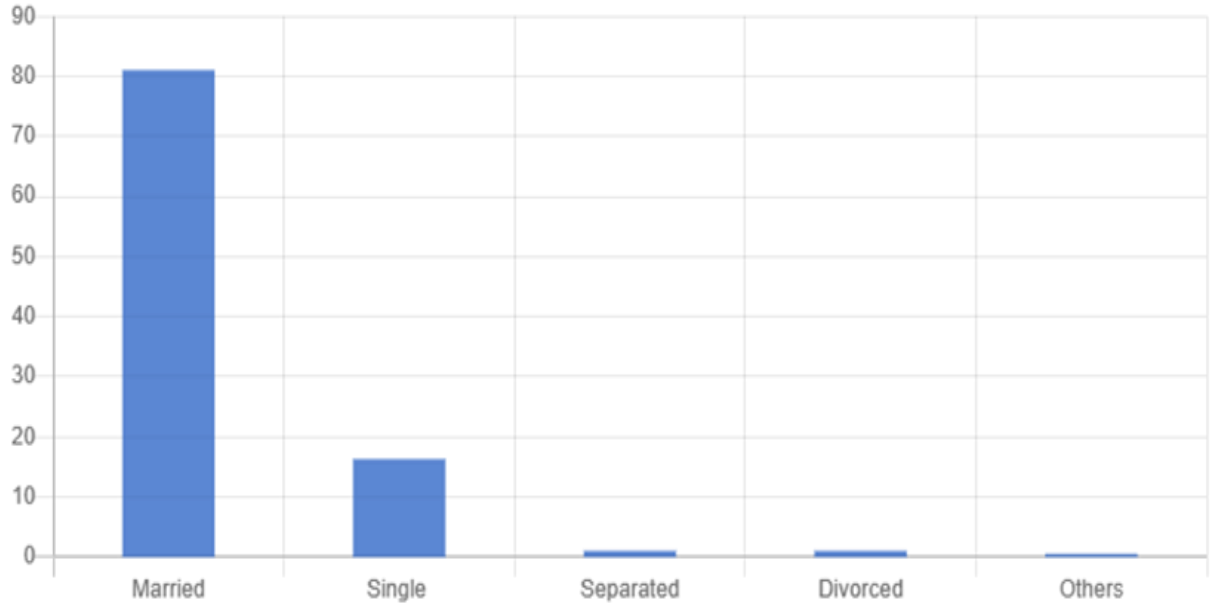


Figure 5- 13: Marital status of the respondents

Age

Age was another socio-economic factor that influenced the increased artisanal mining activities. Majority of the miners were in their most productive age. The figure below indicates the age distribution as per the household survey.

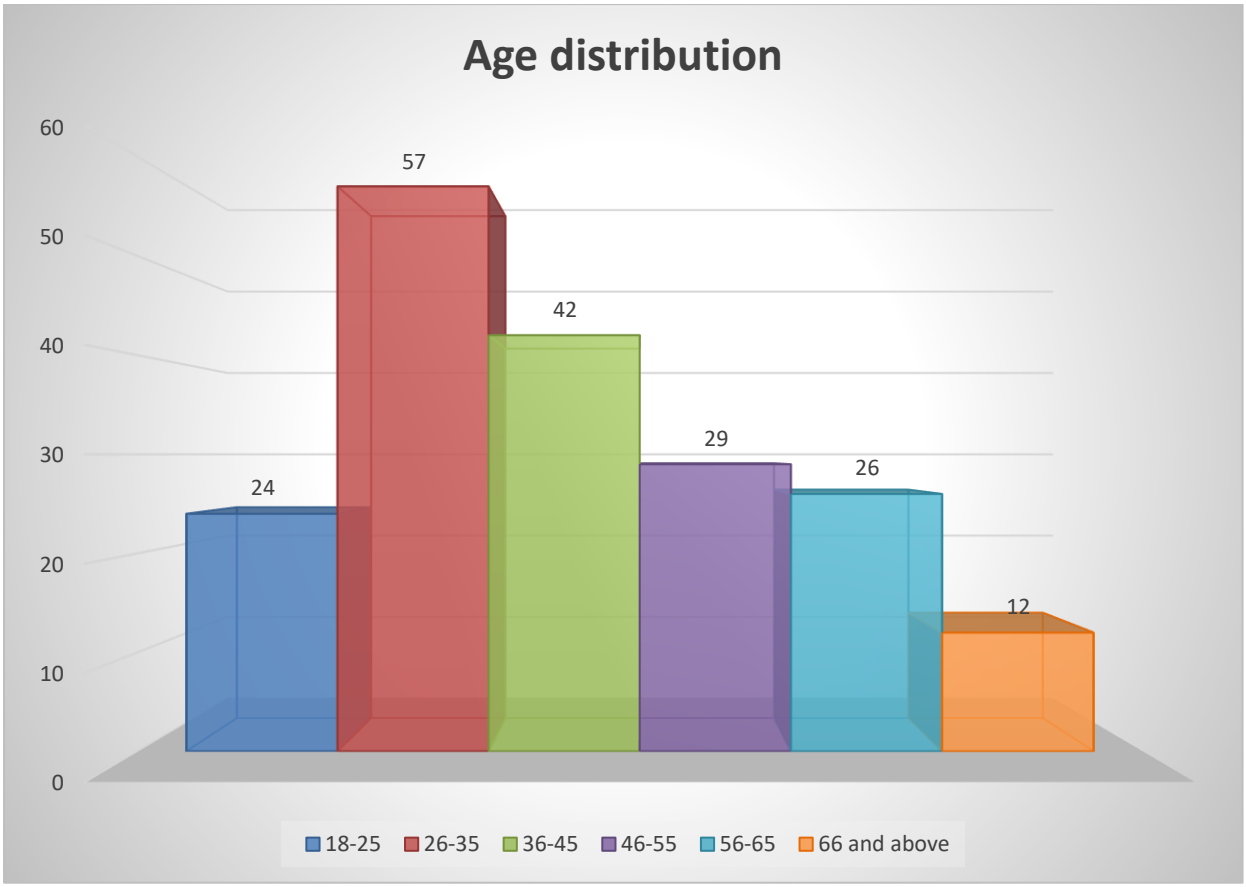


Figure 5- 14: Age distribution chart

The age of the household heads ranges from 18 to 75 years old. The age distribution of the respondents living adjacent to the mines is indicated in the figure below. Most of the household heads in the Rosterman area are aged between 26-35 years, consisting of 57 out of 190 respondents. Those aged between 36 and 45 comprised 42 respondents, those aged between 46 and 55 included 29 respondents, and those aged between 56 and 65 comprised 26 respondents. The household heads aged 18-25 years follow with a total of 24 out of 190, and finally, those aged over 66 years and above are the fewest, with only 12 out of 190 respondents.

Politics also played a part in the effects of artisanal gold mining in the Rosterman area. There was a lack of political goodwill in supporting the artisanal gold mining sector in resource allocation and implementation.

c. Governance Factors

Governance factors that were found to contribute to the effects of ASGM on adjacent land uses include:

i. Inadequate social amenities

ii. Poor road infrastructure

iii. Political interference

Residents' responses on their level of agreement with the factors' contributions to the effects of ASGM were in form of a Likert scale as indicated in figure 5-15;

(1= Strongly Agree, 2 = Agree, 3 = Neutral, 4 = Disagree and 5 = Strongly Disagree)

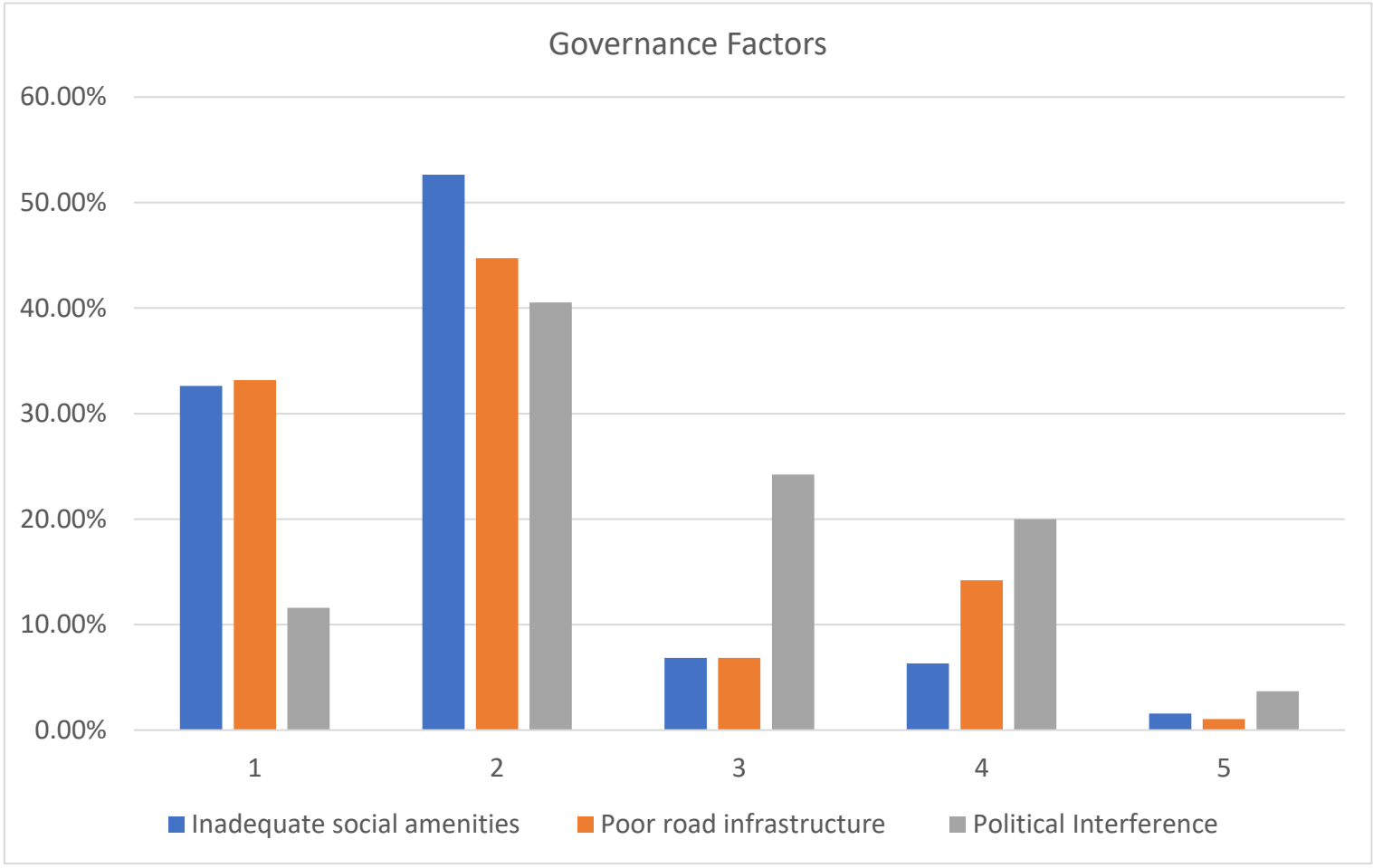


Figure 5- 15: Governance factors contributing to the effects of ASGM on adjacent land uses

Inadequate social amenities

85.26% of residents found that the lack of adequate social amenities contributed to the effects of ASGM on adjacent land uses in Ikolomani and Rosterman areas, while 7.9% of residents stated that they did not agree that inadequate social amenities contributed to the effects of ASGM on adjacent land uses.

Poor physical infrastructure

77.91% of residents stated that the poor conditions of roads in Rosterman and Ikolomani has contributed to the effects of ASGM on adjacent land uses while 15.26% did not find this to contribute to ASGM's effects on adjacent land uses.

Political Interference

Politics was stated by the Environment Department of Kakamega, to also play a part in the effects of the mines on the adjacent land uses. The politicians avoided interfering with the mining activities due to the fear of losing their votes during elections which enabled the miners to continue with their extraction activities without care about the adjacent land uses and the environment in general. Politics was noted to have a negative impact on ASGM in Rosterman and Ikolomani areas by 52.11% while 23.68% did not see its contributions to the effects of ASGM on adjacent land uses.

Conclusively, this objective adopted the "Spatiology" Theory which was developed by Lagopoulos (2018) to interlink analytical theory with the normative theories to cover the gap between practice and science in the theories of land use planning. In order to cover the informality gap in artisanal gold mining, it is essential to link ASGM with the policies, institutions and practice so as to come up with a land use plan incorporating zoning and a local physical development plan.

5-5 Roles, behavior and perceptions of stakeholders in relation to artisanal gold mining and adjacent land uses

To achieve this objective, the public and the private stakeholders of the mining sub-sector were asked to react to several statements intended to describe their roles, behavior and perception in relation to artisanal gold mining and adjacent land uses. Data on this objective was analyzed under the hypothesis "Roles, behavior and perceptions of gold mining stakeholders have a contribution to the adverse effects of ASGM on adjacent land use in the study area." The household questionnaire responses were summarized using a Likert scale of 1-5 as shown in Table 5-8 and 5-9 below.

Table 5- 6: Likert scale

Value	Response
1	Strongly Agree
2	Agree
3	Neutral

4	Disagree
5	Strongly Disagree

Table 5- 7: Summary of findings

Value	1	2	3	4	5
Variable					
Artisanal gold mining provides employment to a majority of residents	**24.21%**	**61.05%**	**9.47%**	**4.74%**	**0.53%**
Artisanal gold mining has increased the incomes of residents	**21.58%**	**40.53%**	**27.37%**	**10%**	**0.53%**
All miners are licensed	**4.21%**	**11.05%**	**21.58%**	**45.79%**	**17.37%**
Artisanal gold mining has improved the living standards of the miners and the villagers in this area	**15.26%**	**34.74%**	**32.11%**	**16.32%**	**1.57%**
The Government ensures that gold mining is conducted according to the mining legal frameworks	**3.16%**	**20.53%**	**25.26%**	**38.95%**	**12.11%**
Artisanal gold mining has improved the road infrastructure in the area	**7.37%**	**18.95%**	**13.68%**	**41.58%**	**18.42%**
Artisanal gold mining has increased access to clean water and electricity to residents	**6.84%**	**17.89%**	**1.58%**	**47.37%**	**26.32%**

Artisanal gold mining has increased access to educational facilities for residents in the area	**4.74%**	**14.74%**	**15.79%**	**43.16%**	**21.58%**
Artisanal gold mining has increased access to healthcare facilities in the area	**1.05%**	**12.11%**	**15.26%**	**48.95%**	**22.63%**
Artisanal gold mining has led to the construction of markets in the area	**2.63%**	**16.32%**	**18.95%**	**32.63%**	**29.47%**
Artisanal gold mining has caused degradation of adjacent agricultural land	**10%**	**68.95%**	**8.42%**	**11.05%**	**1.58%**
Artisanal gold mining has worsened soil and water pollution in the area	**27.37%**	**62.63%**	**3.16%**	**6.32%**	**0.53%**
Artisanal gold mining has worsened air pollution in the area	**11.05%**	**56.84%**	**20.53%**	**10.53%**	**1.05%**

5-5.1 Roles and behaviors of the stakeholders

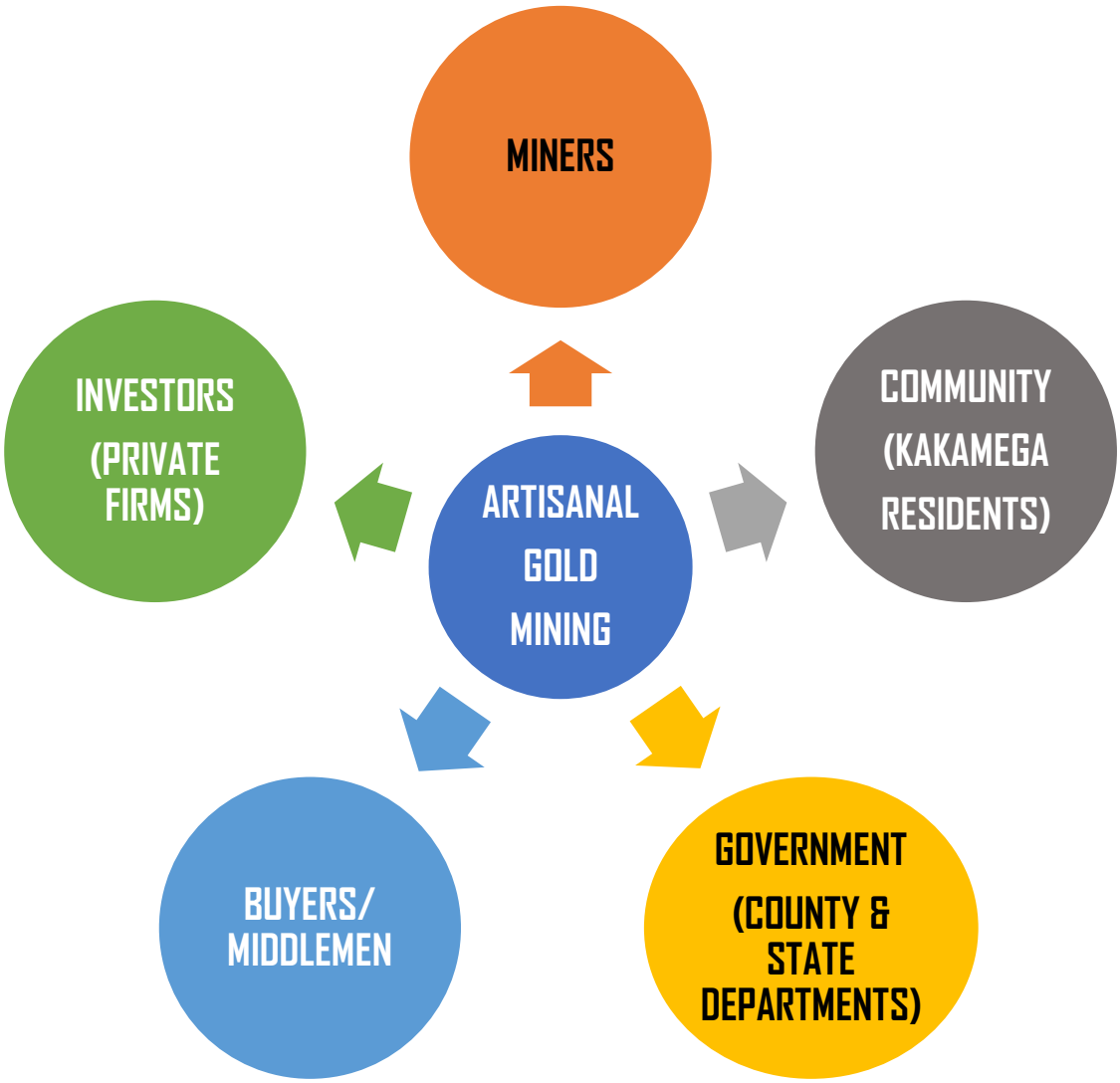


Figure 5- 16: Public and private stakeholders in the Study area.

Miners

Based on the FGDs with the miners, they viewed themselves as the backbone of the artisanal gold mining sector, whose primary role was to extract gold deposits directly from the shafts. The miners worked day and night in the shafts until they reached the gold ores. They, however, used rudimentary tools and lacked appropriate safety attire to conduct the mining process. Notwithstanding the lack of safety work attire, they still work diligently day and night to make ends meet since it was the source of livelihood for many residents in Rosterman Area.

Residents

The Residents living adjacent to the Ikolomani and Rosterman mining sites constituted the public stakeholders. Majority of the residents adjoining the mining sites complemented

mining with other alternative incomes. Most of the household heads in the household survey provided labor for artisanal gold mining practices with the minority opting for other income sources based on the level of education and expertise in other sectors.

Government

According to the key informants, Kakamega County has; the Mineral Rights Board formed within the Mining Department under the National Government, to advise the Director of Mining on matters entailing; mining licensing, inspections on mining sites, closure of mines, and land reclamation of mining areas. The Kakamega County Environment Department which focuses on regulating noise pollution in the county, including mining areas such as Rosterman. NEMA County Department is in charge of enforcing environmental laws related to the artisanal mining sector. The County Planning Department is mandated to develop spatial plans entailing all the sub-sectors of the economy including mining.

Investors

According to the FGDs, the Private firms were the financers of the mining process. They were the ones who established the shafts and allocated the miners where to extract gold. Some were natives of the area, while others were immigrants from other counties with a thirst for gold. The private firms were permitted to conduct gold mining for a limited time and location.

Buyers/Middlemen

The FGDs confirmed that the middlemen and the buyers were mainly from other counties and countries. They purchase the unrefined gold at a lower price and later sell it at a higher price after refining it. The miners were limited to the middlemen's offers because they lacked a formal market where they could sell the gold at a standardized price.

5-5.2 Perception of the stakeholders

These perceptions of the public and private stakeholders have been represented in the Likert scale in figure 5-17;

(1= Strongly Agree, 2 = Agree, 3 = Neutral, 4 = Disagree and 5 = Strongly Disagree)

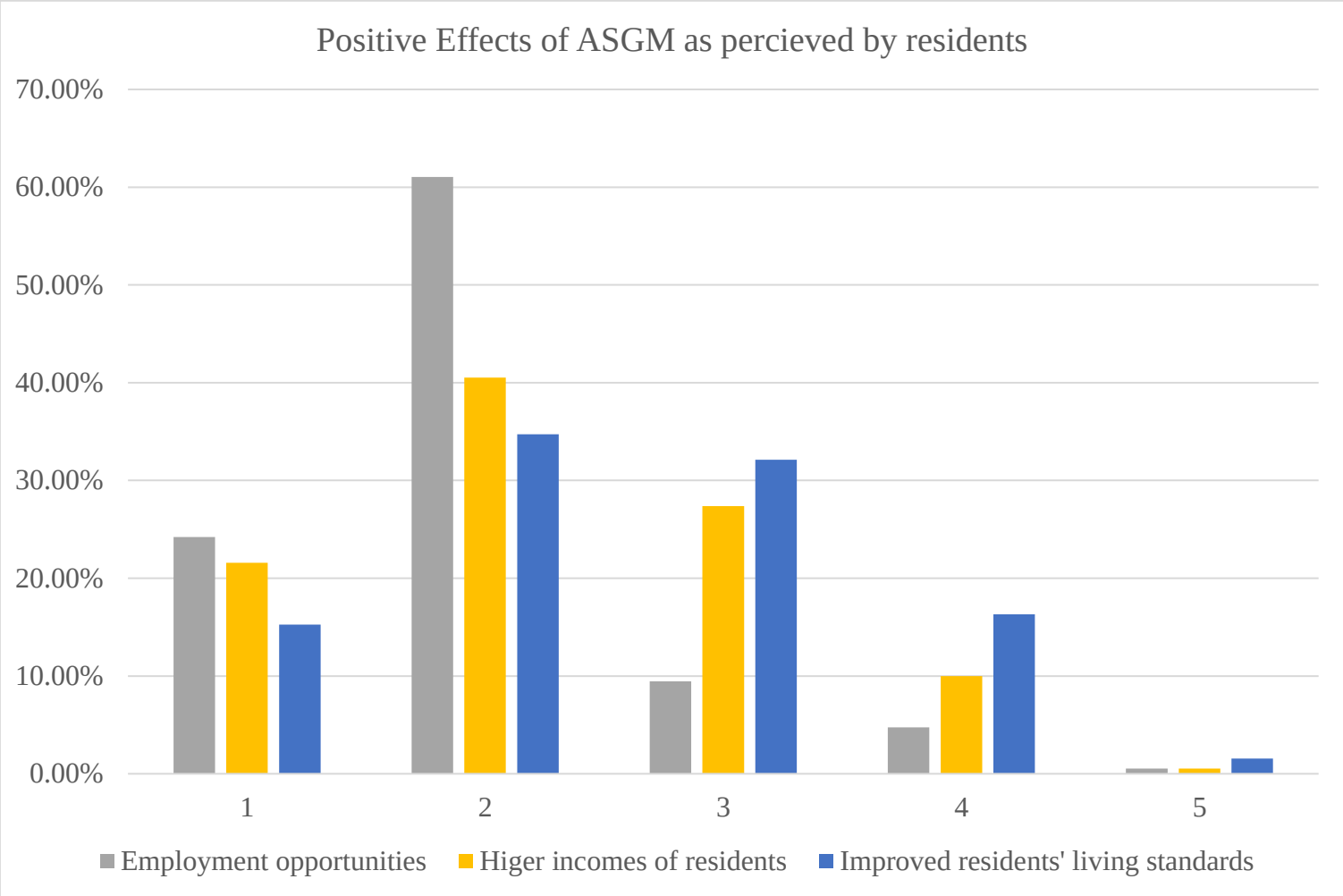


Figure 5- 17: Positive effects of ASGM as perceived by residents

Creation of employment opportunities

About 85.26% of the household questionnaire respondents agreed that ASGM contributed to employment opportunities. Nearly 14.74% disagreed that ASGM led to creation of employment.

The Director of the County Environment Department confirmed that gold mining had assisted the economy of the Rosterman area by offering employment to the miners, laborers, lumbers, and food vendors, among others. Part of the reason for the increased artisanal gold mining activities was that the gold acquired from the extraction in Rosterman was high-grade; hence, the sector's growth was potential. He specified that artisanal gold

mining at Rosterman was “small-scale mining” and not “artisanal” because they had mechanized the gold extraction process.

Study findings by Leuenberger (2021) conducted in Burkina Faso, Mozambique and Tanzania, confirmed that gold mining provided employment opportunities for residents residing adjacent to the mines. The living standards of the residents working in the mines in Rosterman and Ikolomani has greatly improved because of the employment opportunities offered. Study findings by Gajigo et al., (2012) in Tanzania confirmed a great improvement in the living standards of residents adjoining the mines.

Increased income levels

Roughly 62.11% stated that ASGM contributed to increased incomes for the residents living adjacent to the mines. About 37.89% of the respondents disagreed that ASGM resulted in increases incomes for the adjoining residents.

The income generated from artisanal gold mining was minimal for the miners who offered physical labor to the shaft owners. In comparison majority of the respondents in the Household survey stated their income levels as indicated in the figure below.

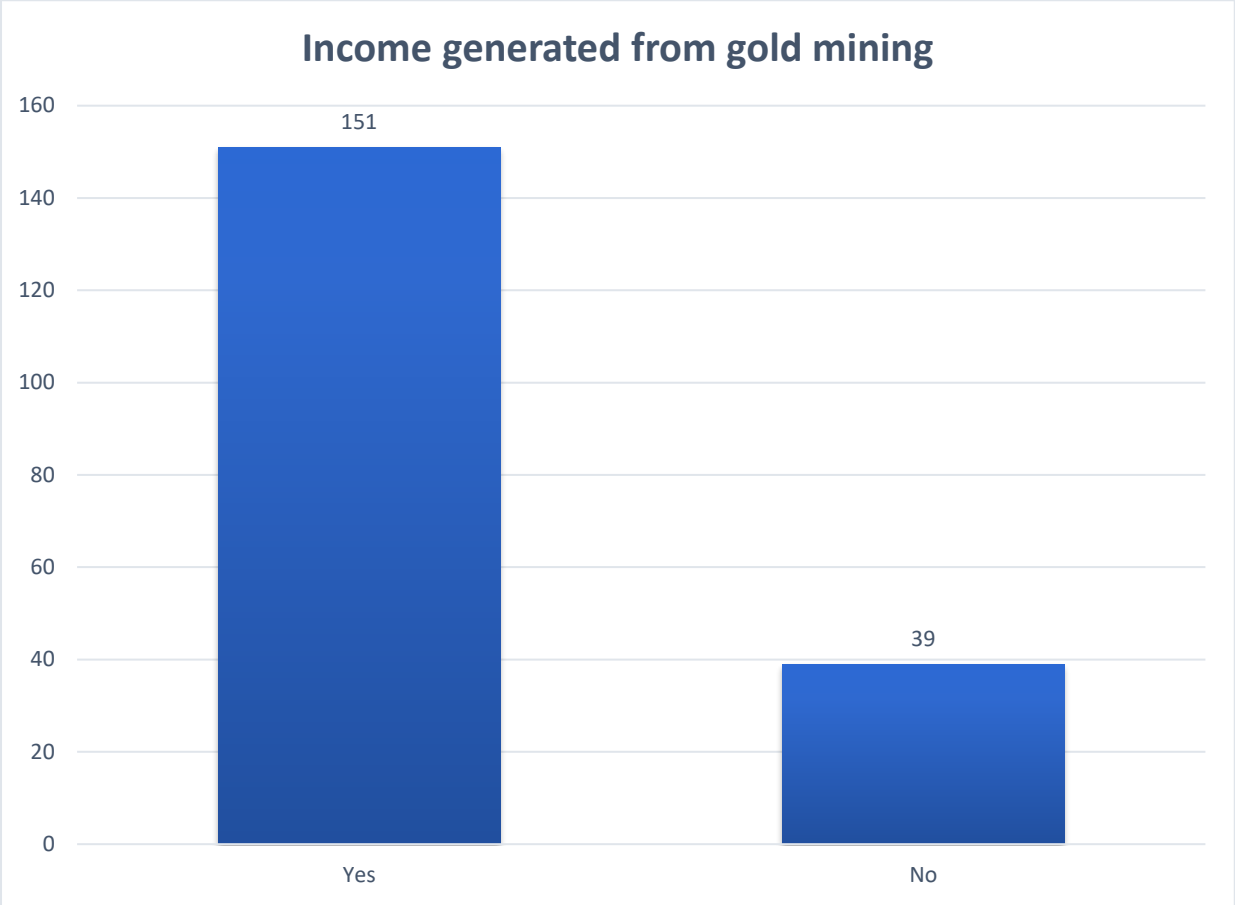


Figure 5- 18: Income generated from gold mining

The figure above indicates that 79.48% of the respondents earn from artisanal gold mining, whereas the remaining 20.52% acquire income from other sources. It shows that most respondents depend on gold mining for survival. The average income level generated from gold mining is KSH 16,229 while the most common level of income is KSH 10,000. The standard deviation is 17862.65 which is high and hence means there is a great variation in the income levels from the mean with income ranging from KSH 1,500 to KSH 100,000.

Living Standards

Half of the respondents (50%) stated that ASGM improved their living standards while the other half disagreed. The FGDs confirmed that the miners used their daily wages to cater for their families' basic needs and hence had no savings. The profits earned by the laborers who dug and washed gold depended on the amount of gold they acquired. One of the miners quoted, "if I don't acquire any gold, I will go home empty-handed." The miners who worked in shafts only got 3% of the value of gold acquired, while the shaft owners kept the

remaining lion's share. The miners' roles also included cleaning and purifying the gold deposits before selling the final products to the middlemen.

These perceptions of the public and private stakeholders have been represented in the Likert scale in figure 5-19;

(1= Strongly Agree, 2 = Agree, 3 = Neutral, 4 = Disagree and 5 = Strongly Disagree)

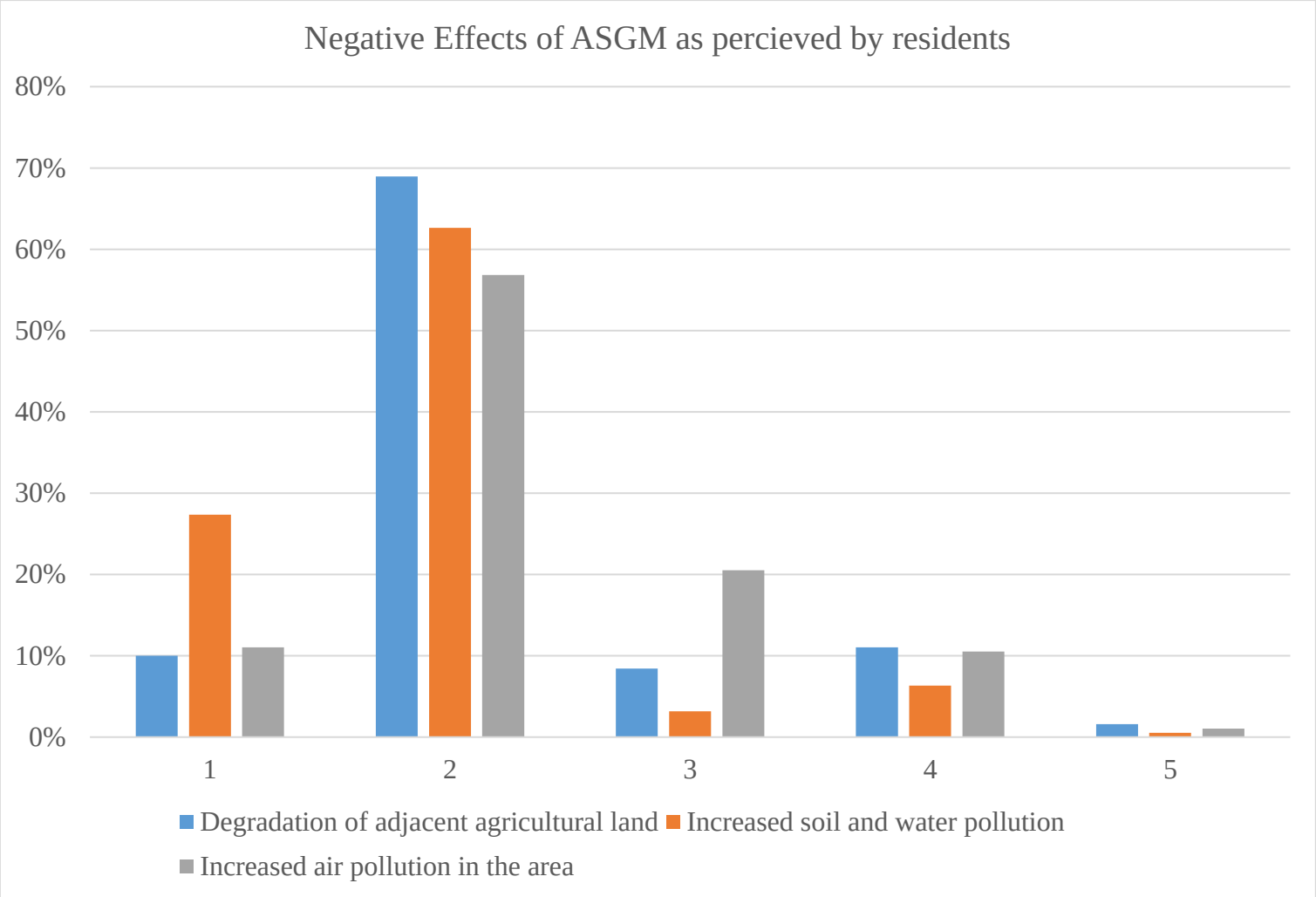


Figure 5- 19: Negative effects of ASGM as perceived by residents

a) Negative effects

Informality of ASGM

Approximately 51.06% of the respondents perceived that the Government should not ensure gold mining is conducted legally. The remaining 48.91% were of the opinion that the government ought to ensure mining is carries out legally.

According to the Deputy Director of the Mining Department, there was room for growth for small-scale gold mining in Rosterman Area to generate revenue from the sector. The harmful effects could be controlled if all the stakeholders collaborated to develop a policy reform to regulate artisanal gold mining.

The Key informant from the County Environment Department confirmed that there were policy gaps when it came to government institutions. The government needed to implement policies specifically focused on gold in order to address some of the harmful effects triggered by artisanal gold mining in Kakamega County. To address the effects caused by artisanal mining activities, the government needed to; build capacity for the miners, support rehabilitation of the degraded land, manage occupational hazards, regulate noise through issuing hefty noise licenses, mobilize a task force that recommends the safety and regulations, and liaise with water authority to conduct routine water monitoring, inspection and monitoring of the mining sites

The Director, NEMA insisted that it was essential to properly redefine artisanal gold mining into small scale mining and actually formalize the sector. The County Planner, additionally emphasized that there was a gap in the artisanal mining sector when it came to the policies and regulations covering; licensing, enforcement, land conflicts, environmental pollution, and safety measures. The tunneling process should have been mitigated to avoid overlapping land uses. Furthermore, the sector was left to free range without regulations with many negative short-term and long-term adverse effects.

About 64.74% disagreed with the statement that ASGM has led to establishment of markets in the Study area. Nearly 35.26% agreed that ASGM has contributed to the establishment of markets in the Study area. This highlighted the need for developing market infrastructure.

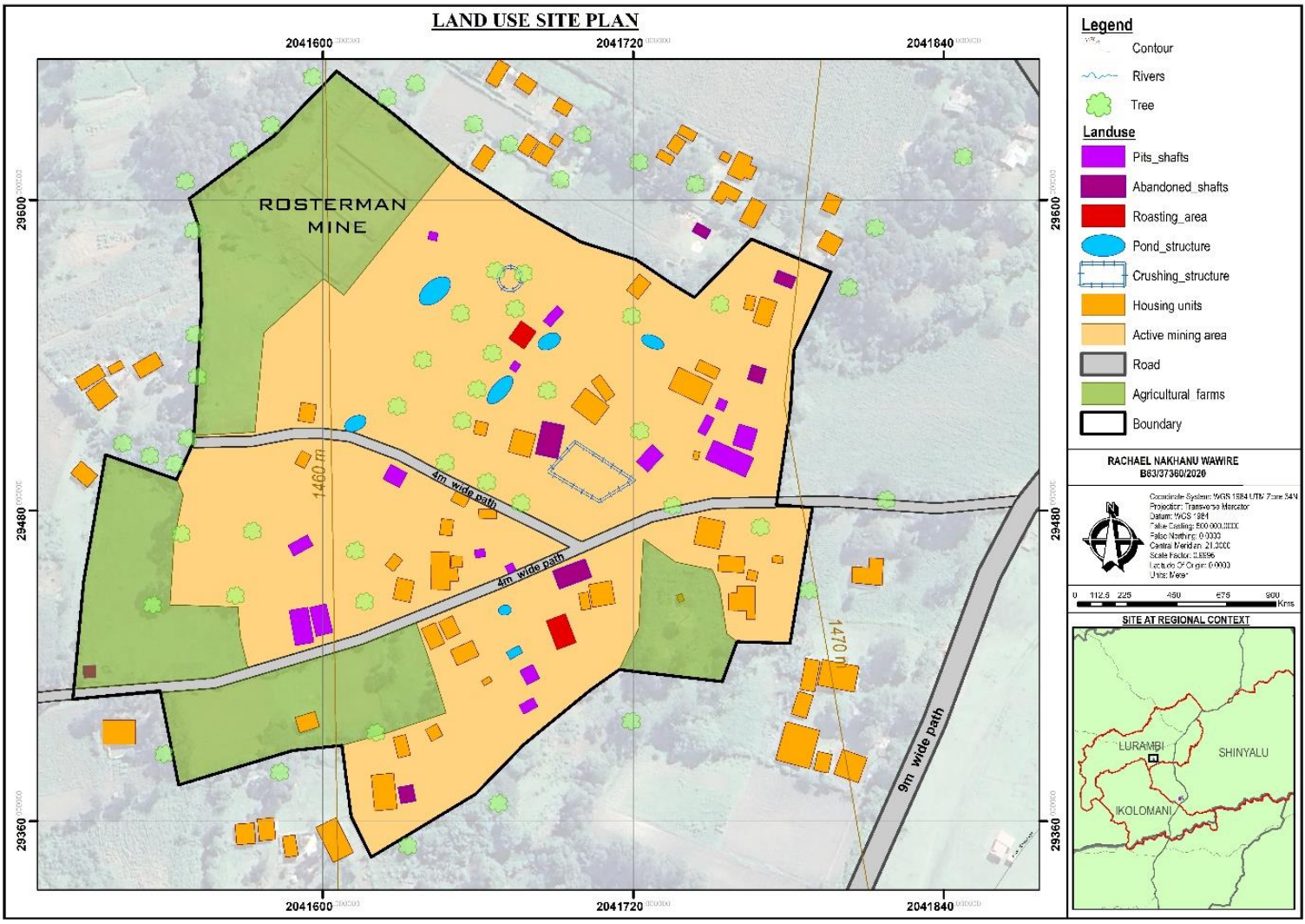
From the FGDs, the miners confirmed there was no formal gold market in Kakamega County, and they were thus forced to sell their gold to brokers who visited the area in search of gold. Moreover, the miners added that often got small quantities of gold which did not enable them to find better offers from the outside market. Convincingly, the miners said there was room for growth for the gold mining sector only if they acquired credit and technical support from the government and other investors.

Lack of a County Spatial Plan for Kakamega County

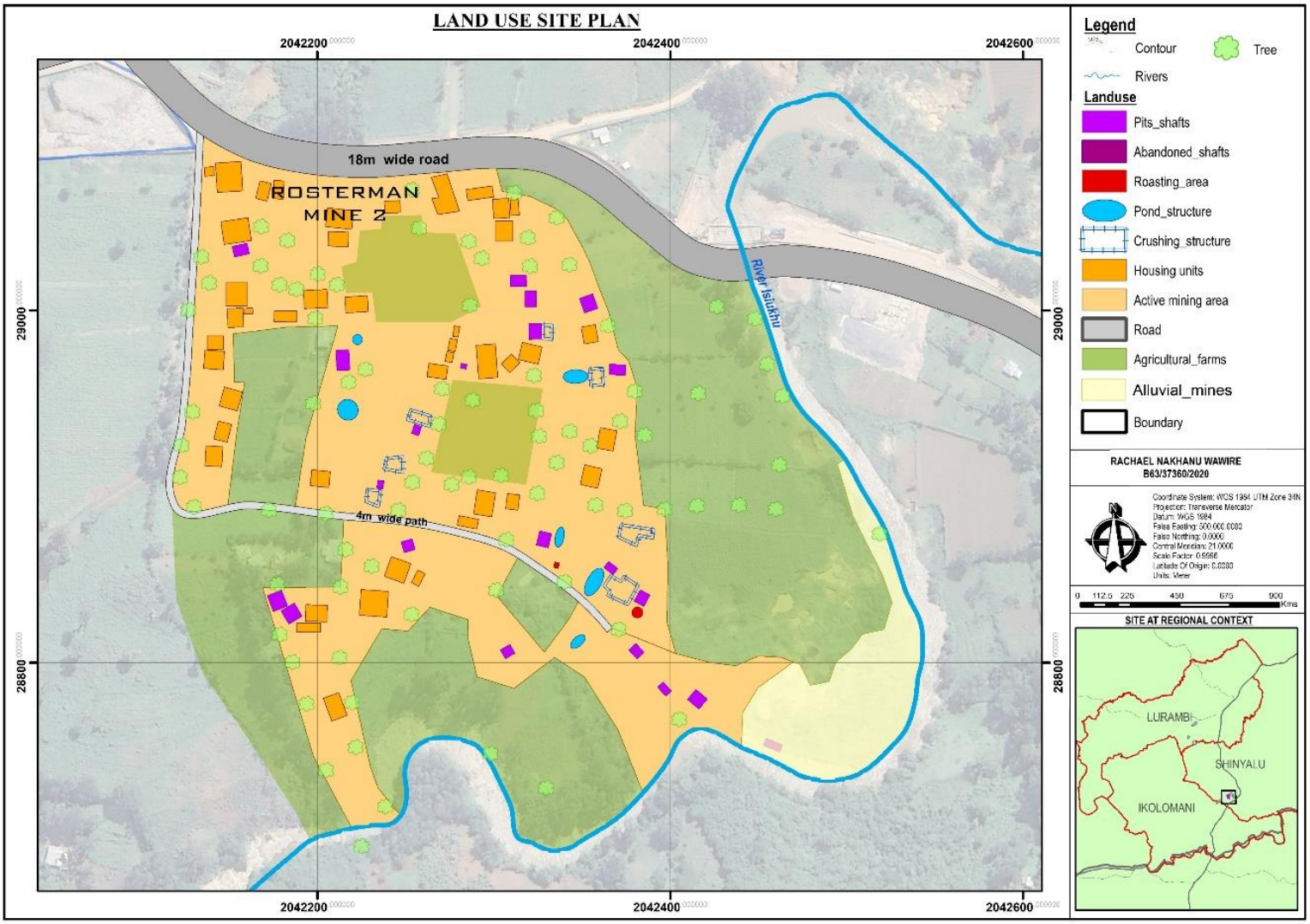
The County Planner extensively confirmed that the Rosterman and Ikolomani mines were not incorporated in the physical and spatial plans in Kakamega County because it was challenging to plan for the gold mining sites due to the mobility of the artisanal miners. Moreover, the mining sites cropped up on a need of a site basis making it a problem to plan for the ASGM sites.

The County Planner, however specified that the mining sites were not usually incorporated in the physical and spatial plans in Kakamega County because it was challenging to plan for the gold mining sites since the artisanal miners are very mobile and cropped up on a site basis. According to PLUPA (2019), the County Planning Department in Kakamega is in charge of planning the various economic sectors of the County including mining. Failure to plan for all the sub-sectors of the economy, results in consequential effects such sustainable land use.

The County Planner confirmed overlapping land uses as the greatest spatial planning challenge in the Study area. Google earth imagery assisted in mapping out of the overlapping land uses within the study area which as shown on maps 5-1, 5-2 and 5-3 below.

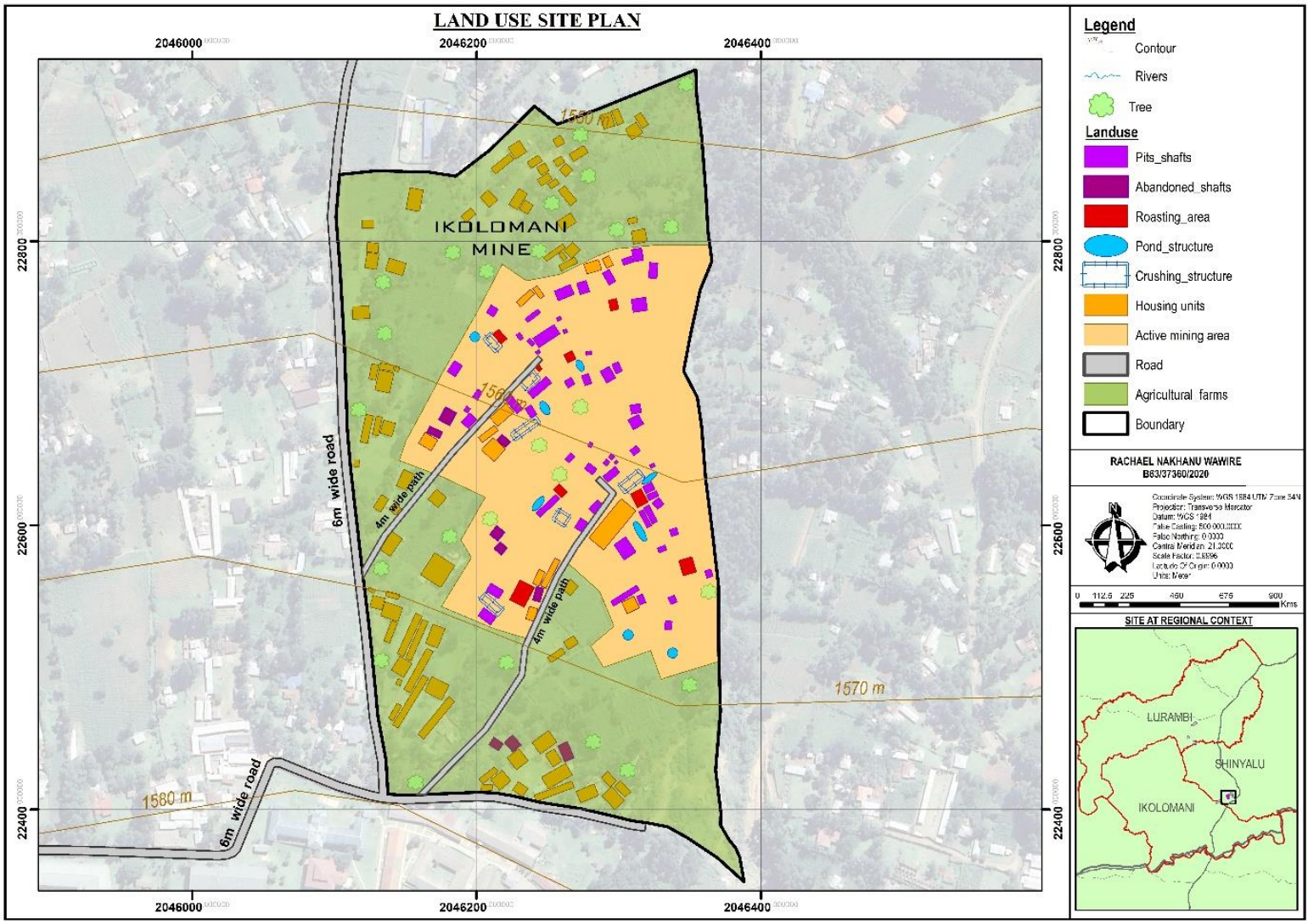


Map 5- 1: Rosterman Mining site 1



Map 5- 2: Rosterman Mining Site 2

Map 5-1 and 5-2 indicate how the various artisanal gold mining activities have resulted in the overlapping land uses in Rosterman area. The mining structures have intruded the adjacent residential area, agricultural land and ecologically sensitive areas.



Map 5- 3: Ikolomani Mining Site

Map 5-3 indicates how the various artisanal gold mining activities have resulted in the overlapping land uses in Ikolomani area. The mining structures have intruded the adjacent residential area, agricultural land and ecologically sensitive areas.

Moreover, the shaft structures were constructed without any proper guidelines with no standardized building materials and depths for the shafts. Below is a sketch of the shaft gold mine site within the Study area.

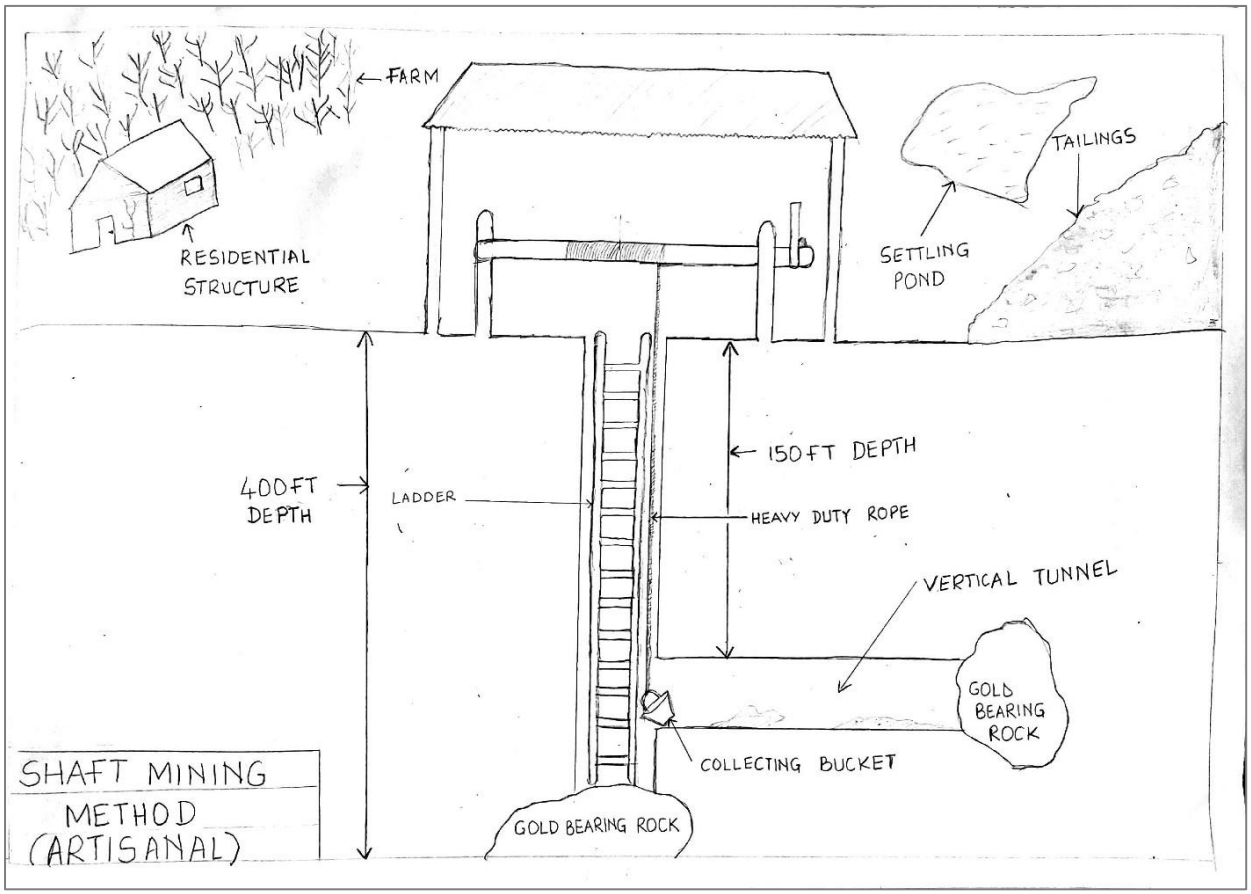


Figure 5- 20: Shaft Mine Layout

However, the Planner confirmed potential growth in the sector as long as; stakeholders were involved in land use planning for artisanal gold mining, policies and regulations were reformed in Kenya and the artisanal miners provided with training and expertise in mineral exploration and extraction process.

Lack of infrastructural development to ease mining activities

About 51.06% disagreed with the statement that ASGM has led to improvement of road infrastructure. Nearly 48.91% agreed that ASGM has contributed to the improvement of the road infrastructure in the Study area. There were underdeveloped roads leading to the mining sites which highlights the needs for the County Government to prioritize road projects within the study area for easement of mining activities.

About 73.69% disagreed with the statement that ASGM has improved accessibility to clean water and electricity. Nearly 26.31% agreed that ASGM has improved accessibility to clean water and electricity in the Study area. Basic utilities are fundamental in all the land uses,

it is therefore a responsibility for Kakamega County to ensure that Ikolomani and Rosterman areas have accessibility to clean water and electricity. This will ease the mining practices in the Study area since mining requires both utilities.

About 71.58% disagreed with the statement that ASGM has led to improvement of healthcare facilities. Nearly 28.42% agreed that ASGM has contributed to the improvement of the healthcare facilities in the Study area. Healthcare facilities are vital in mining areas. Due to the health risks that the miners and the residents neighboring the mining sites are prone to, there is need to develop adequate healthcare facilities to offer medical services to all.

About 64.74% disagreed with the statement that ASGM has led to improvement of educational facilities. Nearly 35.26% agreed that ASGM has contributed to the improvement of the educational facilities in the Study area. Adequacy of educational facilities are very important in improving the educational levels of all residents and even miners. Training facilities for the miners will educate the miners on the skills and technical expertise to use in sustainable mining.

Objective 3 has incorporated both Systems theory and Stakeholder theory. Systems theory deals with an open system made up of the environment around the mines, communities involved in and/or affected by the mining activities, governmental and non-governmental institutions, the business community involved and the planning aspect of gold mining. The systems approach in this study therefore links all the theories mentioned in sub-section 2-9.

Stakeholder theory assesses stakeholders' identities and relationships. The stakeholder theory has been extensively practiced in the private sector with a cumulative adoption of the theory in evaluating the public sector and the government policies. Stakeholder theory in this case is used to enhance our understanding of the stakeholders’ roles, behaviors and perception, and sustainability, from the social, economic and environmental pillar.

5-6 Planning interventions to ensure sustainable Gold Mining and adjacent land uses

To achieve this objective, the public and the private stakeholders of the mining sub-sector were asked to react to several statements intended to describe planning interventions to ensure sustainable gold mining in relation to adjacent land uses. Data on this objective was analyzed under the hypothesis "Planning interventions will ensure sustainable gold mining in relation to adjacent land uses." The household questionnaire responses were summarized using a Likert scale of 1-5 as shown in Table 5-8 and 5-9 below.

The household survey responses were analyzed using a Likert scale of 1-5 as shown below.

Table 5- 8: Likert scale

Value	Response
1	Strongly Agree
2	Agree
3	Neutral
4	Disagree
5	Strongly Disagree

Table 5- 9: Summary of findings

Value	**1**	**2**	**3**	**4**	**5**
Variable					
There is need for greater organization of miners into legally recognized groups	54.21%	43.68%	1.58%	0.53%	-
There is need to improve access to technology for clean gold	57.89%	38.42%	2.11%	1.05%	0.53%

production, including expertise and mechanization					
Access to capital to acquire technical resources can enhance artisanal gold mining	56.32%	38.95%	1.58%	2.63%	0.53%
Formal training of miners in geological exploration, ore reserve estimation, mining and concentration techniques, environmental impact, water reclamation, tailing pond building, revegetation, safety issues, bookkeeping, etc., can improve gold production	59.47%	38.95%	0.53%	1.05%	-
Formalization of mining activities so that miners can obtain legal titles after satisfying the legal requirements for environmental practices can enhance gold production and its benefits	53.16%	40%	3.68%	1.58%	1.58%
There should be a framework for reclaiming degraded agricultural land to improve the potential for alternative livelihoods	47.37%	49.47%	1.58%	1.05%	0.53%
The County Planning Department should develop a spatial plan for Rosterman Mines to minimize cases of land subdivision and land fragmentation.	56.84%	38.95%	1.58%	2.63%	-
The County should improve road infrastructure in the mining areas	50.53%	46.32%	1.04%	1.58%	0.53%

The County should establish a strong environmental audit and monitoring framework for the gold mining sub-sector	56.84%	41.58%	0.53%	1.05%	-
The County should establish a formal market for gold trading to enhance economic outcomes	52.11%	44.21%	-	3.68%	-
The County should increase political and institutional support to miners	50%	45.26%	1.58%	2.11%	1.05%

5-6.1 Formalization strategies of artisanal gold mining

The greatest challenge facing ASGM in the study area was informality of the sub-sector. Approximately 93.16% of the respondents agreed that formalization of ASGM will bring about accountability and a correspond cost benefits. Only a minority (6.84 %) were not in support of the statement. The Export base theory confirms this finding since it aims at improving accountability and efficiency in Kenya's and Kakamega's trading systems through; economic diversification, investment & employment, and trade balance.

The Likert Scale in figure 5-21 shows the level residents agreed to the planning interventions of ASGM on adjacent land uses in Ikolomani and Rosterman (1= Strongly Agree, 2 = Agree, 3 = Neutral, 4 = Disagree and 5 = Strongly Disagree)

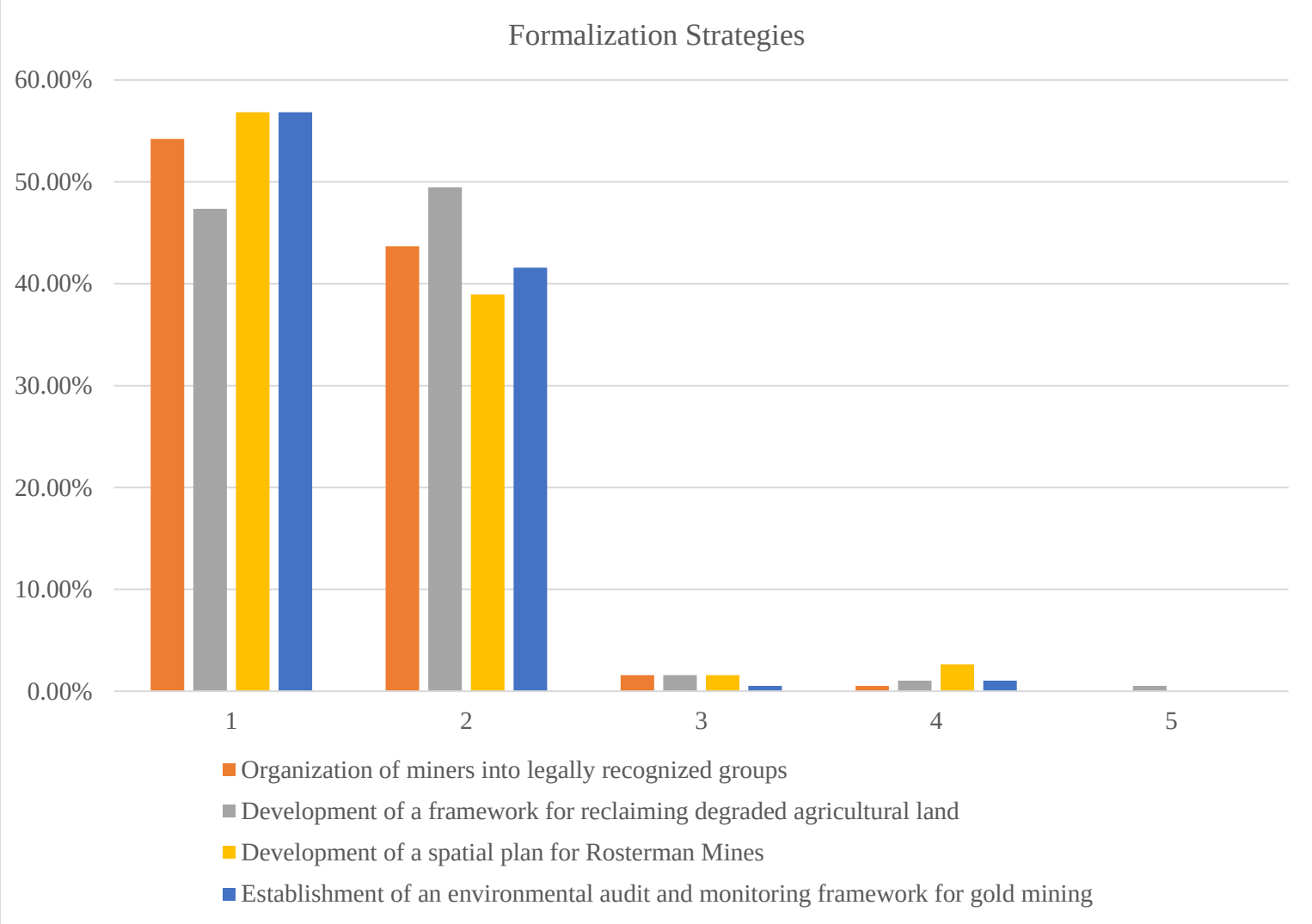


Figure 5- 21: Formalization strategies of artisanal gold mining

Study findings by (Hook, 2019), carried out in Guyana, confirmed that formalization of the gold mining sector assisted in tackling of the institutional gaps, land tenure insecurity, forest degradation and loss of green cover in Guyana.

Policy and Legal reforms

The FGDs responses made propositions for the government to formalize the sector from artisanal mining to small-scale gold mining. Moreover, there was need to develop policy and regulatory reforms at the county level. Additionally, the government should enforce artisanal mining legislation and regulations and establish a formal gold market to exclude brokers

The County Environment Department representative further proposed that the Gold Policy Bill in the National Assembly should be implemented to cover the policy gap in the artisanal gold mining sector.

The County Planner proposed that the government should work towards reforming the mining legislation, policies, and regulations to lay the framework for increasing Rosterman gold mines revenue. Study findings by (Adu-Baffour et al., 2021) in Ghana, proposed a review of the legal and policy frameworks to tackle issues such as tenure insecurity, unlicensed miners and resource misallocation. Furthermore, the studies proposed a collaborative governance system to enable natural resource management and ensure sustainable land use through involvement of all stakeholders in planning and policy making.

Legally recognized Groups and co-operatives

According to 97.89% of the respondents, there was a need for better organization of miners into legally recognized groups and co-operatives so as to empower them with technical and financial resources. Only 2.11% had a different opinion regarding registration of miners' groups. This was confirmed by 95.27% of the respondents who perceived that accessibility to capital and technical resources can enhance artisanal gold mining in the study area.

County Planner confirmed that creating institutions such as registered groups, societies, and saccos to mobilize resources (capital) for the miners to upgrade the mining equipment, better technology, and a formal market.

Land reclamation initiatives

Approximately 96.84% of the respondents proposed a land reclamation framework for the degraded land while only 3.16% disagreed to the development of a Land reclamation framework. Study findings by (Mhlongo & Akintola, 2021) in Limpopo Province in South Africa associated the impacts of gold mining to land degradation and suggested mapping of the mining zones so as to strategically implement land reclamation and rehabilitation of the abandoned and active mining areas. Further Study findings by Mwakesi, et al. (2020) proposed the development of a legal and regulatory framework to enable reclamation of degraded agricultural land.

Development of a Spatial Plan for the Study area

The need to plan for the mining sites is crucial in minimizing the implications of artisanal gold mining on the adjacent land uses. Nearly 95.79% of the respondents proposed the development of a land use plan of the area to address unsustainability of land uses caused by the artisanal gold mining activities. Only 4.21% of the respondents disagreed to the development of a land use plan for the area.

(Maus, et al., 2022) study findings incorporated spatial planning as an intervention to sustainable mining where gold mining areas were among the mining sites mapped worldwide using satellite imagery. This study confirmed the prerequisite for land use planning for the mining sites to ensure sustainable land use.

Additionally, the Mining Department representative proposed creation of a land use plan which will include a processing zone in Rosterman Area. The processing plant will minimize environmental pollution because it will consist of wastewater treatment before releasing it into the atmosphere

The PLUPA (2019) confirms provisions for zoning of mining sites as industrial zones. According to section 46 of the Act, Kakamega County Government should prepare a LPLUDP to spatially categorize all the current land uses within the county.

The Physical Planning Handbook, considers artisanal gold mining to be customary and hence emphasizes on the need of planning for the designated artisanal gold mining zones through land use planning.

Environmental audit and monitoring framework

About 98.42% of the respondents stated that Kakamega County should establish a strong environmental audit and monitoring framework for the gold mining sub-sector to regulate ASGM practices. Only about 1.58%of the respondents were of a different opinion due to reasons only best known by them.

The study findings by (Serwajja & Mukwaya, 2021), recommended a strong environmental audit and monitoring framework to tackle environmental pollution in Karamoja region in Uganda.

The Constitution of Kenya, 2010 in section 60(1) (c) & (e) advocates for sustainable mining while protecting ecologically sensitive areas such as the riparian reserves. In order to

incorporate land use planning, the riparian reserves for Rivers Isiukhu, Mlombole and Koa should be conserved. ASGM activities should be limited to 30Metres from the river sides

The Environmental Management and Co-ordinate Act (Amendment) 2015, mandates Kakamega County Environment Department to enforce sustainable mining through conservation of natural resources, auditing of the value of the mineral resources, protection of ecologically sensitive areas such as riparian reserves through conducting Environmental Impact Assessment.

5-6.2 Capacity-Building Strategies

The Likert Scale in figure 5-22 shows the level residents agreed to the planning interventions of ASGM on adjacent land uses in Ikolomani and Rosterman.

(1= Strongly Agree, 2 = Agree, 3 = Neutral, 4 = Disagree and 5 = Strongly Disagree)

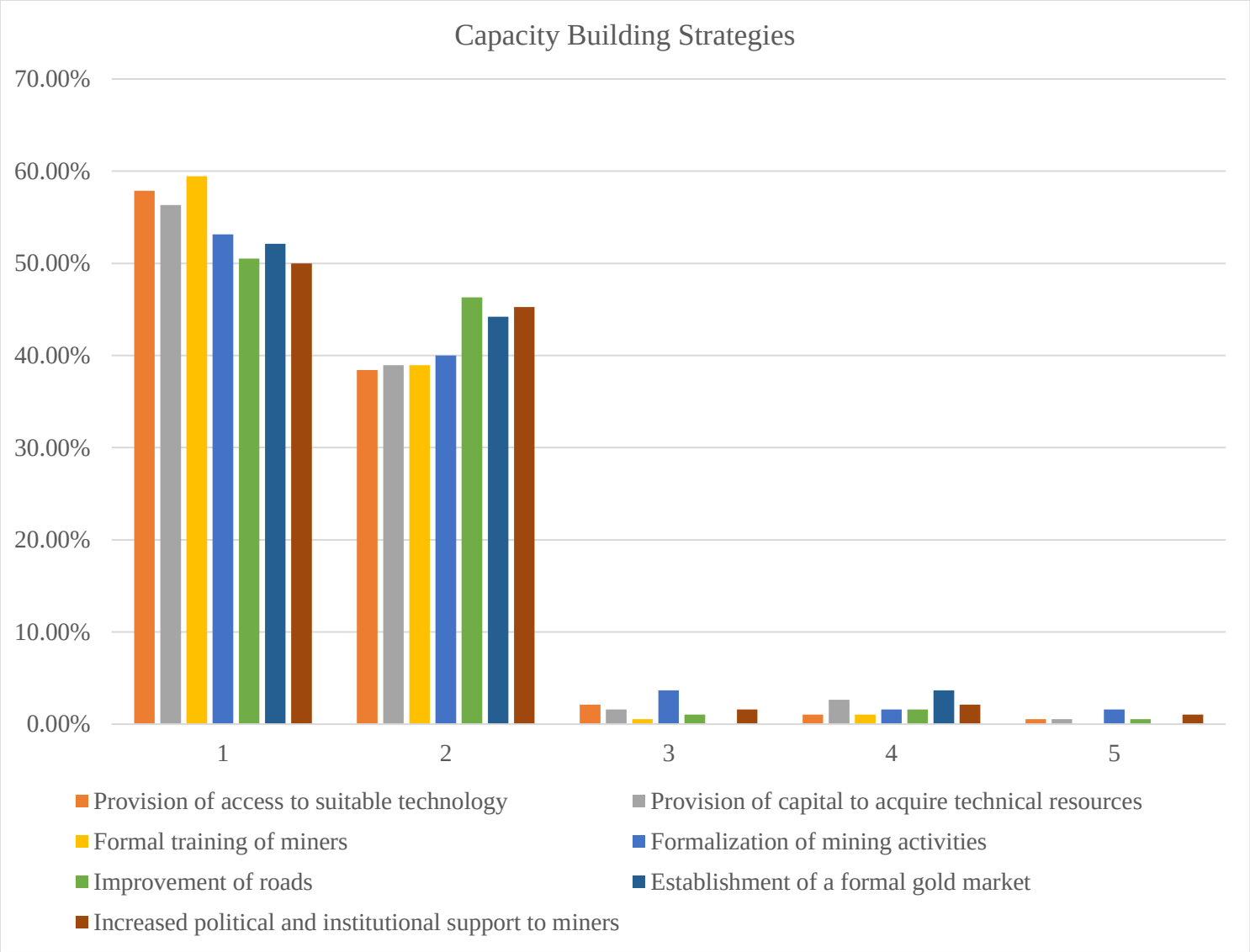


Figure 5- 22: Capacity-Building Strategies

Advancement in gold mining technology

Roughly 96.31% of the respondents agreed that there is a need to improve access to technology for clean gold production, including expertise and mechanization. Only 3.67% dismissed the need of advanced mining technology.

Studies by Mitchell and Palumbo-Roe (2020) in Migori County discovered that the deep gold shafts were unstable and dangerous and there were frequent cases of mine collapse leading to fatalities. The findings proposed the use of advance mining technology to address the rudimentary practices adverse effects.

The FGDs proposed provision of mining machinery and safety equipment such as sub massive water pressure pump, sensor grinder with reduced noise, helmet, aprons, boots, eye guard, nose mask, oxygen machine, jembes, and well-insulated electric cables to promote safety measures and enhance revenue growth.

About 98.42% of the respondents stated that formal training of miners in geological exploration and sustainable mining techniques can improve gold production. The Mining department representative confirmed the urgency of the government to organize training and awareness on the appropriate mining technology, socio-cultural change and emphasize gold as a non-renewable resource to progress ASGM sub-sector.

Developing of Gold Mining Infrastructure

Approximately 96.32% of the respondents agreed with the establishment of a formal gold market within the mining sites. Only 3.68% disagreed to the proposal. The FGDs respondents also confirmed the need for constructing a formal market to standardize the gold prices and to remove brokers from the market who extort the miners.

Political and Institutional support to miners by the Government

The government's input in ASGM as one of the stakeholders in the sub-sector, is very fundamental. This is evidenced by 95.26% of the respondents who stated that Kakamega County government should increase political and institutional support to miners so as to promote revenue growth in the county.

The NEMA County representative proposed initiatives by the government through enforcement of conservation measures, disaster preparedness measures, safety measures, establishment of training centers, establishment of response centers

The FGDs suggested government interventions in development of a water treatment plan for the wastewater discharged from the mines to curb water pollution of the rivers within the Study area. Additionally, the government needed to prioritize development of the road infrastructure in the mining areas in Kakamega County to ease accessibility of all the stakeholders. This would fasten the completion of the ongoing tarmac road construction along the Lurambi-Shinyalu corridor and enable accessibility during the rainy seasons.

The Mining Department representative proposed miners' partnerships with the Government after formalizing the sector. Mining should be devolved so there is enough resource allocation and enforcement of the mining laws.

In summary the key informants suggested that the Government should; create awareness of the safety measures, facilitate capacity building in the mining-related departments (Mining, Environment, NEMA, and Public Health), offer technical assistance to the miners, and establish gold mining training institutions in the current education system.

Conclusively, Objective 4 adopted the Rationale Comprehensive which focused on goal formulation and alternative form of actions while planning for land use. Additionally, this theory synchronizes written text with maps and policy to physical expression spatially.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6-1 INTRODUCTION

This chapter presents the study conclusions as well as the recommendations. All the sub-conclusions and recommendations are related to the four objectives of the study.

6-2 CONCLUSIONS

This study investigated the implications of artisanal gold mining on the adjacent land use and it was intended to find planning interventions to address the problem at hand. In view of the findings in chapter 5, the study concludes that; artisanal gold mining has resulted in land use unsustainability and environmental sustainability in Ikolomani and Rosterman areas.

6-2.1 Determination of the effects of artisanal gold mining on adjacent land uses in the Study area

Artisanal gold mining has resulted in unsustainable land uses. Due to the intrusive nature of the mining activities, there has been direct effects to adjacent land uses causing unproductive farmlands, cracked residential and commercial structures, and destruction of the riparian reserves along Rivers Isiukhu, Mlombole and Koa.

Artisanal gold mining has resulted in environmental unsustainability. The leaching of heavy metals into the environment ecosystem causes water pollution, soil pollution and air pollution. which is very poisonous to humans and other living organisms. Mining activities have also affected forests and other ecologically sensitive areas. Alluvial mining activities have intruded on the riparian reserves in Rivers Isiukhu and Mlombole, dramatically tampered the water ecosystem by introducing harmful heavy metals such as mercury and cyanide. Constructing the shafts has a high timber demand which leads to deforestation of the adjacent forested areas.

Artisanal gold mining has resulted in use of poor mining technology. Some of the mines are unstable due to the low expertise, leading to collapsing, which has adverse health effects on the miners and the residents living adjacent to the mines. The rudimentary methods used have also hindered sustainable mechanized utilization of the gold mines which can enhance revenue growth in Kakamega county.

6-2.2 Factors Contributing to the effects of artisanal gold mining on adjacent land uses

In reference to the Study findings and discussions, the factors contributing to the effects artisanal gold mining include; inadequacies in the implementation of legislation and regulatory framework pertaining gold mining, lack of a Local land use plan in the study area and lack of governmental involvement in ASGM sub-sector.

6-2.3 Roles, behavior, and perceptions of on artisanal gold mining and adjacent land uses

The Stakeholders involved in artisanal gold mining included the; locals, miners, investors/private mining firms, the middlemen, the buyers, and the government. The stakeholders' roles, behavior and perceptions contributed to adverse effects of ASGM on the adjacent land uses.

The Stakeholders need to be made aware of their roles in the sub-sector in terms of land use sustainability, environmental conservation and natural resource management in order to minimize the adverse effects of the sub-sector.

6-2.4 Planning Interventions to ensure sustainable gold mining and its adjoining land uses

The gold mining sub-sector needed to be formalized through Institutional reviews, policy reforms and regulation reforms pertaining gold mining. In addition, Kakamega County Environment Department should; establish a strong environmental audit and monitoring framework, and conduct land rehabilitation programs within gold mining areas. Kakamega County Planning department should zone out the mining sites and develop a county spatial plan covering ASGM. Artisanal miners should be trained on sustainable geological exploration and extraction techniques, and increase political and institutional support to the miners. Development of physical infrastructure to ease mining activities is also fundamental in growing the gold mining sub-sector.

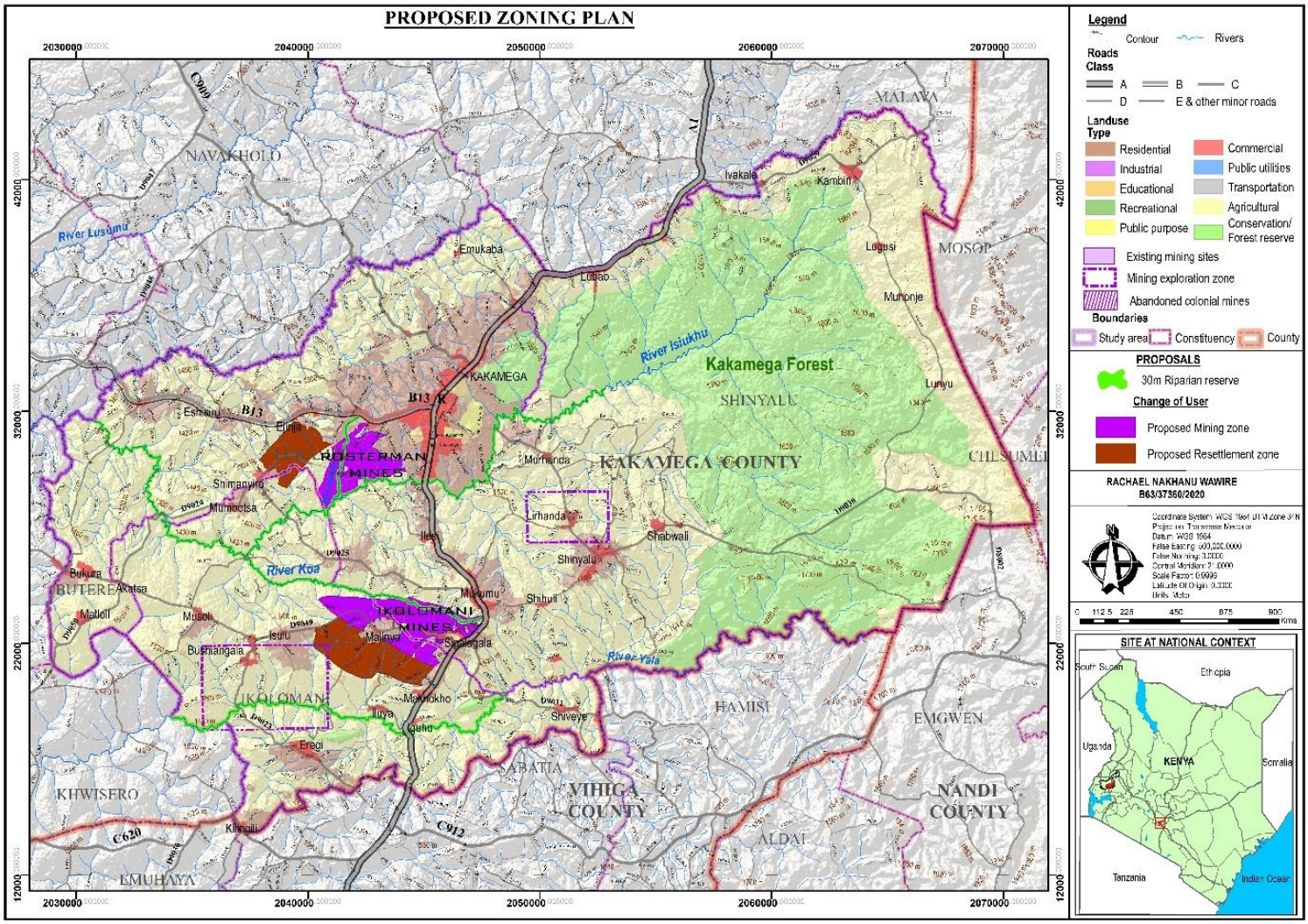
6-3 RECOMMENDATIONS

The researcher has argued in this report that there lacks a link between planning theory, policy, practice and artisanal gold mining. The study has also revealed that, artisanal gold mining has resulted in unsustainable land use and environmental unsustainability. It is against the background that the recommendations below are made. Despite the limitations, the study should be able to link artisanal mining with planning theory, policy and practice. Basing overviews on the conclusions of this study, the researcher recommends the following:

6-3.1 Effects of artisanal gold mining on adjoining land uses in the Rosterman area

Theory Oriented Recommendations

To address the effects of artisanal mining on the adjacent built-up area, the County Planning Department should properly zone the mining areas to avoid overlapping land uses and minimize land conflicts. In a similar study by Polat (2014) in Mali, there were minimized effects in residential areas due to zoning guidelines. Zoning will also prevent the illegal conversion of agricultural land to mining sites. The Zoning plan proposal is adopted from Comprehensive rationale planning which aims at solving the problem of overlapping land uses. Below is a zoning plan for the study area in shown in figure 6-1.



Map 6- 1: Zoning plan of the study area

According to literature review, rift golf mining would be a possible alternative for the rudimentary shaft mining technique as illustrated in the table 6-1 below.

Table 6- 1: Comparison of Gold mining in South Africa and Kenya

COUNTRY	SOUTH AFRICA	KENYA
Mining Method(s)	Combination of conventional drift and bench and low-profile.	Shaft mining (informal)
Technology	Highly advanced and mechanized	Rudimentary
Scale	Large	Small
Depth of pits	Upto12,800 ft	150-400ft
Size of the land	45Km	1-9 acres
Number of workers in a mining site	Approximately 1500	Approximately 400

Policy Oriented Recommendations

On the other hand, noise pollution can be minimized by enforcement of noise regulations by NEMA officials and inspections to confirm miners possess noise permits. The degradation of agricultural land is an effect that the Ministry of Environment can control by conducting land rehabilitation programs. In addition, a tailings disposal strategy should be developed to address the dumped heaps of waste adjacent to the mines. Occupational safety standards on the use of heavy metals in the extraction process should also be enforced while ensuring protective gear use.

Water pollution is an adverse threat to all living organisms within the mining areas; hence, a water treatment plant is needed to treat the waste before releasing it to the neighboring rivers

6-3.2 Factors Contributing to the effects of artisanal gold mining on adjacent land uses

Policy Oriented Recommendations

Environmental pollution can be addressed through the EMCA measures on environmental conservation and natural resource management. On the other hand, noise pollution can be minimized by enforcement of noise regulations by NEMA officials. The degradation of agricultural land can be addressed by the Ministry of Environment through conducting land rehabilitation programs. In addition, a tailings disposal strategy should be developed to address the dumped heaps of waste situated adjacent to the mines. Occupational safety standards on the use of heavy metals in the extraction process should also be enforced through use of protective gear to minimize adverse health effects.

6-3.2 Factors Contributing to the effects of artisanal gold mining on adjacent land uses

Institutional Reforms

The Export Base Theory proposes establishment of strong Institutional and Governance Reforms. This can be done by; establishing registered miners' groups and co-operatives to offer financial assistance to the miners, encouraging partnerships with the Government after formalizing the sector and recruiting adequate expertise on site, such as Geologists, to assist in the exploration and extraction process.

Moreover, the government needs to apportion sufficient resources to the Mining department in Kakamega and finance the Artisanal Mining Committee, which is responsible for issuing artisanal mining licenses in Kakamega County. Politicians perform a significant role in the policy-making and implementation of projects.

Conclusively, the government should; create awareness of the safety measures, facilitate capacity building in the mining-related departments (Mining, Environment, NEMA, and Public Health), offer technical assistance to the miners, and establish gold mining training institutions in the current education system.

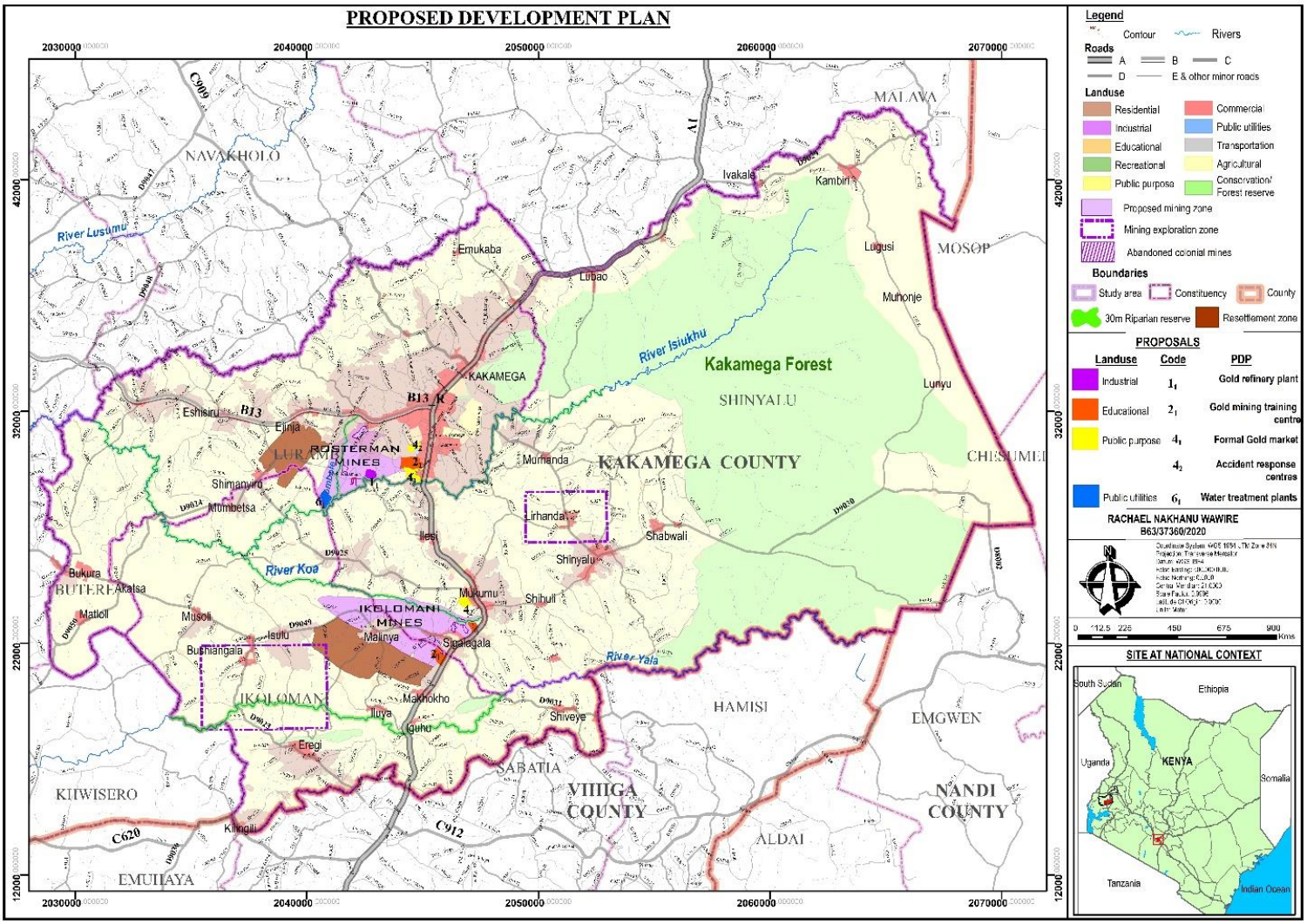
6-3.3 Roles, behavior, and Perceptions of Stakeholders on artisanal gold mining and its adjacent land uses

There should be clearly defined roles for all the various stakeholders involved in artisanal gold mining, including the; locals, miners, investors/private mining firms, the middlemen, the buyers, and the county government departments. Moreover, these roles should be incorporated in the law for accountability purposes. The miners should be trained in clean and advanced mining technology to ensure environmental sustainability. Furthermore, the

Government should allocate sufficient resources to the relevant county and state departments to enable proper inspections and enforcement of the mining laws.

6-3.4 Planning interventions to ensure sustainable gold mining and adjacent land uses

To ensure that mining is conducted in a sustainable manner, the researcher proposed a Local Land Use Development Plan constituting the study area which could in future be implemented by Kakamega County. The plan adopted concepts in Comprehensive rationale planning, the theory of Spatiology and the Export Base theory as shown in map 6-2 below;



Map 6- 2: Proposed Development Plan

Map 6-2 above shows the details of the Proposed Local Development Plan. It entails; establishing a water treatment plant to minimize water pollution, establishment of a gold refinery plants adjacent to the mines, establishment of a formal gold market in Kakamega

County, incorporating conservation measures of ecologically sensitive areas such as riparian reserves and forests, establishment of training centers and establishment of response centers. The social needs are theoretically addressed by spatiology theory as illustrated in the Proposed Development Plan.

Comprehensive rationale planning seeks to solve the study gaps encountered in research. It therefore proposes regulatory reforms including; enforcing of the mining standards and safety measures by limiting use of mercury and cyanide, incorporating conservation measures such as land rehabilitation programs, disaster preparedness measures to handle occupational hazards and development of a Tailings disposal strategy.

6-4 SUGGESTIONS FOR FURTHER RESEARCH

1. The Lirhanda corridor, which extends from Bushiamala, Isulu, and Lirhanda to Ramola in Siaya County, should be researched further as potential gold mining zones. Acacia Company commenced gold exploration in Lirhanda in 2020 with evidence of high-grade gold but recently went silent without many updates.
2. There is room for further studies to determine artisanal gold miners' advancement and legislation needs, which were not tackled in this study.
3. Any gold mining developments should be done in collaboration with geologists and other geological experts.

REFERENCES

A.J. Smyth, J. D. (1993). *An international framework for evaluating sustainable land management.*

A.K. Donkor, J.-C. J. (2006). Mercury in different environmental compartments of the Pra River Basin, Ghana. *Science of The Total Environment*, 76-164.

Aboka, E., Cobbina, S., & Doke, A. (2018). Review of Environmental and Health Impacts of Mining. *Journal of Health Pollution, 17*, 43-52.

Acheampong, T., Ashong, M., & Syanikier, V. (2016). An assessment of local content policies in oil and gas producing countries. *J World Energy Law Bus, 9*, 282-302.

Adu-Baffour, F., Daum, T., & Birner, R. (2021). Governance challenges of small-scale gold mining in Ghana: Insights from a. *Land Use Policy, 102*, 105271.

Alwanga, R., Mulinya, C., & Mabonga , J. (2020). Gold Mining Industry and its Implications on the Environment in Kakamega South Sub-County, Kakamega County, Kenya. *IOSR Journal of Humanities And Social Science, 25*(9), 47-61.

Anukwonke, C. C. (2015). *CONCEPT OF TRAGEDY OF THE COMMONS; ISSUES AND APPLICATIONS.* Uli, Nigeria: Chukwuemeka Odumegwu Ojukwu University.

Appiah, D., & Bauben, J. N. (2012). Is gold mining a bane or a blessing in Sub-Saharan Africa: The Case of Ghanaa. *International Journal of Development and Sustainability, 1*(3), 1033-1048.

Barbier, E. B. (1987). The Concept of Sustainable Economic Development.

Barney, N. (2007-2023). Retrieved from TechTarget: https://www.techtarget.com/searchcio/definition/stakeholder

Barreto, L. (2018). *Economic Contributions of Artisanal and Small-Scale Mining in Kenya: Gold and Gemstones.* UK Department for International Development (DFID).

Cambridge University. (2023). Retrieved from Cambridge University Press & Assessment : https://dictionary.cambridge.org/dictionary/english/intervention

Chepkwony, A. K. (2018). *Environmnetal Radiation Dose Rate in the Gold Mining Region of Lolgorian in Narok County.* Nairobi: The University of Nairobi Repository.

CIESIN. (2015). *What is Sustainable Land Management.* CEISIN. Retrieved from http://www.ciesin.org/lw-kmn/slm/slm.html

Cooper, D. R., & Schindler, P. S. (2006). *Business Research Methods.* New York: McGraw-Hill Irwin.

County Government of Kakamega. (2023, May 24). *Kakamega County Integrated Development Plan, (2023-2027)*. Retrieved August 6, 2023, from Kakamega County Government: https://kakamega.go.ke/download/kakamega-county-integrated-development-plan-2023-2027/#

Creswell, J. W., & Creswell, D. J. (2017). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches.* New York: SAGE Publications.

Encyclopedia Britannica. (2012, August 17). Retrieved from Google: https://www.britannica.com/place/Kakamega

Erling Holden, K. L. (2016). *The Imperatives of Sustainable Development.* Wiley Online Library.

Esteves, A. M., & Moreno, A. (2013). *Local contet initiatives: Enhancing the subnational benefits of the oil, gas and mining sectors.* Briefing July 2013. National Resource Governance Institute.

Fisher, E., Mwaipopo, R., Mutagwaba, W., Nyange, D., & Yaron, G. (2009). The ladder that sends us to wealth: Artisanal mining and poverty reduction in Tanzania. *Resources Policy, 34(1–2)*, 32-38.

Francis Xavier Dery Tuokuu, Stephen Debar Kpinpuo, Hinson Robert Ebo. (2019). Sustainable development in Ghana's gold mines: Clarifying the stakeholder's perspective. *Journal of sustainable mining, 18*(2), 77-84.

Funoh, K. N. (2014). *The impacts of artisanal gold mining on local livelihoods and the environment in the forested areas of Cameroon.* Working Paper 150, Center for International Forestry Research.

Gajigo, O., Mutambatsere, E., & Ndiaye, G. (2012). *Gold mining in Africa: Maximizing economic returns for countries.* Working Paper No 147, African Development Bank Group.

Gajjar, D. N. (2013). Ethical Consideration in Research. *International Journal for Research in Education*, 8-15.

Glauco De Vita, O. L. (2016). Nigerian oil and gas industry local content development: A stakeholder analysis. *Journal of Public Administration and Governance*.

Hilson, G., & Garforth, C. (2012). Agricultural poverty' and the expansion of artisanal mining in Sub-Saharan Africa: Experiences from Southwest Mali and Southeast Ghana. *Population Research and Policy Review 31(3)*, 435-464.

Hilson, G., & Maconachie, R. (2017). Formalizing artisanal and small-scale mining. *Insights. Contestations and Clarifications Area, 49(4)*, 43-51.

Hook, A. (2019). Over-spilling institutions: The political ecology of 'greening' the small-scale gold mining sector in Guyana. *Lan Use Policy, 85*, 438-453.

Institute, E. (2019, September 26). *Target Population differs from an Accessible Population*. Retrieved from Elite institute: http://www.elitemv.com

Jotham, K., & Mulinya, C. (2020). The Impact of Artisanal Surface Gold Mining on Socio-Economic Development of Residents of Rosterman Area, Kakamega County. *IOSR Journal of Humanities and Social Science, 25*(12), 9-16.

Kenya, R. o. (2016). *Minerals Policy Sessional Paper no. 7 of 2016.* Nairobi: Government Printers.

Kenya, T. R. (2010). *Constitution of Kenya* . Nairobi: Government Printers.

Kilkenny, M., & Partridge, M. D. (2009). Export Sectors and Rural Development. *American Journal of Agricultural Economics, 91*(4), 910-929.

Kinyondo, A., & Villanger, E. (2017). Local content requirements in the petroleum sector in Tanzania: A thorny road from inception to implementation? *The Extractive Industries Society, 4*, 371-384.

Kitula, A. (2006). The Environmental and Socio-Economic Impacts of Mining on Local Livelihoods in Tanzania: A Case study of Geita District. *Journal of Cleaner Production*.

Kothari, C. R. (2004). *Research Methodology.* New Delhi: New Age International Publishers.

Lagopoulos, A. P. (2018). Clarifying Theoretical and Applied Land-Use. *Urban Science*, 2-3.

Lélé, S. M. (1991). Sustainable development: A critical review.

Lemma, Y. T. (2022). *Impact of Gold Export on Economic Growth in Ethiopia Using ARDL Approach.* St Mary's University.

Leuenberger, A., Winkler, M. S., Cambaco, O., Cossa, H., Kihwele, F., Lyatuu, I., . . . Munguambe, K. (2021). Health impacts of industrial minining on sorrounding communities: Local perspectives from three sub-Saharan African countries. *PLoS ONE, 16*(6), e0252433.

Manga, J. O. (2016). *Women's labour shift from farming to mining and it's influence on food security within households headed by women miners in Nyatike Sub-County Kenya.* University of Nairobi.

Marcelle, C. (2015). Ethical Consideration in Research. *The Praxis of English Language Teaching and Learning (PELT)*, 55-73.

Marcello M. Veiga, P. A. (2006). Origin and consumption of mercury in small-scale gold mining. *Journal of Cleaner Production*, 436-447.

Marvasti, A. (2000). Resource Characteristics, Extraction Costs, and Optimal Exploitation of Mineral Resources. *Environmental and Resource Economics, 17*, 395-408.

Maureen, K., & Mark, D. P. (2009). Export Sectors and Rural Development. *American Journal of Agricultural Economics*, 910-929.

Maus, V., StefanGiljum, Silva, D. M., JakobGutschlhofer, Rosa, R. P., 1, S. L., . . . &, M. L. (2022, July 22). An update on global mining land use. *Sci Data*, 433. Retrieved from Scientific Data.

Mhlongo, S. E., & Akintola, G. O. (2021). Artisanal and small-scale mining activities as post-mining land use in. *Journal of Degraded and Mining Lands Management, 8*(2339-076X), 2502-2458.

Mining and Minerals Policy Sessional Paper No. 7. (2016). Retrieved from MINISTRY OF PETROLEUM AND MINING.

Ministry of Lands. (2018). *County Spatial Planning Guidelines: Towards Sustainable Development and County Effectiveness.* Ministry of Lands and Physical Planning & Council of Governors.

Miriam, B. (2014). *Certifying improvement, improving certification: An analysis based on the artisanal and small-scale mining sector.* Working Paper Sustainability and Innovation, No. S9/2014, Fraunhofer-Institut für System- und Innovationsforschung ISI, Karlsruhe.

Mitchell, C. J., & Palumbo-Roe, B. (2020). *Artisanal & Small-scale Gold Mining research field work, Migori County, Kenya.* British Geological Society.

Mkodzongi, G., & Spiegel, S. (2018). Artisanal Gold Mining and Farming: Livelihood Linkages and Labour Dynamics after Land Reforms in Zimbabwe. *Journal of Development Studies*, 1-17.

Mugenda, O., & Mugenda, A. (2008). *Research Methods: Quantitative and Qualitative Approaches.* Nairobi: ACT Press.

Muigua, K. (2019). *Regulating Mining: A New Vision for Kenya?* Nairobi: Kariuki Muigua & Co Advocates.

Mutemeri, N., Walker, J., Coulson, N., & Watson, I. (2016). Capacity building for self-regulation of the Artisanal and Small-Scale Mining sector: A policy paradigm shift aligned with development outcomes and a pro-poor approach. *Extractive Industries and Society*, 653-658.

Mutono, N. R. (2016). *Environmental and Health Problems Associated with Artisanal Mining in Kenya: A Case Study of Macalder Mines in Migori.* University of Nairobi.

Mwakesi, I., Wahome, R., & Ichang'i, D. (2020). Mining impact on communities' livelihoods: A case of Taita Taveta County, Kenya. *AIMS Environmental Science, 7*(3), 286-301.

Mwango, O. K. (2013). *Impact of Open Pit Artisanal Gold Mining: A Case of Rongo County.* Kenyatta University.

Nguyen, N., Boruff, B., & Tonts, M. (2018). Fool's Gold: Understanding Social, Economic and Environmental Impacts from Gold Mining in Quanag Nam Province, Vietnam. *Sustainability, 10*(1355), 1-22.

Persaud, A. W., Telmer, K., Costa, M., & Moore, M. (2017). Artisanal and small-scale gold mining in Senegal: Livelihoods, custom authority and formalization. *Society & Natural Resources, 30(8)*, 980-993.

Peter Motavalli, K. N. (2015). Global achievements in sustainable land management. 1-10.
PlanetGold. (2021). *Supporting the adoption of mercury-free technologies for a safer environment and better livelihoods* . PlanetGold. Retrieved from https://www.planetgold.org/kenya
Polat, B., Aktakke, N., Aran, M., Dabalen, A., Chuhan-Pole, P., & Sanoh, A. (2014). *Socioeconomic Impact of Mining Activity: Effects of Gold Mining on Local Communities in Tanzania and Mali.* Development Analytics Research Paper Series.
Santander Universidades. (2022, April 6). *Santander Scholarships*. Retrieved from Santander: https://www.becas-santander.com/en/blog/what-is-sustainability.html
Schoneveld, G., Chacha, M., Njau, M., Weng, X., & Jonsson, J. (2017). Upgrading Tanzania's artisanal and small scale mining through investor partnerships: Opportunities and challenges. *CIFOR Infobrieves, 201*, 1-6.
Serwajja, E., & Mukwaya, P. I. (2021). Environmental, health and safety intricacies of artisanal mining in the gold rich landscapes of Karamoja, north-eastern Uganda. *Journal of Sustainable Mining, 20*(2).
Shrestha, N. (2021). Factor Analysis as a tool for Survey Analysis. *American Journal ofApplied Mathematics and Statistics*, 11.
Signé, L. (2021). *Africa's Mining Potential: Trends, Opportunities, Challenges and Strategies.* Rabat, Morocco.: Policy Center for the New South.
Smyth, A. J., & Dumanski, J. (FESLM: An international framework for evaluating sustainable land management. A discussion paper.). *2013.* World Soil Resources Report 73. Food & Agriculture Organization, Rome, Italy.
Statistics, K. N. (2019). *2019 Kenya Population and Housing Census: Volume II* .
Steinø, N. (2018). *Urban Design and Planning: One Object - Two Theoretical Realms.* SINTEF Academic Press.
Sustainable Mining. (2020). Retrieved from Pan African Resources: https://www.panafricanresources.com/sustainable-mining/
The Constitution of Kenya. (2010). Retrieved from The Kenya Gazette.
(2015). *The Environmental Management and Co-ordinate Act (Amendment) 2015.* Nairobi: Government Printers.
The Mining Act No. 12 . (2016, May 13). Retrieved from Kenya Gazette.
The Republic of Kenya. (2017). *National Action Plan for Artisanal and Small-scale Gold Mining in Kenya.* Nairobi: Government Printers.
The Republic of Kenya. (2019). *The Physical and Land Use Planning Act 2019.* Nairobi: Government Printers.
The Republic of Kenya. (2022). *The Physical Planning Handbook.* Nairobi: Government Printers.
Thomas, D. (2011). The Importance of Development Plans/Land Use Policy for Development Control. *Prepared for the USAID/OAS Post-Georges Disaster Mitigation Project, Workshop for Building Inspectors, January 15 - 26, 2011*. OAS/USAID. Retrieved from http://www.oas.org/pgdm/document/bitc/papers/dthomas.htm
University in Wageningen, Netherlands. (2023, March 1). *Sustainable Land Use*. Retrieved from Wageningen University and Research: https://www.wur.nl/en/research-results/research-institutes/environmental-research/programmes/sustainable-land-use.htm
WCED. (1987). *Report of the World Commission on Environment and Development.*
WCED, W. C. (1987). *Report of the World Commission on Environment and Development.*
Weng, E. L., Levang, P., Margules, C. R., & Sayer, J. A. (2015). Asian investment at artisanal and small-scale mines in rural Cameroon. *The extractive Industries and Society 2(1)*, 64-72.

World Bank. (2019). *Mining Together: Large-Scale Mining Meets Artisanal Mining - A Guide to Action.* World Bank.

APPENDICES

1. Household Questionnaire

HOUSEHOLD QUESTIONNAIRE

PERSONAL INFORMATION

1.	What is your name?	_____				
2.	What is your age?	_____				
3.	What is your gender?	Male [ ]	Female [ ]			
4.	What is your marital status?	Single [ ]	Married [ ]	Divorced [ ]	Separated [ ]	Others [ ]
5.	If others, kindly state	_____				
6.	What is your highest level of education?	No formal education [ ]	Primary school [ ]	Secondary school [ ]	College education [ ]	University education [ ]
7.	What is the number of people in your household?	_____				
8.	How long have you been involved in gold mining activities in this area?	Never [ ]	Less than 5years [ ]	6-10 years [ ]	More than 10 years [ ]	
9.	Are there any other alternative livelihoods available to you beside mining?	Yes [ ]	No [ ]			
	If yes, name them_____					

10. Do you acquire any income from gold mining — Yes [ ] No [ ]

11. If yes to 8, what is your monthly gold income? _____

OBJECTIVE 1: TO ASSESS THE EFFECTS OF ARTISANAL GOLD MINING ON ADJACENT LAND USES IN ROSTERMAN AREA

1. To what level do you agree with the following statements on the effects of artisanal gold Mining on adjacent land uses in Rosterman and Ikolomani Areas?

Statements	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
a) Artisanal gold mining activities have contributed to land degradation					
b) Artisanal gold mining activities have contributed to the unproductivity of farmlands					
c) Artisanal gold mining activities have contributed to occurrence to soil erosion on adjacent land uses					
d) Artisanal gold mining activities have contributed to increased land subdivision in the area					
e) Artisanal gold mining activities have contributed to increased land fragmentation in the area					
f) Artisanal gold mining activities have led to increased heaps of waste in Rosterman dumpsite					
g) Artisanal gold mining activities have contributed to the pollution of River Isiukhu caused by amalgamation while extracting gold					

h) Artisanal gold mining activities have contributed to soil pollution causing soil degradation					
i) Artisanal gold mining activities have contributed to air pollution through roasting of mercury during gold extraction					
j) Artisanal gold mining activities have contributed to noise pollution in adjacent residential areas					

OBJECTIVE 2: FACTORS THAT HAVE CONTRIBUTED TO THE EFFECTS OF ASGM ON ADJACENT LAND USES

To what level do you agree with the following statements on the challenges facing artisanal gold mining at Rosterman and Ikolomani mines?

Statements	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
a) Miners are not organized into groups that are registered and legally recognized.					
b) Miners do not have access to appropriate technology for clean production of gold					
c) Miners do not have access to formal funding sources to support their mining activities					
d) Miners lack formal training in geological exploration, ore reserve estimation, mining and concentration techniques, water reclamation, and safety issues among others					
e) There are no clear procedures for obtaining					

legal permits for mining activities					
f) There are inadequate social amenities, such as healthcare services in Rosterman and Ikolomani areas					
g) Mining activities have degraded agricultural land and destroyed alternative livelihoods					
h) There is poor road infrastructure in Rosterman and Ikolomani areas					
i) There is a weak environmental audit and monitoring framework in Kakamega County					
j) Miners do not have access to a formal market for gold trading					
k) Politics has a negative impact on artisanal gold mining in Rosterman and Ikolomani areas					
l) There are no institutional or legal frameworks guiding gold mining in Rosterman and Ikolomani areas					
m) There is no financial or technical support offered to miners by the County government					

OBJECTIVE 3: TO EVALUATE THE ROLES, BEHAVIOUR AND PERCEPTIONS OF PUBLIC AND PRIVATE STAKEHOLDERS IN RELATION TO ASGM AND ADJACENT LAND USES IN ROSTERMAN AREA

To what level do you agree with the following statements on the implications of artisanal gold mining at Rosterman and Ikolomani gold mines?

Statements	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
a) Artisanal gold mining provides employment to a majority of residents					
b) Artisanal gold mining has increased the incomes of residents					
c) All miners are licensed					
d) Artisanal gold mining has improved the living standards of the miners and the villagers in this area					
e) The Government ensures that gold mining is conducted according to the mining legal frameworks					
f) Artisanal gold mining has improved the road infrastructure in the area					
g) Artisanal gold mining has increased access to clean water and electricity to residents					
h) Artisanal gold mining has increased access to educational facilities for residents in the area					
i) Artisanal gold mining has increased access to healthcare facilities in the area					
j) Artisanal gold mining has led to the construction of markets in the area					
k) Artisanal gold mining has caused degradation of adjacent agricultural land					

l) Artisanal gold mining has worsened soil and water pollution in the area					
m) Artisanal gold mining has worsened air pollution in the area					

OBJECTIVE 4: PLANNING INTERVENTIONS/STRATEGIES THAT CAN BE EMPLOYED TO ENSURE SUSTAINABLE GOLD MINING IN RELATION TO ADJACENT LAND USES

To what level do you agree with the following statements on planning interventions for improving artisanal gold mining at Rosterman and Ikolomani gold mines?

Statements	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
a) There is need for greater organization of miners into legally recognized groups					
b) There is need to improve access to technology for clean gold production, including expertise and mechanization					
c) Access to capital to acquire technical resources can enhance artisanal gold mining					
d) Formal training of miners in geological exploration, and sustainable mining practices can improve gold production					
e) Formalization of mining activities so that miners can obtain legal titles after satisfying the legal requirements for environmental practices can enhance gold production and its benefits					
f) There should be a framework for reclaiming					

degraded agricultural land to improve the potential for alternative livelihoods					
g) The County Planning Department should develop a spatial plan for Rosterman Mines to minimize cases of land subdivision and land fragmentation.					
h) The County should improve road infrastructure in the mining areas					
i) The County should establish a strong environmental audit and monitoring framework for the gold mining sub-sector					
j) The County should establish a formal market for gold trading to enhance economic outcomes					
k) The County should increase political and institutional support to miners					

2. Key Informant Guide- County Physical Planner

INTERVIEW WITH COUNTY PLANNER

SECTION 1: PERSONAL INFORMATION

i. Name of the Respondent
ii. Respondent's Telephone number
iii. Occupation of the Respondent
iv. Residence
v. How long have you lived in this Sub- County?
vi. How long have you worked in Kakamega County?

Objective 1: To assess the effects of artisanal gold mining on adjacent land uses in Rosterman and Ikolomani Area

1. How has ASGM affected the adjacent Agricultural land?
2. How has ASGM contributed to the productivity of adjacent Built-up area?
3. What role has ASGM played in matters such as increased land subdivision and land fragmentation?
4. In your opinion, does the waste generated from the mines lead to environmental pollution in the adjacent areas?
5. In this jurisdiction, are there laws that have been created to monitor and control mining activities?
6. Do you have any information if residents have experienced health problems associated with gold mining in this area?

Objective 2: To examine the factors that have contributed to the effects of ASGM on adjacent land uses

7. Is there any existing County Legal Framework on ASGM in Kakamega County?
8. In your opinion, do you think Kenya has weak regulatory and legal reforms in terms of gold mining?
9. If yes to 8, will this help with accountability in the gold mining sector?
10. What are the social factors that have contributed to the effects of ASGM on the adjacent land uses?
11. What are the economic factors that have contributed to the effects of ASGM on the adjacent land uses?
12. What are the political factors that have contributed to the effects of ASGM on the adjacent land uses? (Institutions and Governance)
13. What are the ecological factors …….

Objective 3: To evaluate the roles, behavior, and perceptions of public and private stakeholders concerning ASGM and adjacent land uses in Rosterman and Ikolomani area

14. What is your perception of ASGM in Rosterman and Ikolomani Area? (When it comes to extraction process and gold revenue collected)
15. In your opinion, do you feel like there is potential growth of mining sector while complementing other land uses? (Agricultural Use and Residential use)
16. Is there need for the government to come up with policy reforms covering ASGM in Kenya?

Objective 4: To propose planning interventions/strategies that can be employed to ensure sustainable gold mining concerning adjacent land uses

17. Do you think that reforming the mining legislation and regulations can lay framework for increasing Rosterman mines' and Ikolomani mines' gold revenue?
18. Can formalization of the ASGM increase productivity output of gold in Rosterman and Ikolomani Area?
19. Do you feel like the government should develop policy reforms covering Artisanal gold mining in Kenya?
20. In your view, what else can the government do for the gold mining sector to promote revenue growth?
21. Are there any existent spatial plans in the County Planning Department of the Rosterman and Ikolomani mines? (If yes, request for them)
22. As a Planner, what planning interventions would you propose to ensure sustainable gold mining in Kakamega to minimize any impacts on the adjacent land uses?

3. Key Informant Guide- Mining Officer Kakamega

INTERVIEW WITH MINING DEPARTMENT REPRESENTATIVE

SECTION 1: PERSONAL INFORMATION

vii. Name of the Respondent

viii. Respondent's Telephone number

ix. Occupation of the Respondent

x. Residence

xi. How long have you lived in this Sub- County?

xii. How long have you worked in Kakamega County?

Objective 1: To assess the effects of artisanal gold mining on adjacent land uses in Rosterman and Ikolomani Area

1. In your opinion, has ASGM affected the adjacent Agricultural land?
2. In your opinion, has ASGM affected the adjacent Built-up area?
3. What role has ASGM played in matters such as increased land subdivision and land fragmentation?
4. In your opinion, does the waste generated from the mines lead to environmental pollution in the adjacent areas?
5. In this jurisdiction, are there laws that have been created to monitor and control mining activities?
6. Do you have any information if residents have experienced health problems associated with gold mining in this area?

Objective 2: To examine the factors that have contributed to the effects of ASGM on adjacent land uses

7. Is there any existing County Legal Framework on ASGM in Kakamega County?
8. In your opinion, do you think Kenya has weak regulatory and legal reforms in terms of gold mining?
9. If yes to, will this help with accountability in the gold mining sector?
10. What are the social factors that have contributed to the effects of ASGM on the adjacent land uses?
11. What are the economic factors that have contributed to the effects of ASGM on the adjacent land uses?
12. What are the political factors that have contributed to the effects of ASGM on the adjacent land uses? (Institutions and Governance)
13. What are the ecological factors that have contributed to the effects of ASGM on the adjacent land uses?

14. Are there any land Rehabilitation programs for the abandoned mines? (If yes list them. If no give reasons why there aren't any)

Objective 3: To evaluate the roles, behavior, and perceptions of public and private stakeholders concerning ASGM and adjacent land uses in Rosterman area

15. What is your perception of ASGM in Rosterman and Ikolomani Area? (When it comes to extraction process and gold revenue collected)
16. In your opinion, do you feel like there is potential growth of mining sector while complementing other land uses? (Agricultural Use and Residential use)
17. Is there need for the government to come up with policy reforms covering ASGM in Kenya?

Objective 4: To propose planning interventions/strategies that can be employed to ensure sustainable gold mining concerning adjacent land uses

18. What should be done at the legislative and regulatory level to maximize the potential of gold mining and its associated socio-economic benefits in this area?
19. What propositions can you offer to others working to formalize and improve the artisanal and small-scale mining sector in other areas?
20. Can formalization of the ASGM increase productivity output of gold in Rosterman Area?
21. Do you feel like the government should come up with policy reforms covering Artisanal gold mining in Kenya?
22. In your view, what else can the government do for the gold mining sector to promote revenue growth?
23. Are there any existent spatial plans in the County Planning Department of the Rosterman and Ikolomani mines? (If yes, request for them)
24. As a Government Official, what planning interventions would you propose to ensure sustainable gold mining in Kakamega to minimize any impacts on the adjacent land uses?

4. Key Informant Guide- County Environment Officer

INTERVIEW WITH A REPRESENTATIVE FROM THE MINISTRY OF ENVIRONMENT, WATER, NATURAL RESOURCES AND CLIMATE CHANGE

SECTION 1: PERSONAL INFORMATION

xiii. Name of the Respondent
xiv. Respondent's Telephone number
xv. Occupation of the Respondent
xvi. Residence
xvii. How long have you lived in this Sub- County?
xviii. How long have you worked in Kakamega County?

Objective 1: To assess the effects of artisanal gold mining on adjacent land uses in Rosterman and Ikolomani Area

1. In your opinion, has ASGM affected the adjacent Agricultural land?
2. In your opinion, has ASGM affected the adjacent Built-up area?
3. What role has ASGM played in matters such as increased land subdivision and land fragmentation?
4. In your opinion, does the waste generated from the mines lead to environmental pollution in the adjacent areas?
5. In this jurisdiction, are there laws that have been created to monitor and control mining activities?
6. Do you have any information if residents have experienced health problems associated with gold mining in this area?

Objective 2: To examine the factors that have contributed to the effects of ASGM on adjacent land uses

7. Is there any existing County Legal Framework on ASGM in Kakamega County?
8. In your opinion, do you think Kenya has weak regulatory and legal reforms in terms of gold mining?
9. If yes to, will this help with accountability in the gold mining sector?

10. What are the social factors that have contributed to the effects of ASGM on the adjacent land uses?
11. What are the economic factors that have contributed to the effects of ASGM on the adjacent land uses?
12. What are the political factors that have contributed to the effects of ASGM on the adjacent land uses? (Institutions and Governance)
13. What are the ecological factors that have contributed to the effects of ASGM on the adjacent land uses?
14. Are there any land Rehabilitation programs for the abandoned mines? (If yes list them. If no give reasons why there aren't any)

Objective 3: To evaluate the roles, behavior, and perceptions of public and private stakeholders concerning ASGM and adjacent land uses in Rosterman area

15. What is your perception of ASGM in Rosterman and Ikolomani Area? (When it comes to extraction process and gold revenue collected)
16. In your opinion, do you feel like there is potential growth of mining sector while complementing other land uses?
17. Is there need for the government to come up with policy reforms covering ASGM in Kenya?

Objective 4: To propose planning interventions/strategies that can be employed to ensure sustainable gold mining concerning adjacent land uses

18. What should be done at the legislative and regulatory level to maximize the potential of gold mining and its associated socio-economic benefits in this area?
19. What propositions can you offer to others aiming to formalize and advance artisanal and small-scale mining sub-sector in other areas?
20. Can formalization of the ASGM increase productivity output of gold in Rosterman and Ikolomani Area?
21. Do you feel like the government should come up with policy reforms covering Artisanal gold mining in Kenya?

22. In your view, what else can the government do for the gold mining sector to promote revenue growth?
23. Are there any existent spatial plans in the County Planning Department of the Rosterman and Ikolomani mines? (If yes, request for them)
24. As a Government Official, what planning interventions would you propose to ensure sustainable gold mining in Kakamega to minimize any impacts on the adjacent land uses?

5. Key Informant Guide- NEMA Officer Kakamega County

INTERVIEW WITH KAKAMEGA COUNTY NEMA DEPARTMENT REPRESENTATIVE

SECTION 1: PERSONAL INFORMATION

1. Name of the Respondent
2. Respondent's Telephone number
3. Occupation of the Respondent
4. Residence
5. How long have you lived in this Sub- County?
6. How long have you worked in Kakamega County?

Objective 1: To assess the effects of artisanal gold mining on adjacent land uses in Rosterman and Ikolomani Area

1. In your opinion, has ASGM affected the adjacent Agricultural land?
2. In your opinion, has ASGM affected the adjacent Built-up area?
3. What role has ASGM played in matters such as increased land subdivision and land fragmentation?
4. In your opinion, does the waste generated from the mines lead to environmental pollution in the adjacent areas?
5. In this jurisdiction, are there laws that have been created to monitor and control mining activities?
6. Do you have any information if residents have experienced health problems associated with gold mining in this area?

Objective 2: To examine the factors that have contributed to the effects of ASGM on adjacent land uses

7. Is there any existing County Legal Framework on ASGM in Kakamega County?
8. In your opinion, do you think Kenya has weak regulatory and legal reforms in terms of gold mining?
9. If yes to, will this help with accountability in the gold mining sector?
10. What are the social factors that have contributed to the effects of ASGM on the adjacent land uses?
11. What are the economic factors that have contributed to the effects of ASGM on the adjacent land uses?
12. What are the political factors that have contributed to the effects of ASGM on the adjacent land uses? (Institutions and Governance)
13. Has NEMA developed audits of gold mining concessions (rights) in this area?
14. Does NEMA routinely carry out environmental audits, particularly on monitoring of the quality of water resources in the mining zones?
15. Are there any land Rehabilitation programs for the abandoned mines? (If yes list them. If no give reasons why there aren't any)
16. Does NEMA have enough resources to effectively enforce mining regulations?

Objective 3: To evaluate the roles, behavior, and perceptions of public and private stakeholders concerning ASGM and adjacent land uses in Rosterman area

17. What is your perception of ASGM in Rosterman and Ikolomani Area? (When it comes to extraction process and gold revenue collected)
18. In your opinion, do you feel like there is potential growth of mining sector while complementing other land uses? (Agricultural Use and Residential use)
19. Is there need for the government to come up with policy reforms covering ASGM in Kenya?

Objective 4: To propose planning interventions/strategies that can be employed to ensure sustainable gold mining concerning adjacent land uses

20. What should be done at the legislative and regulatory level to maximize the potential of gold mining and its associated socio-economic benefits in this area?
21. What propositions can you offer others working to formalize and advance the artisanal and small-scale mining sub-sector in other areas?
22. Can formalization of the ASGM increase productivity output of gold in Rosterman and Ikolomani Area?
23. Do you feel like the government should come up with policy reforms covering Artisanal gold mining in Kenya?
24. In your view, what else can the government do for the gold mining sector to promote revenue growth?
25. Are there any existent spatial plans in the County Planning Department of the Rosterman and Ikolomani mines? (If yes, request for them)
26. As a Government Official, what planning interventions would you propose to ensure sustainable gold mining in Kakamega to minimize any impacts on the adjacent land uses?

6. Focus Group Discussion

FOCUS GROUP DISCUSSION GUIDES (MINERS)

1) Is the land occupied by the mines mainly leasehold or freehold?
2) What is your perception of ASGM in Rosterman and Ikolomani Area?
3) What mining methods do you use to extract gold?
4) Are you licensed gold miners?
5) What is your average income per year?
6) Do you have a formal market for trading gold?
7) How do you transport the gold from the mines to the market?

8) In your opinion has ASGM affected Residents living adjacent to the mines?

9) Has ASGM affected the neighboring farmlands?

10) Has ASGM affected the commercial activities neighboring the mines?

11) What are the factors that have led to the impacts mentioned in 6,7 & 8 above?

12) Is there any existing County Legal Framework on ASGM in Kakamega County?

13) Has the absence of adequate legislation affected the rights and security of the miners?

14) Has there been any land conflicts over access to land and land use caused by the mining activities in Rosterman and Ikolomani area?

15) Are there any governance structures and institutions to solve any land disputes in Rosterman and Ikolomani area?

16) In your opinion, do you think Kenya has weak regulatory and legal reforms in terms of gold mining?

17) Does the government offer any technical assistance to the miners?

18) Is there need for the government to come up with policy reforms covering ASGM IN Kenya?

19) If yes to 14 above, will this help with accountability in the gold mining sector?

20) Do you think that reforming the mining legislation can lay framework for increasing Rosterman mines' and Ikolomani mines' gold revenue?

21) Are there fair-trade practices in the ASGM sector in Kakamega County and in Kenya?

22) Can formalization of the ASGM increase productivity output of gold in Rosterman and Ikolomani Area?

23) Should the Government formalize education initiative in the gold mining sector?

24) Generally, what are the challenges facing ASGM in Rosterman and Ikolomani mines?

25) What are the opportunities for gold mining in Rosterman and Ikolomani?

26) Propose any planning interventions that can develop the gold mining sector