SAND HARVESTING AND LIVELIHOOD SECURITY IN WEST POKOT COUNTY, KENYA

BY

MILKAH PSIWA

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DECLARATION

Declaration by the Candidate

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Milkah Psiwa

SHRD/PHDD/06/15

Declaration by the Supervisors

This thesis has been submitted for examination with our approval as university supervisors

Signature …… **Date ……**

Prof. Leonard Simiyu Mulongo

Department of Geography and Environmental Studies

School of Arts and Social Sciences

Moi University

Signature …… **Date ……**

Prof. Alice Kurgat

Department of History, Political Science and Public Administration

School of Arts and Social Sciences

Moi University

DEDICATION

This thesis is specially dedicated to my late father, Mr. Thomas Psiwa Zakayo. You Loved education so much and inspired me to the extent that I have reached the appex of my education pursuit. Though you are not here to witness my graduation, your spirit will remain forever my pillar in pursuit for more knowledge.

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ABSTRACT

Despite the abundance availability of sand and the enormous harvesting activities of the sand in West Pokot County, the activities have not translated into meaningful socio-economic returns to support livelihood and development in the study area. From the literature, there are few comprehensive studies on the implications of sand harvesting on livelihood s, especially in the study area. The purpose of this study was to fill this knowledge gap by providing empirical evidence on how sand harvesting is affecting livelihood security in the study area. The main objective of the study was to examine the effects of sand harvesting on sustainability of peoples' livelihoods in West Pokot County. Specifically, to analyze the social implications of sand harvesting on livelihood security, to assess the economic implications of sand harvesting on livelihood security, and to evaluate the environmental implications of sand harvesting on livelihood security. The study was guided by the DFID sustainable livelihood framework, which explains constraints and dynamics of rural institutions in providing an enabling environment for sustainable livelihoods. A pragmatic philosophy addressing a practical issue in the society was employed. A descriptive survey design that blends quantitative and qualitative data to provide relevant and accurate information about phenomena in terms of its conditions, practices, processes or relationships guided the study. A total of 9995 households were targeted. Using Krejcie & Morgan table, a total of 368 participants were engaged in the study. Simple random, systematic and purposive sampling techniques were employed. Instruments of data collection were open and closed-ended questionnaire, key informant interviews, focused group discussions and direct observation. Quantitative data was analyzed by both descriptive and inferential statistics-Chi Square and Pearson Cramers's V coefficient, while the qualitative data was thematically analyzed. It was found that there was low collective bargaining power for sand prices. Sand harvesting contributed to school dropout 109(30.6%), increased school absenteeism at 241(67.7%), drug abuse among the youth 208(58.4%), upsurge of criminal activities 120 (33.7%), promiscuity, prostitution and early marriages 173(48.6%), increased incidences of alcoholism 240(67.4%), increased domestic violence 180(50.5%) and family breakdown 147(41.3%). The economic implications showed sand harvesting as a source of employment 325(91.3%), low product price 295(82.6%), creates market for other goods and services 264(74.1%), and the R^2 value for the structural model was .404 implying that 40.4 % of the variance in livelihood security is explained by economic factors. Environmentally, land for farming has reduced 145(40.7%), increased dust pollution (207(57%), increased erosion 308(86.6%), induced water scarcity 289(81.1%), and the structural model R^2 value was .570 implying that 57 % of the variance in livelihood is explained by environmental factors. With all the factors statistically significant ($p= 0.004, 0.000, 0.000$ respectively at $p<0.05$), there was a significant relationship between economic implications of sand harvesting and livelihood security. The county government was yet to reap the benefits of sand harvesting in West Pokot. The study concluded that sand harvesting had both positive and negative attributes towards livelihoods in the study area. The study recommends integration of environmental aspects in utilization of resources in order to minimize on the emerging environmental hazards observed. It advocates for formulation of appropriate policies by both national and county governments, and creation of awareness among the residents on proactive sand harvesting measures.

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ABBREVIATIONS

ADB:	Africa Development Bank
ANOVA:	Analysis of Variance
ASAL:	Arid and Semi-Arid Land
CIDP:	County Integrated Development Plan
DFID:	Department for International Development
EIA:	Environmental Impact Assessment
FGD:	Focus Group Discussion
GDP:	Gross Domestic Product
NACOSTI:	National Commission for Science, Technology and Innovation
NEMA:	National Environment Management Authority
NGOs:	Non-Governmental Organizations
PPP:	Public Private Partnership
SDGs:	Sustainable Development Goals
SPSS:	Statistical Package for Social Sciences
UN:	United Nations
UNEP:	United Nations Environment Programme
USA:	United States of America
WRUAs:	Water Resource Users Association

DEFINITION OF TERMS

Development: Overall advancement of communities' living standards towards meeting the basic needs.

Economic Implication: This is associated with the eventual results or outcomes that accrue from sand harvesting activity such as job creation, source of revenue to the government, improved infrastructure, and the general growth of construction industry. They may also include loss of livelihoods.

Environmental Implication: This entails sand harvesting effects that impact on the surroundings of harvesting places; they are manifested by decrease of water quality, damage of aquatic ecosystem, air pollution, noise from the activity, loss of agricultural land and other risk effects like formation of deep holes and hollows that frequently collapse leading to injury and loss of lives to human beings and animals.

Household: A group of people who live in the same dwelling or compound and eat together and consider themselves a unit in making plans and decisions about their daily life and activities like, production, consumption and reproduction.

Implications: Used in this study to refer to consequences of sand harvesting on livelihood security. They may be positive or negative in nature.

Livelihood Security- Household protection from income and asset shocks through enhanced income, employment opportunities, food security,

productivity, competitiveness and alleviation of the social and environmental threats/ills.

Livelihood: Resources utilized and activities involved by the households to make ends meet or gain a living. Includes activities, assets and access to resources that jointly determine the living gained by the household.

Sand Harvesting Process: a chain or series of activities from the identification of sand sites to the final sale of the sand to the end users.

Sand Harvesting: The practice of sand mining, extracting, gathering or carrying away of parts of the solid sand mainly through an open pit.

Sand: A natural resource extracted from beneath river beds and mainly used as one of the essential raw materials for construction purposes.

Social Implication: This involves undesirable and desirable communal practices brought about by sand harvesting activity; the practices are mainly depicted by conflicts between sand harvesters and the local community, prostitution, and abuse of drugs which threaten the security of the local residents. They may also be positive attributes like participation in community activities.

Sustainability: The practice of maintaining processes of productivity indefinitely natural or human made by replacing resources used with resources of equal or greater value without degrading or endangering natural biotic systems

Sustainable Development: Development that is compatible in aspects of social, economic, and environmental equity.

CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter presents the framework from which the study was based. It seeks to bring to the core, the concept of sand harvesting and its social, economic and environmental implications on livelihoods. Key issues discussed in this chapter include: the background of the study, statement of the problem, objectives, and research hypotheses, justification, significance, scope and limitation of the study.

1.2 Background of the Study

Construction aggregates, which include sand, gravel, and crushed rock, account for the majority of anthropogenic mass worldwide (Torres *et al.*, 2021). Asia is the epicenter of the sand extraction phenomenon (Larson, 2018). Urbanization (Hugo, 2019) and infrastructure development (Torres *et al.,* 2021), including significant expenditures in dams (Hackney *et al.*, 2020), are driving factors behind the need for sand. This is related to how commonplace sand is—among its uses are in concrete, glass, electronics, cosmetics, and medications (Bendixen *et al.*, 2021). In the meantime, it is predicted that there will be 5.6 billion urban residents worldwide by 2035, with Asian cities experiencing the greatest urban expansion (UN-Habitat, 2021). Asian cities have a pressing need to build their infrastructure, and a lot of that development depends on sand. Large amounts of sand are required for land reclamation and flood protection; therefore, this demand will only increase as nations deal with the effects of climate change, particularly sea level rise (Torres *et al.,* 2021). All of this is taking place at the same time as sand scarcity is emerging as a major worldwide issue (Bendixen *et al.* 2019). The United Nations Environment Program (UNEP, 2019) has released a paper on sand governance that highlights the lack of global sand governance and research on

the topic. Undoubtedly, in the last few years, sand has garnered more scholarly attention as researchers have started dissecting sand in its granular form rather than sticking to artificial papers in Science or Nature. As demonstrated by studies that look at the materiality, temporalities, and timescales of sand (Kothari and Arnali, 2020; Torres *et al.,* 2021), consider sand as a granular system (Jamieson, 2021a), and consider the role of sand in the built form (John, 2021; Moser and Cˆot´e-Roy, 2021). As evidenced by the recent discussions on the idea of granular geography in the Dialogues in Human Geography, this has led to fascinating discussions on how to think about sand (Jamieson, 2021b; Kothari, 2021).

Additional insights were revealed by further social science thinking that put sand in dialog with precarious labor regimes (Marschke *et al.,* 2021), flow studies (Lamb and Fung, 2022), and illicit supply networks (Magliocca *et al.,* 2021). Sand is still a little-studied commodity, though, thanks to the efforts of journalists (Beiser, 2018) and activist organizations (Mother Nature, Sand Stories, Asienhaus), who have brought attention to a number of specific cases, such as the deaths linked to sand mining in India (Hadevan, 2019), the widespread practice of sand mining in Bangladesh (Vice News, 2021), the alterations made to China's Poyang Lake as a result of decades of sand mining (Hernandez *et al.,* 2021), and Singapore's sand procurement from less developed regional neighbors for infill and construction (Global Witness, 2010). These particular instances highlight how sand flows cross international borders, traveling through rivers into water basins and delta estuaries before being dredged, moved, and changed into a solid state. Along unstable commodity boundaries, sand moves before becoming fixed (Jamieson, 2021).

Sand harvesting has grown to be an essential social activity, yet unsustainable collection has serious consequences for livelihood and the environment (Will, 2020). Positive and negative effects on society, the economy, and the environment have resulted from sand harvesting (Koehnken *et al.,* 2020). The processes and forms of social interaction, cooperation, competition, conflict, and efforts to resolve them are the social implications of sand mining; on the other hand, the economic implications are linked to a source of income through the creation of jobs, improved infrastructure, and the general expansion of the construction industry (Koehnken *et al.,* 2020). Reduced water quality, harm to the aquatic ecology, air pollution, and noise from the activity are examples of the environmental effects. In addition, it results in the loss of agricultural land and other hazardous consequences including the creation of deep craters and hollows that frequently collapse, injuring and killing both humans and animals. As a result, the consequences provide citizens cause for grave concern regarding their security (Koehnken *et al.,* 2020).

According to Ghanney (2020), sand harvesting can have both positive and negative effects on the economy. Positive effects occur when those involved benefit from the activities' proceeds, while negative effects include the waste of productive agricultural land, lost time for engaging in other profitable endeavours, relatively lower income that is insufficient to support their livelihoods, environmental damage, and the lack of non-sustainability strategies for the sand resource. As a result, the locals in a given location experience both benefits and drawbacks from sand harvesting (Ghanney, 2020).

Natural resources, which can take many forms, such as sand, gold, diamonds, and oil, are the foundation of human life, according to claims made by Hackney *et al*. (2021). If they are used sustainably, natural resources can lead to economic development. The

process of extracting sand in its natural form from streams, creeks, beaches, rivers, and lakes is known as "sand harvesting." Sand is also extracted from inland dunes that are located on ocean floors (Hackney *et al.*, 2021). Sand finds applications in the building sector, water purification, electronics, aeronautics, and the production of glass and tile (Ahlbrandt & Thomas, 2021). According to a UN report from 2020, river sand and gravel are mined globally each year at a rate of 32 to 50 billion tons, which means that they significantly contribute to GDP (gross domestic product) worldwide.

According to Filho *et al*. (2021), sand is a resource that is becoming more and more important and is necessary for economies to continue growing globally. Sand is being extracted at unhealthy rates in several nations, outpacing the rates of replenishing (Musa, 2020). The demand for sand is expected to reach 60 billion tons annually by 2030 due to factors such as fast urbanization, population growth, and infrastructure development over the previous three decades (UNEP, 2019). Currently, the world produces 40–50 billion tons of sand annually.

The enormous demand for sand has led to an increase in sand mining, which has a detrimental impact on human livelihoods and the environment. It is predicted that the worldwide construction industry would grow by 70 percent to 15 trillion USD by 2025 (worldwide Construction Perspectives, 2018). Because of the increased demand for river sand, sand is now more vulnerable to uncontrolled harvesting, necessitating participatory sand harvesting for sustainability. By involving all relevant stakeholders, participatory sand harvesting enables bodies, acts, and policies to be put in place for the conservation of the resource (UNEP, 2019).

As the world economy grows in the twenty-first century, raw materials will be needed to construct infrastructure. One of the basic resources that is extracted from river beds

is sand. Furthermore, because weak material is separated from strong material by sorting processes, it is generally accepted that material from alluvial deposits is of higher quality than material from other sources (Kondolf, 1994). Around the world, instream sand harvesting is becoming a common occurrence. Globally, there is an increasing need for sand, especially in developing nations like Kenya, China, and India where the building sector is expanding rapidly due to their fast economic expansion. Concerns regarding the effects of sand harvesting on the ecosystem are growing worldwide, according to reports from nations including China (Wu *et al.*, 2007), Ghana (Mensah, 2002), and India (Padmalal *et al.*, 2008). Accordingly, it has been suggested that sand harvesting need to be seen as a component of global environmental change due to the scope of globalization and the strength of its effects (Sonak *et al.*, 2006). Many times, unplanned and unscientific sand harvesting results in serious environmental issues for river basin environments that require quick attention and corrective action.

One worldwide organization that sets the environmental agenda is the United Nations Environment Programme (UNEP), which promotes the sustainable use of natural resources like sand among other things. Globally, the sustainable use of natural resources and the preservation of the environment are also supported by the International Union for Conservation of Nature (IUCN), which has over 1,200 members from both the public and private sectors. As a result of cooperation from 183 countries, the Global Environment Facility (GEF) aims to support initiatives related to international water, biodiversity, climate change, land degradation, and the ozone layer.

According to He, Wang, and Yan's (2021) research, sand mining plays a significant economic role in China's socioeconomic development, especially with regard to the

expansion of the nation's building sector. Nonetheless, the study admitted that the ecosystem has been harmed by mining activities such exploration, bulk sampling, extraction, and product transportation (He, Wang, & Yan, 2021). A study by Hackney *et al*. (2021) found that sand harvesting activity was having a negative impact on communities in the United States of America (USA), especially in Maryland and Delaware. This activity was causing erosion and the collapse of beachfront houses and properties, as it was unstable the surrounding ground. Additionally, sand mining has been linked to altered river forms, higher turbidity, and effects on aquatic life. According to Hackney *et al*. (2021), there was a decline in macroinvertebrate species in the areas where the mining was occurring, as well as modifications, enlargements, and lengthening of river channels.

According to Will's (2020) disclosures, the United Kingdom has reaped significant benefits from the extraction of sand from rivers. These benefits include the generation of jobs for harvesters, prevention of flooding, and provision of raw materials to the building and construction sector. A study by Schrecker, Birn, and Aguilera (2018) found that harvesting sand can, in many cases, lead to well-paying jobs and low levels of poverty in the Netherlands; however, the activity is linked to unsustainability, which has caused conflicts between the harvesters and the surrounding community. Fish species in swimming pools and areas of rivers downstream have decreased as a result of sand mining. Sreebha & Padmalal (2019) revealed the unfavorable effects of sand harvesting in India in other places. Sand harvesting had reduced part of the river waters, and the practice had damaged the sea, forests, rivers, and other environmental elements.

A study by Schrecker, Birn, and Aguilera (2018) on the impact of extractive industries on health was done in the Netherlands. Among the reported discoveries was the

discovery that the employment generated by sand mining has contributed to a decrease in crime and suicide rates in rural regions, as well as an increase in living standards that has managed the frequent syndrome of rural-to-urban migration. Furthermore, the trenches made during sand mining operations functioned as water storage facilities and mosquito breeding grounds, creating a risk to public health and safety. As a result of the challenging working conditions, health issues like malaria, stomach disorders, hernias, and physical and sexual weakness were prevalent. But because the study was limited to a single company, it seemed overly simplistic.

Results on the effects of sand mining in Austria listed by Rascher, Rindler, & Sass (2018) revealed that conflict has arisen between groups vying for these dwindling resources due to resource depletion and environmental deterioration. Furthermore, after the sand harvesting activity, ambient air pollution was also prevalent. This led to unfavorable health conditions and increased the incidence and severity of respiratory illnesses and infections. Children are among the most sensitive demographic groups, making them more susceptible. Additionally, exposure to high levels of air pollution may negatively impact children's everyday academic performance. Hospital admissions, death rates, absenteeism, and cognitive deficiencies in children have all been impacted by ambient air pollution.

According to the Africa Development Bank (2020), the bulk of Africans depend on natural resources for their livelihoods, and the rate at which those resources are being depleted is concerning. For example, Igbayiloye & Bradlow (2021) showed that in South Africa, businesses that harvest sand help build important socioeconomic infrastructure like roads, schools, hospitals, and housing; on the other hand, harvesting activities like heaping and transportation were found to have harmed the environment.

Bello, Okechuku, and Okindele (2022) revealed the social ramifications of sand harvesting in Nigeria. These consequences, which were primarily negative, included prostitution, disputes between harvesters and the community, and a high proportion of high school dropouts. While employment for locals was one of the activity's benefits, the residents' part of the money is still insufficient. They also emphasize how little the local population benefits from sand harvesting operations and how much worse off they will be if land is destroyed and the river system is continued to deteriorate.

Sand harvesting provided some of the essential materials for Ghana's construction industry, which depends mostly on sand and other natural resources to create houses, roads, and bridges, according to a survey conducted by Bosco & Sumani (2019). Negative effects, however, included loss of agricultural land, degradation of the environment, and biodiversity loss. In the coastal areas close to Accra, sand harvesting has also greatly increased coastal degradation. As a result, the Ghanaian government has been obliged to spend millions of dollars fighting sea erosion (Bosco & Sumani, 2019). The study recommended that in order to enable enforcement at all levels, practical and unambiguous legislation be established in a participatory manner. According to Gedela, Subhani, and Bahurudeen (2021), sand harvesting in Tanzania has given participants a source of income; nevertheless, the study also revealed a link between the activity and school dropout among adolescents who engaged in it.

Among other statutes and institutions, the Kenyan Mining Act (2016) acknowledges sand as a valuable natural resource for the building sector and, as such, has released rules aimed at making the activity sustainable. However, sand harvesting is done intensively and uncontrollably in many parts of Kenya. In Kenya's semi-arid and arid regions, sand harvesters encroach on seasonal rivers. According to Isere, Mugatsia, and

Agevi (2022), the open cast method is utilized in Kenya for sand harvesting because of its unique characteristics.

The majority of mining regions in Kenya, including Machakos County, which supplies the majority of the sand used in Nairobi's construction industry, have experienced instances of environmental degradation as a result of sand harvesting. This activity has negatively impacted surface water quality and quantity as well as disrupted aquatic ecosystems (Isere, Mugatsia, & Agevi, 2022). Due to their acceleration of soil erosion and disruption of soil stability, sand-carrying vehicles have caused major environmental damage in Homabay County (Ouma, 2021). Sand stacking in Kerio Valley has caused damage to the area's surface by removing flora and stealing land that may be used for farming (Kiprotich, 2017).

Sand harvesting is done in most of West Pokot County; however, it is mostly done in West Pokot Sub County along the Kongelai River. According to the West Pokot Spatial Plan, 2018–2028, this also covers regions like Atacha, Serewo, Konyanga Mtembur, and Chesra. Although the practice appears to increase the harvesters' standard of living, it has also resulted in unfavourable social issues like prostitution, drug and alcohol misuse, and deaths caused by conflicts between the sand harvesters and the local community, endangering the safety of the locals.

An analysis of mining operations in Kenya reveals that regulations designed to protect the environment from unsustainable mining are not being followed. The Kenyan Mining Act (2016), the NEMA guidelines, and the 2010 Constitution are all null and void (UNEP, 2019). The research also emphasized how the nation's goals for resource extraction have not kept pace with the global agenda for development, which includes sustainable industrialization and infrastructure improvement as two of its main tenets.

As a result, efforts to match Kenya's development plan with the Sustainable Development Goals (SDGs) must be bolstered. The Sustainable Development Goals (SDGs), as listed by the member states of the United Nations, are a set of 17 global objectives intended to serve as a roadmap for achieving a better future for everybody. The aim is to formulate a comprehensive set of global objectives that address the pressing environmental, political, and economic issues confronting the globe. Building excellent infrastructure, enhancing healthcare, encouraging equitable and sustainable industrialization, and encouraging innovation are a few of the main objectives (Faremo, 2015).

In 2018, President Uhuru Kenyatta's administration identified the "Big Four"—a group of important economic achievements from Vision 2030 (Kimathi, 2018). In order to improve Kenyans' standard of living and put the nation on track to become an upper middle-income nation by 2030, the "big four agenda" (Kimathi, 2018) placed a high priority on four essential needs: access to affordable health care, manufacturing and employment opportunities, a healthy diet, and affordable housing. Sand, gravel, gold, diamonds, and oil are examples of natural resources that have been crucial in the majority of countries that have gone from being impoverished to being middle-class and wealthy (Ndungu, 2018). The Kenyan government anticipates that mining activity, which is included in the "big four" manufacturing/employment sectors, will significantly raise people's living standards by providing the construction industry with resources like sand, gravel, and blocks. This is because the government has linked its manufacturing/employment agenda with the SDGs. The nation's infrastructure development will benefit from these commodities. Consequently, the Sustainable Development Goals (SDGs) reiterate the global commitment to attain significant growth in the industrial and infrastructure sectors by 2030.

By (1) conducting Environmental Impact Assessments (EIAs) in sand harvesting areas prior to harvesting, (2) designating authorized sand harvesting sites on riverbeds, lakeshores, seashores, farms, Government or Trust land, and (3) developing procedures in conjunction with pertinent Lead Agencies, NEMA has worked to streamline sand harvesting activities nationwide to ensure environmental protection. Other legal frameworks that aim to establish unambiguous guidelines for streamlining sand harvesting operations throughout the country include the Kenyan Constitution (2010), the Mining Act (2016), the County Government Act (2012), the Land Act (2012), the Trust Land Act (1961), and the Forest Act (2005). The unfavorable social, economic, and environmental effects persist in the harvesting areas in spite of the issued rules, endangering the safety of the local populace. In light of this, the researcher conducted a study in West Pokot County on how sand harvesting affects the security of livelihoods.

1.3 Statement of the Problem

This research was a result of a practical observation that, in spite of the large amount of sand that is readily available and the extensive sand harvesting activities carried out by West Pokot County residents, the activities have not produced significant socioeconomic returns to sustain livelihood and development in the study area. At the time of the study, the majority of the sand mining activity was located in Serewo, Kanyarkwat, and Mtembur, which are located near the River Thwake catchment area. These areas provide young people with part-time jobs as sand scoopers and cooks for the casual laborers. At the household level, the effects of these economic prospects had not yet materialized. Despite this, sand harvesting was also linked by media reports to a number of household socioeconomic problems and environmental deterioration, which led this study to wonder how sustainable sand harvesting is in terms of creating

livelihood chances in the study area. Evidence from the literature had also indicated that there was lack of a comprehensive study on implications of sand harvesting on livelihood in the study area.

Sand is vested in the government, just like other natural resources like fisheries, minerals, geothermal resources, renewable energy sources, water, and public forests, according to Legal Notice No. 67 of 2017 and section 6 (1) of the Mining Act. In spite of the fact that the Mining Act grants the state ownership of sand, West Pokot sand mining uses an open access methodology. As Hardin anticipated, this has resulted in the "tragedy of the commons" in numerous places. Free access, particularly to public lands (rivers and riverine areas), produces a low-risk, low-cost environment for a product that is in high demand, leading to a competitive race to the bottom where dealers and sand harvesters have no incentive to manage or conserve the resource.

Practical data also revealed that, although providing the majority of households in the study region with their primary source of disposable income, sand harvesting does not appear to be providing the county government with the significant cash it would have anticipated. Thus, questioning the need to address the way revenue is collected and invested back for the development of the same area.

After all, the research area's poor growth is not due to the amount of sand. Instead, it appears that the abundance of a sand resource has encouraged inadequate wealth management, which has the unintended consequence of slowing rather than accelerating growth. Sand harvesting is a process that has the power to change people's lives. People are moving in large numbers into sand harvesting sites due to the rising demand for sand and the increasing gathering of it. The study's main question was why, despite widespread community involvement, sand harvesting isn't leading to

development in West Pokot County. What were the ramifications of this situation? To this effect, this study adopted a holistic approach to unearth the social, economic and environmental implications of sand harvesting on livelihoods in West Pokot County.

1.4 General Objective

The main objective of this study was to examine the socio-economic and environmental implications of sand harvesting on livelihood security in West Pokot County, Kenya.

1.4.1 Specific Objectives

i. To analyze the social implications of sand harvesting on livelihood security.
ii. To assess the economic implications of sand harvesting on livelihood security.
iii. To evaluate the environmental implications of sand harvesting on livelihood security.

1.5 Research Hypotheses

Ho1: There is no significant relationship between social implications of sand harvesting and livelihood security.

Ho2: There is no significant relationship between economic implications of sand harvesting and livelihood security.

Ho3: There is no significant relationship between environmental implications of sand harvesting and livelihood security.

1.6 Scope of the Study

The target population was restricted to the three regions of Serewo, Kanyarakwat, and Mtembur within the West Pokot Sub County. These were areas that had the highest sand harvesting activities in West Pokot and thus, ideal for the study. The social,

economic, and environmental effects on West Pokot residents' livelihoods were the main topics of the study. Data were gathered for the study through questionnaires, interviews, focus groups, and content analysis of sand harvesting activities. Additionally, the study was grounded in the methodological and pragmatic philosophical underpinnings. The findings are appropriate to the research location in West Pokot County; although extrapolation can be made to the other sand harvesting sites in arid and semi-arid areas with similar characteristics and problems.

1.7 Significance of the Study

The study was important in a number of ways. Firstly, it was to clarify the relationship between livelihood security and sand harvesting. Second, it was to highlight the chances and difficulties for a living that come with sand harvesting in the impacted areas. Thirdly, the findings of this research provided guidelines and data to planners, environmental advocates, policy makers, non-governmental organizations (NGOs), and researchers to guarantee appropriate resource management via sustainable sand harvesting methods. Fourthly, the study's conclusions were to advance our understanding of sand harvesting operations, support empirical data, and add to the body of theoretical research on livelihood security. Lastly, this study was valuable to the sand harvesting communities because it was anticipated to inform strategies that could be adopted to address impediments in the sand harvesting process and other resource use.

1.8 Justification of the Study

This research is significant from a theoretical and practical standpoint. Numerous research has been conducted regarding the effects of sand harvesting on lifestyles. The various effects of sand harvesting—that is, the social, economic, and environmental

effects on livelihood security in Kenya, and particularly in West Pokot County—have received less research, nevertheless. In the same spirit, development policies and environmentally friendly sand harvesting techniques have gained more attention. The Big Four Agenda, Vision 2030, and Sustainable Development Goals priority areas are all in line with the report. As a result, this study is pertinent in adding to the body of information about the problem of sand harvesting and the implications it has for livelihoods. As such, it not only filled a knowledge gap but also supplied empirical data for use in scientific and academic research going forward. Development actors in West Pokot County can use the study's empirical data to explain some of the causes of social evils, subpar academic achievement, high rates of poverty, and environmental degradation.

1.9 Limitations of the Study and Assumptions

Certain conceptual, methodological, and contextual restrictions were recognized and addressed in order to carry out and finish the study within the allotted time and resource constraints. Conceptually, the study was restricted to the effects of sand harvesting on the social, economic, and environmental aspects of livelihood security for West Pokot County population. These could not be the only variables that affect stable livelihoods, though. The material that is now accessible generally suggests that there are more components, such people and physical assets. However, appropriate data acquisition made compressive analysis easier.

Furthermore, data gathering was limited to Kenya's West Pokot County in order to conduct a thorough situational study of sand harvesting operations and provide a solution that is appropriate for the given context. The results, nevertheless, might hold true for other regions with comparable traits.

The study used a mixed method approach, which was costly and time-consuming in terms of methodology. Nonetheless, the investigator conducted the investigation with meticulousness to gather sufficient and pertinent data for further investigation.

Language barrier. The researcher had to use a research assistant to translate the questionnaire for the respondents. This was because the tool was in English yet, almost half of the respondents were semi-illiterate.

Accessibility. The terrain was rough and not easily accessible. West Pokot County is a land of hills and valleys, rocky and also ragged. The roads were not very well established and in the study area, the roads were mainly earth roads, murram, and not recently repaired. The area was therefore, largely accessible but with private vehicles and motorbikes. The researcher used motorbike/*bodaboda* option for transportation. This was actually tedious and it extended the time taken during data collection from one month to about two calendar months.

1.10 Chapter Summary

Sand harvesting generates significant economic benefits and is in high demand. Sand harvesting can have either beneficial, negative, or a combination of both consequences on livelihoods. In Kenya, sand harvesting offers semi-arid people an alternative source of income and job opportunities, but it also poses a threat to the environment and the livelihoods of those living close to the sand mining sites and the government. Sand wars and sand cartels/mafias are examples of permeable sand harvesting regulations that have the potential to have catastrophic cumulative effects on local livelihoods. The study clarifies the potential and problems related to sand harvesting for livelihoods and advances our understanding of the relationship between livelihood security and sand harvesting. To ensure livelihoods, all parties involved in the sand harvesting sector must

work together. In order to uncover the social, economic, and environmental effects of sand harvesting on livelihoods in West Pokot County, this study takes a comprehensive approach.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

This chapter focuses on the literature review that lay foundation to the study. Areas covered include sand harvesting practices and its social, economic and environmental implications on livelihood security from global, regional and local perspectives. The chapter also covers the conceptual framework and the theoretical framework that guided the study.

2.2 Sand Harvesting Concepts

2.2.1 Sand Harvesting Practices

Understanding the fundamental mechanisms governing the supply, transport, and deposition of sediment is essential. Given that it seems to be in plentiful supply in our deserts, sand may look like a plentiful resource. Sand subjected to wind erosion, like desert sand, regrettably has a spherical shape that makes it less useful for building. Sand intended for construction use needs to have a specific mineral composition and be angular. Because river sand offers a wide range of particle sizes and mineral characteristics, it is of great importance (Padmalal *et al.*, 2008).

For thousands of years, mineral aggregates have been employed in a variety of applications. According to UNEP (2014), up to 50 billion tons of aggregate are extracted year, while quantification is challenging due to a lack of worldwide data on extraction. Of this amount, the construction industry uses up to 30 billion tons to produce concrete and asphalt, which are composed of 80% and 90% sand, respectively (UNEP, 2014). Another common application for sand is road foundation; according to Villoth (2014), one kilometer of roadway requires 30,000 tons of sand. Another

extensive use of sand is land reclamation, which usually targets floodplains by utilizing sand taken from nearby rivers.

Sand is a necessary ingredient for development on a global scale in the modern world. It is essential to our daily existence and is used in everything from electronics to glass to concrete to asphalt (Delestrac, 2013). It is also essential for maintaining river and coastal ecosystems, as well as resource-based livelihoods, urban development, and population increase.

At the bottom of river, sea, and valley valleys lies a natural resource called sand. Sand is a heavy, inexpensive material made up of tiny fragments of rock and mineral that are left over after weathering creates deserts and beaches. For centuries, the building industry has appreciated the resource's textural qualities, flexibility, and compressibility (Saviour, 2012). It is useful as a natural resource that humans can take out to support their livelihoods.

Every year, the demand for sand rises because to the growth of urbanization in many regions of the world. One of the most abundant natural resources used in the production of concrete is sand; the construction sector requires six to seven times as much sand and gravel for every ton of cement (USGS, 2013). According to Peduzzi (2014), the globe is gradually running out of sand as the rate and scale of extraction rise and exceed the rates of natural replenishment.

Roughly half of the estimated 40 billion metric tons of sand that are removed annually and utilized, among other things, in the construction sector and the production of glass are non-renewable, according to Edwards (2015). Furthermore, an annual growth rate of roughly 4% is predicted for these statistics to continue (USGS, 2016; The Freedonia

Group, 2017). Sand mining, on the other hand, involves taking sand out of its natural state. Large-scale and small-scale sand mining operations are carried out in several regions of the nation. with a projected housing shortage of 16 million units (Ezekiel, 2010; Isah, 2011).

Mining for sand is the process of removing sand, usually using an open pit. Hull (2001) defines it as the process of gathering and removing solid earth components, such as sand and gravel, in order to build roads and structures. Sand from beaches, inland dunes, and ocean bottom dredging are all included in the process of marine sand harvesting (Peck Yen *et al.*, 2010).

According to Steinberger *et al*. (2010) in Koehnken and Rintoul (2018), because of their abundant reserves and low-cost extraction techniques, sand and gravel—which are mineral aggregates—make up the majority of all minerals mined worldwide. The process of removing the sand and gravel from an aggregate deposit begins with clearing the area of any vegetation and topsoil, then excavating a hole that eventually fills with water. Additionally, it is occasionally dredged from river and ocean beds and mined from beaches and inland dunes. It is frequently utilized in concrete or as an abrasive. Even though there is a lot of sand in the deserts, this kind of sand is not suitable for the construction industry, so the supply is limited. Additionally, because of the boom in construction of homes, malls, offices, and other facilities brought on by the world's rapid economic growth, the sources of sand will be rapidly depleted by the constant excavation that occurs (Greensand Trust, 2010).

Hill and Kleynhans (1999) talked about different ways to mine gravel and sand. Sand is removed above the water table from exposed bars and dry stream beds using a technique called "dry pit mining," which involves the use of traditional bulldozers,

loaders, and scrapers. Using a hydraulic excavator or dragline, wet pit miners remove sand and gravel from a perennial river or stream channel that is below the water table. Preliminary dewatering can facilitate simple excavation; however, this is contingent upon deposit thickness, ground permeability, and post-use and restoration needs. When only the top layer of soil is scraped off without digging below the summer water table—the level of subsurface water during the summer—a technique known as bar skimming or scalping is employed (Hill and Kleynhans, 1999).

In conclusion, in-stream mining, which can take place in a river's main channel or along its edges, entails the direct extraction of aggregate from the bed of a river while it flows. On floodplains, periodically exposed river edges, or in ephemeral rivers that are dry for a significant portion of the year, dry mining occurs. Removing the top layer of visible sand bars is known as bar scalping or skimming (to varied depths).

Furthermore, there are four primary forms of mining: placer, in-situ, open-surface (pit), and subterranean. The more costly underground mines are frequently utilized to access deposits that are farther down. Generally speaking, shallower and less profitable deposits are mined using surface methods. Valuable metals can be extracted via placer mining from sediments found in riverbeds, beach sands, and other habitats. The method of dissolving a mineral resource in place and processing it at the surface without transferring rock from the ground is known as in-situ mining, and it is mostly employed in the uranium mining industry.

The type of mineral resource mined, its location at or below the surface, and whether or not its value justifies its extraction all influence the method employed. Additionally, the effects of each mining technique on the ecology and surrounding area varies. Historically, surface gravel deposits were the main source of sand extraction; however,

these resources are now depleted, and alternative sources of sand have been identified (Delestrac, 2013). More and more nations are utilizing mechanized dredgers to remove sand from beaches, deltas, sand dunes, lagoons, and oceans.

2.2.2 Global Sand Mining

Globally, both developed and developing nations engage in the mining of sand and gravel (Draggan, 2008). Around the world, industrial sand and gravel are produced, processed, and used in industry and construction. Due to the rising need in the building industry, sand harvesting is in high demand and should greatly benefit the local population economically. All continents, with the exception of Antarctica, actively exploit sand deposits (Naveen, 2012). The United States of America, Australia, Austria, Belgium, Brazil, India, Spain, Nigeria, Kenya, and South Africa are the top countries in the world for sand and gravel mining and processing. Many businesses mine it both legally and illegally because it's an inexpensive and easily accessible resource, but they don't think about the harm they're doing to the environment (Draggan, 2008).

While sand is harvested in all fifty states in the US, the states that produce the most are California, Texas, Michigan, Minnesota, Ohio, Arizona, Utah, Colorado, and Washington. Together, they generate almost 52% of the world's supply of gravel and sand for building. The annual production and consumption of sand and gravel exceeds one billion tonnes. Some sand and gravel are still imported from Australia, the Bahamas, Canada, and Mexico due to the high demand in these States (Draggan, 2008). According to Goddard (2007), soil mining operations in Australia started in the 1930s to feed the growing Sydney building industry. These operations continued throughout the 1990s, during which time an estimated 70 million tonnes of sand were taken. The three main economic sources of sand and gravel are glacial deposits, river floods, and

river channels. In the Kurnell Peninsula, sand is harvested, and the harvesters spend the money they make in their businesses, send their kids to school, and help build new structures. Even though it has greatly improved people's lives, sand has also had unfavorable effects, such as habitat degradation and the permanent loss of sand in certain places (Naveen, 2012). According to Pereira (2012), sand and gravel are needed in huge quantities because India is the country with the third-largest building industry in the world, behind the United States and China.

Dubai, the capital of the United Arab Emirates, is home to some of the most breathtaking architectural characteristics on the planet, particularly when it comes to hotels and commercial buildings. Some of the modernly designed buildings are constructed directly out in the middle of the water. There must have been a significant impact on the sand demand and supporting environment due to the spectacular design. Sand is taken out of the desert, coastal sand dunes, or in-stream. After its own marine sand resources ran out, Dubai was forced to import sand from Australia in order to construct the Burj Khalifa tower. According to records, Dubai's real estate market saw such a boom that, in 2013, there was more office space available in the city center than there was demand for. An estimated 451 million tonnes of sand were needed to build Palm Jebel Ali and other projects. A large portion of the aggregates used in construction were utilized to reclaim land from the sea so that towers could be built.

Sand is so vital to Singapore’s economic growth and expansion that they constructed three large stockpiles of sand, making up a national reserve of sand which can be released to counter rising prices or short-ages in supply. Seletar stockpile is next to Seletar Aerospace Park and Seletar Military Camp. The Tampines Avenue 10 stockpile is located adjacent to former sand quarries. And the Palau Punggol Timor is a reclaimed

island dedicated to the processing of sand. Part of Singapore's northeastern coastline reclamation project in 1985-90— a stockpile site, a processing plant, and an aggregate-receiving terminal surrounded by tall security fences — sits atop what was once the sea (Lin, 2011).

Singapore used to source its materials for land reclamation projects domestically, but as a small, wealthy nation with few natural resources, it became more and more dependent on importing sand from nearby nations to satisfy its desire to expand through construction and land reclamation (i.e., supplies for concrete) (Pilkey, 2022). Despite its modest geographic area, it needed land space to expand its infrastructure. Singapore's population tripled between 1960 and 2010, which fuelled the need. Additionally, the nation had an industrial revolution, and in reaction to According to a 2014 research, Singapore has imported more than half a billion tons of sand over the past 20 years, making it the world's largest sand importer (GEAS, 2014).

The authors of an article on the blog Failed Architecture, Robert John and William Jamieson (2020), note that Singapore's growth is dependent on both foreign labor and sand that is almost exclusively taken from other countries in the region. They also point out that the intricate networks of subcontracting and supply chains purposefully conceal the true costs of Singapore's urban growth model. For over ten years, Cambodia was a willing partner of Singapore after several nations outlawed the export of sand. According to Comtrade data from 2019, Singapore's imports of stone, gravel, and sand from Cambodia increased from zero in 2006 to $24.5 million in 2008 (Pilkey, 2020).

Perched on ground that was reclaimed from the sea is Changi Airport. A large amount of swampland was filled in during this reclamation process, and canals were built to drain water from three rivers. A colossal 2,100 acres of reclaimed land were produced

by the land-fill and sea-fill project. Singapore has aggressively expanded its land area since gaining independence, creating land where there used to be water through land reclamation initiatives, increasing its acreage by 25%. Singapore used to source its materials for land reclamation projects domestically, but as a small, wealthy nation with few natural resources, it became more and more dependent on importing sand from nearby nations to satisfy its desire to expand through construction and land reclamation (i.e., supplies for concrete). Singapore's territory has expanded by an incredible 65 square miles since 1965, mostly due to the importation of sand from neighboring nations. The Port of Singapore and the famous Marina Bay Sands hotel and casino in Singapore were constructed on reclaimed ground in addition to the airport (Pilkey, *et al.*, 2020).

Large marshes encircle Phnom Penh, the capital and most populous city of Cambodia (2.3 million people), which is located in a low floodplain. Sand is needed to fill in the marshes and make the area suitable for construction so that Phnom Pen can handle its expanding population (Guest, 2016). The rural poor who migrate to cities do not benefit from this urban development. Rather, a large portion of Cambodia's real estate boom serves the country's affluent elites by creating roomy "satellite cities" outside of Phnom Penh (ibid.). The "ING City" satellite city, which is partially funded by Chinese real estate corporations, is now the largest urban development project under construction in Cambodia (Compass, 2019; McFarlane, 2016). 2,572 hectares of wetlands in Phnom Penh's southern outskirts will need to be filled up with sand as part of the project (ibid.). According to official records, an alliance of non-governmental organizations in Cambodia projected in a July 2020 report that 100 million tonnes of sand would be needed to fill in this wetland region (Knaus, 2020). This amount of sand is over six

times the total amount dredged in the country in 2019. Sand is already being transported in from further north via the Mekong River to fill in the wetland.

Farmers in Myanmar accuse river dredging of increasing erosion, but the government responds that little environmental harm has occurred and that the rivers must be dredged in order to remove sediment from the waterways. The government and the dredging companies can also blame erosion on other issues, such as climate change, which complicates the farmers' complaints. Dr. Vanessa Lamb, a geographer at the University of Melbourne whose research interests include sand studies, noted in an Ear to Asia podcast (Clarke, 2020) that the increased demand for sand for construction purposes within Myanmar drives external demand, while Singapore's needs drive internal demand.

In Papua New Guinea, sand mining is still largely unrecognized. However, it is important to note that communities may make poor decisions that could lead to widespread environmental destruction if they are unaware of the economic and social ramifications. The Turtle Island Restoration Network released a press release on March 1, 2021, stating that Makata's grassroots efforts resulted in the Singaporean company withdrawing its application for a sand-mining exploration license across 51 kilometers of protected habitat for endangered leatherback sea turtles (Turtle Island Restoration Network, 2021).

Pereira (2012) carried out on three villages in Maharashtra, India, it was found that there was a spike in the demand for sand around the world. Because of this, aggregates were being mined more quickly than the natural world could supply them, making the situation unsustainable. In terms of demand for sand and gravel, India ranked third globally in the construction industry, after the United States and China. Because people

believed that the resources were infinite and of poor value, minor minerals, there had never been much control. According to Pereira (2012), the cost and demand for sand had risen from $110 to $300 each truck load. Both regulated and unregulated mining existed in India, but even the state of regulation was hindered by the absence of an effective framework for monitoring and regulating the sustainable extraction of sand (Madyise, 2013).

As per Kuttipuran's (2006) report, contractors are engaged in the illicit mining of the Narmada, Chambal, and Wainganga rivers, resulting in widespread depletion of the river beds. The second-longest Bharathapuzha river and the third-longest Pamba River in the Southern Province of Kerala are the targets of indiscriminate sand mining, when miners steal dirt from them. Despite being governed by legislation, soil mining is nevertheless prohibited in India. On the banks of the Painganga River, illegal sand mining is rife, resulting in tunnels that are fifty feet by fifty feet that cut across farmland. Bagchi (2010) added that although the Minor Minerals Rules of 1996 granted the state government an exemption from sand mining, this led to a rise in sand extraction that was done illegally. The Indian Mining Cooperation of Madhya Pradesh granted numerous leases to remove sand from state territory while ignoring environmental laws.

According to Kamaladasa (2008), riverbed levels have lowered by up to 7 meters in some cases due to the massive amount of sand being taken out of the main rivers along Sri Lanka's west coast, far exceeding the supply of sand from the upper parts of the catchment. He went on to discuss additional effects of salt water seeping inland, such as how it lowers the water table near rivers, which in turn decreases well water levels, and how it affects agricultural and drinking water supplies. Riverbank instability has

grown and paddy fields' flooding with nutrient-rich water has decreased as a result of irrigation channels drying up.

One of the industrial areas that helps Indonesia's economy grow is mining (Suseno, 2019). According to data from Statistics Indonesia (2021), mining and other sector exports were USD 14,041.5 million in June 2021, making up 14.47% of Indonesia's total export earnings. This industry helps the government raise money and creates new business opportunities that promote social welfare (Tonts *et al.,* 2012).

Instream mining provides the majority of the sand in Malaysia. As a result of the mining sites' proximity to "markets" or along the route of transportation, which lowers transportation costs, in-stream sand mining is a prevalent technique. Aquatic ecosystems as well as public and private property can be harmed by in-stream sand mining. An excessive amount of sand removal can seriously alter a stream channel's natural equilibrium. Through the removal of sediment from the active channel bed, in-stream mines disrupt the sediment mass balance downstream in the river and cause channel adjustments (usually incision) that extend significant distances (usually one km or more) beyond the extraction site itself. According to Kotzolf *et al*. (2001), the extent of the impact is mostly determined by the extraction levels in relation to the supply and movement of bed load material through the reach.

2.2.3 Sand Mining in Africa

The African economy depends heavily on sand mining (Manga *et al.,* 2013). In a broader sense, the practice of extracting natural resources is a widespread phenomenon that encompasses revenue streams at every stage of the value chain, from extraction to transportation and final consumers. Despite the notable drawbacks that impair the

ecosystem's ability to function, the activity boosts the local economy (Muiruri and Meshack, 2017).

At the moment, a number of growing economies in the Global South, particularly those in Africa, are concentrating development more in urban areas. This has resulted in extensive sand mining to satisfy the building industry's demand for sand for constructions, at the price of the rural areas where the sand is mined experiencing an infrastructural deficiency. In most African states, sand mining and gravel extraction are prevalent practices, however they can be done legally or illegally. Sand and gravel are inexpensive, easily accessible resources that have been utilized for thousands of years throughout Africa to build sturdy homes, roads, and dams (Mwangi, 2008).

Lupande (2012) asserts that sand mining had not historically been a popular industry in Zimbabwe. Since 2009, when the US dollar started to be used in the nation, there has been a significant amount of new building construction, building additions, and restorations in Harare and the surrounding districts. However, Chimbodza (2012) pointed out that river sand is so plentiful in Zimbabwe's Zambezi Valley, especially along the Ruckomechi and Chewore rivers, that a sizable mining corporation was granted a license to extract the material for use in the construction of infrastructure.

The company uses suction, which pulls sand out from the river like a vacuum cleaner, and dredging as mining techniques. Sand is dug up, removed, and then trucked to Chirundu, which is nearby, for processing. According to Mbaiwa (2008), 34.2% of Botswana's GDP comes from the country's reliance on resource mining, notably for sand and gravel. In order to regulate all mining operations in the nation, including the extraction of gravel and sand, the Mines and Minerals Act of 1999 was introduced. As per Mbaiwa (2008), the nation is dependent on the exploitation of mineral reserves like

nickel, gold, and diamonds; nevertheless, mining of soil is carried out in both legal and illicit ways. Pit sand, river sand, and gravel have been mined for thousands of years from different locations for the construction of roads and structures as part of urban growth, including Gaborone, and the demand for these materials has grown in the present day.

Compared to Zanzibar, the majority of sand mining occurs in riverbeds and near the coast in mainland Tanzania. Due to the instability of the river banks and the potential for bridge collapse, this causes significant damage (Nyundwi, 2010). In contrast, the majority of mining activity in Zanzibar takes place on the hinterland's more abundant sand deposits or on the beaches along the coast. Because there is more sand available to miners along coastal zones, this is where sand mining is most likely to occur. The shoreline offers an open space devoid of a lot of vegetation, which makes the process easier and ensures that the evidence of mining will be washed away by the tide. However, this adds significantly to the already serious problem of coastal erosion that Zanzibar is facing (Masalu, 2002 & National Environmental Policy, 1992).

2.2.4 Sand Mining in Kenya

According to Coastal Care (2015), water is the most utilized natural resource, followed by sand. Furthermore, the National Environment Management Authority (NEMA) of Kenya and other government entities acknowledge sand as "an important natural resource whose demand has greatly risen" (National Environment Management Authority). According to Kim (2007), a number of causes, such as the need to expand infrastructure to maintain international competitiveness, the economy's rapid development, the industrial sector's growth, population growth, and the rising standard of living, have contributed to the growing demand. Over 90% of Kenya's yearly sand

supply comes from river sources, where sand collecting got its start in the 1950s (Padmalal and Maya, 2014:60). Several regions of the nation, including the area near Mai Mahiu in Nakuru County, Masinga in Machakos County, Mbeere, Isiolo County, and Mombasa County, are used for sand harvesting.

Sand was obtained from vast areas of land in Machakos and Makueni up to 1995. Over time, there has been a rise in demand for sand from the building industry, particularly in Nairobi. For instance, the Kenyan diaspora invested 60% of its total income in real estate and related services between 1994 and 2014. Due to the fact that sand mining was both profitable and unregulated, cartels were eventually formed as a result (Scheye, 2019).

Rivers that are shared by the two counties provide the majority of the sand that is mined in Machakos and Makueni. While the rivers Kaiti, Kambu, Kiboko, Mwooni, Moandeni, and Kikuu are seasonal, the Athi, Thwake, and Kibwezi are perennial. The Ikiwe, Ngwani, and Mto wa Mawe are a few other rivers. There are numerous tributaries to these rivers, and each one has the potential to yield sand. Sand from land pits is the primary source of sand harvesting in Kajiado, while sand from water sources is running out. In Machakos's Masinga and Yatta sub-counties, sand mining occurs year-round. The majority of this sand is used in Kiambu County, which is experiencing a building boom (Daghar, 2022). In Machakos, Kalama, Kangundo, Kathiani, Mutituni, and Matungulu are further mining hotspots. The Nairobi urban node serves as the market for sand from these regions.

In Kajiado, there are a number of sand-mining hotspot communities in the sub-counties of Mashuru and Isinya. Because to sand mining, at least ten rivers along the Kiserian–Isinya road are now at bedrock level. Certain rivers have no banks at all, and others

have lost their natural flow, so when it rains, they get flooded. Makueni is a stop on the way to Nairobi for the sand extracted from these locations. The changes made to the terrain have resulted in the loss of significant grazing pastures. Now, the villages' pastoralists must look for pastures elsewhere, sending their animals as far as neighboring Tanzania and Nairobi.

There is a need to determine the effects of sand harvesting on the livelihoods of the people who live in the areas where these activities are carried out, with a focus on West Pokot County, since sand harvesting has also been recorded along major river banks across the nation.

2.3 The Concept of Sustainable Livelihoods Security

In addition to being a widely acknowledged goal of environmental policy, sustainable development emerged from the 1987 World Commission on Environment and Development meeting and has since been the primary concept in the interactions between the economy and the biophysical environment.

According to a widely held definition, sustainable development is defined as follows: economic activity must coexist peacefully with the following: sustainable use of naturally occurring resources; protection of ecosystem functions and features; maintenance of biological diversity; harmful emissions must not exceed critical (assimilative) thresholds; and irreversible harm to the environment and nature must be prevented (Daly, 1990).

Sustainable development has some obstacles when it comes to non-renewable resources. The following actions can be taken: reduce their use as much as possible or reorganize their use so that they are completely independent of them. This can be

accomplished by looking into renewable alternatives and taking into account their potential uses as well as technological advancements (Daly, 1990). Due to its capacity to regenerate itself, sand harvesting from rivers can be a feasible alternative source of income in locations where there is a water shortage. According to Carney (2002), the phrase "sustainable" refers to a variety of long-term concerns, including social, institutional, environmental, and economic ones.

With the swift rise of environmental and development movements in the 1980s and 1990s, the term "sustainability" became widely used. These movements focused on development with longer-term environmental shocks and pressures and poverty alleviation. The UN Conference on Environment and Development in Rio de Janeiro in 1992 made it a major policy priority. It mostly followed the 1987 publication of the Brundtland report (World Commission on Environment and Development [WCED], 1987) (Scoones, 1998).

However, a widely accepted definition of sustainable livelihoods did not emerge until 1992, when Chambers and Conway created a working paper for the Institute of Development Studies. As stated by Conway and Chambers (1991):

> "*Sustainable livelihood is when it can cope with and recover from stresses and shocks and manage to enhance its capabilities and assets both now and in the future while not undermining the natural resource base"*

A livelihood is the set of skills, resources, and activities necessary to support oneself. When anything can withstand shocks and strains, bounce back, and retain or improve its resources, activities, and capacities in the present and the future without compromising the foundation of natural resources, it is considered sustainable (Serrat, 2008).

Many other words can be connected to the word livelihoods to create entire disciplines of study and application for development. These areas include livelihoods that are determined by gender or age, jobs that are rural or urban, livelihood routes and trajectories, and resilient or sustainable livelihoods. There are numerous definitions of livelihoods in the literature. According to Chambers (1995) it describes "the means of gaining a living" or "a combination of the actions/activities undertaken in order to live" and the resources used. However, Chambers and Conway (1992) provided a more detailed definition:

> *"A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living".*

A person's or a family's ability to secure a means of subsistence is mediated by social relations and institutions, particularly when it comes to the impact of these relationships and institutions on claims and access. The Food and Agriculture Organization defines livelihoods as "capabilities" as knowledge and skills, material, and above definition.

According to Ellis (2000), a livelihood is;

> *"A livelihood comprises the assets (natural, physical, human, financial and social capital), the activities, and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household".*

This definition is supported by Sarou (2009) defining it as: "Livelihood is about ways and means of making a living based on the assets available and how people use these assets".

The concept of sustainable livelihoods offers a framework for considering the goals, extent, and order of importance of development initiatives. It is predicated on changing perspectives on the value of institutions and policies as well as how the impoverished

and vulnerable live their lives. It aids in the formulation of development initiatives that are dynamic, sustainable, people-centered, responsive and participative, multilevel, and carried out in collaboration with the public and private sectors (Serrat, 2008).

Although they are not a cure-all, the sustainable livelihoods approach makes it easier to identify realistic goals for activities that are based on the opinions and interests of everyone involved. It is not a substitute for other instruments, including integrated rural development, sector-wide approaches, or participatory development. It does, however, draw a link between individuals and the broader supportive environment that affects the results of livelihood initiatives. It draws emphasis to the innate potential of individuals with regard to their abilities, social networks, financial and material resources, and capacity to impact key institutions (Serrat, 2008).

In the discussion of rural development, wealth creation, and environmental management, the concept of sustainable livelihoods is crucial (Scoones, 2009). Social units, or people, communities, and households, are seen as the active actors of their own development as a fundamental component of livelihood perspectives (Ulrich *et al*. 2012). Analyzing how individuals, groups, and particularly households make a living is the main goal of livelihoods research (Scoones, 2009).

Numerous academics have offered differing definitions of the term "livelihood." Chambers and Conway (1992) offered a well-known definition of a livelihood, defining it as "the capabilities, assets (including both material and social resources), and activities for a means of living." Chambers (1995) defined a livelihood as the resources people utilize to engage in an activity with the intention of generating income or making ends meet. The activities, resources, and access that collectively determine an individual's or household's standard of life are collectively referred to as a livelihood.

For a person, a livelihood is defined as their capacity to receive the four essential elements of life: clothing, food, shelter, and water. As a result, a livelihood is any activity that involves obtaining food, looking for water, shelter, clothes, and other essentials for human survival on an individual and household level. Roughly ninety percent of rural households work in agriculture (Davis *et al*. 2010). According to Davis *et al*. (2010), farming activities account for 5% of household income in Asia and Latin America, but 70% of household income in rural parts of Africa comes from farming. Some frequent livelihoods that these rural inhabitants rely on for a living include small-scale farming, fishing, rearing livestock, and non-farm occupations like sand gathering.

A livelihood consists of one's abilities, material and immaterial possessions, and activities required to support oneself (Rakodi, 2014). According to Peprah (2015), a livelihood must improve its results without endangering the base of natural resources on which it is partially based. These capital assets can be broadly divided into five categories: financial, natural, physical, social, and human resources. Social networks made possible by bonds, bridging, and agricultural infrastructure are examples of assets. While some livelihood frameworks have been criticized for being hard to comprehend and for failing to include other processes, such as institutional and political processes, that might affect livelihood outcomes, they have proven helpful in highlighting connections (Scoones, 2009). The main benefit of livelihood approaches is that they put the household front and center, making it easier to comprehend the value of assets resulting from a given resource's usability from a household's perspective (Chaminuka *et al.,* 2014).

2.3.1 Livelihood Determinants

A number of factors influence livelihoods, some of them are as follows (Fabusoro *et al.*, 2010; Khatun and Roy, 2012): unintentional birth into a predisposed livelihood; a designated system that defines an individual's livelihood, such as the Indian caste system; gender, where an individual's livelihood is determined by their gender; inherited livelihoods, where an individual adopts a family-passed occupation, such as farming, pastoralists, fisherman, shopkeepers, artisanal work, etc.; spontaneous livelihoods, which are adopted out of desperation and where an individual's actions are primarily influenced by the social, economic, and ecological circumstances; and migration, where a person's qualifications dictate the kind of job they can pursue. People relocate in quest of employment and a better living; this movement shapes their choice of livelihood.

In general, people who are wealthy have more options for a living than those who are not. The reason for this is that individuals with greater means can afford to receive education or training that can enhance or supplement their existing talents, so expanding their prospects for employment. This is not the case for those with less resources. A greater variety of livelihoods is produced by a household or community's wider economic expansion.

The "many activities undertaken by the household to generate a living" are considered livelihood determinants. A household adopts this pattern of behavior as a result of mediation procedures on the assets in the household. Generally speaking, livelihood strategies are flexible over time, adapting to new opportunities as well as shifting limitations (Maseko, 2013). It examines the actions a community does to change the resources it has, which represents its standard of living.

The environment of vulnerability, the changing structures, and the livelihood outcomes—that is, the end product of livelihood efforts—have a fundamental impact on the determinants. Improved wealth, living standards, and status have the potential to reduce vulnerability. The Sustainable Livelihood Framework examines livelihood tactics used to accomplish goals. In particular, the framework for sustainable livelihoods connects inputs (referred to as "capitals" or "assets") and outputs (livelihood strategies), which are then connected to outcomes. These outcomes combine well-known concepts (such as employment levels and poverty lines) with more expansive conceptions of sustainability and well-being (Elasha *et al.,* 2005).

2.3.2 Livelihoods Assets

According to Carney (1998), a livelihood is made up of the skills, resources (material and social), and activities necessary to support oneself. She described livelihood assets as capital in many forms that, when aggregated, are used to improve the well-being of households. This includes both tangible and intangible assets. Social capital, human capital, financial capital, natural capital, and physical capital are some of the several types of capital.

Earnings Resources or endowments that a community owns might also be considered assets. Both the foundation of rural livelihoods and the central component of the framework for sustainable livelihoods are assets or capitals. Stocks of various forms of capital that can be utilized directly or indirectly to support a person's livelihood are regarded as assets. They may result in an output flow that is subsequently potentially exhausted or they may accumulate as a surplus to be used as capital for more productive endeavors (Elasha, Elhassan, Ahmed and, Zakieldin, 2005).

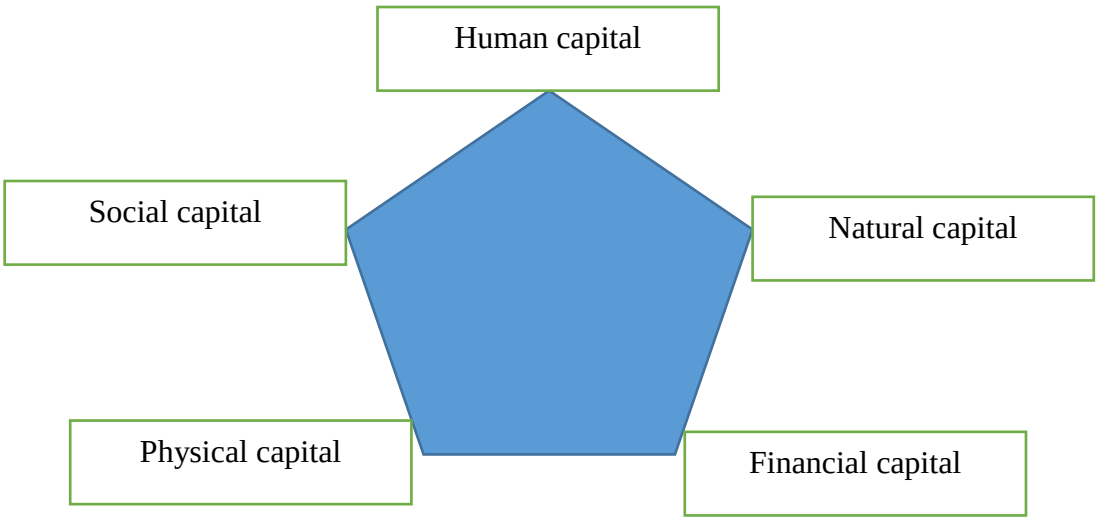

Figure: 2.1: Livelihood Asset Pentagon (Adopted from DFID, 1999)

The capital assets are symbolized by the pentagon. Every individual or household has zero capital assets at the center, and the likelihood of acquiring assets grows as people or households move out from the center.

But just as the opportunities and capacities to acquire assets varies, so does the pentagon's shape from that of an individual or a household. It may be easier to obtain additional capital assets if one capital is accessible (DFID, 1999).Because capital assets may be transformed into liquid or consumer assets to meet demand and preserve livelihood, employing them to maintain livelihood is extremely important (Dorward, Anderson, Clark, Keane, and Moguel, 2001).

2.3.2.1 Social Capital

Liu *et al*. (2017) claim that although social capital is not a new idea, it was not until the 1990s that it was discussed in academic and policy circles. In recent years, its significance in explaining social and economic phenomena has become more apparent. The last ten years have seen a notable increase in the body of literature on theoretical

and empirical elements of social capital. Social ties are at the core of the concept of social capital, which also includes civic involvement, social networks, reciprocity standards, and generalized trust. It is described broadly as an asset of the collective in the form of mutually beneficial shared norms, values, beliefs, trust, networks, social relationships, and institutions that promote cooperation and group action. It is a multifaceted, intricate idea with several dimensions, kinds, and degrees of measurement. One of the five resources—along with natural, human, physical, and financial capital—that are essential for maintaining people's livelihoods is now acknowledged to be social capital. The ideal way to conceptualize social capital is as a method or a procedure for gaining access to different kinds of resources and assistance via social networks. It focuses on the relationships and social networks that exist between society's members. Additionally, belonging to official associations, groups, and organizations fosters reciprocity and trustworthiness, which in turn improves knowledge, information, and skills as well as access to resources for a higher quality of life.

According to Adler and Kwon (2002), social contacts, links, affiliations, and/or connections are among the fundamental components of a person's social existence. This is known as social capital. The majority of the literature sees social relationships, which are built on a foundation of reciprocity, trust, norms, and cooperation, as a resource in a social structure or organization that benefits those who pursue it. Supporters of social capital argue that the idea may be used to comprehend and address problems with any modern social, economic, or business organization, including information asymmetry, governance, transaction costs, breaching contracts, mistrust, and non-cooperation. They list a number of benefits, including coordinated action, influence, solidarity, and information exchange. Additionally, social capital affects how the market functions and

enhances its efficiency. However, detractors of this strategy also highlight the concept's shortcomings and assert that social capital and progress are negatively correlated.

According to Samsudin and Kamaruddin (2013), a social asset is an individual's or household's contacts with the political system, social networks, social system, and local or global associations.

2.3.2.2 Human Capital

The concept of human capital dates back to Adam Smith, who stated in his fourth definition of capital that "the acquisition of... talents during... education, study, or apprenticeship, costs a real expense, which is capital in [a] person. Those talents [are] part of his fortune [and] likewise that of society" (Smith 2003, orig. publ. 1776). According to Bontis *et al.*, (1999) human capital is the combination of intelligence, skills, and expertise that gives an organization its unique personality. The human elements of the organization are those that are capable of learning, changing, innovating, and providing the creative push that, when properly motivated, can ensure the long-term survival of the organization. Human capital was defined by new ideas of economic growth as the total of an individual's innate and learned abilities, knowledge, and experiences. Human capital is defined by the OECD as knowledge, skills, capacities, and other traits that are important for economic activity.

According to Davenport (1998), people's intrinsic traits, skills, and vitality comprise the human capital they contribute to their jobs. Human capital is defined by M. Armstrong (2006) as the information and skills that people acquire, retain, and apply. Human capital includes the aptitudes, life experience, professional competencies, and physical well-being that, when added together, enable communities to adopt various livelihood choices and accomplish their own goals. Human capital is a factor that

affects both the quantity and quality of labor available at the household level. This varies based on factors like family size, education level, capacity for leadership, state of health, and so forth. The paradigm for sustainable livelihoods includes human capital as an asset that influences livelihoods. Human capital is necessary to leverage all other forms of capital in addition to its inherent worth. For this reason, even though it is insufficient as a resource on its own, it is essential to achieving favorable outcomes in all spheres of livelihood (DFID, 1999).

A human asset is a mix of abilities, knowledge, and physical well-being that enables families and individuals to generate income and achieve stable living conditions (Krantz, 2001). Human assets are defined by DFID (1999) as a mix of abilities that enable an individual or household to achieve livelihood outcomes. Human resources benefit vulnerable groups by increasing their opportunities for work, off-farm activities, and other types of involvement that enhance livelihood outcomes and aid in fending off threats to livelihoods or vulnerabilities (Weiss, 2015). Stated differently, Sen (1997) emphasized that a person's human asset is their capacity, which includes their knowledge, economic, social, and mental abilities, all of which contribute to their ability to earn a living.

It stands for various facets of an individual, including their abilities, knowledge, labor force productivity, and state of health, all of which when combined allow them to pursue various livelihood options that further their goals.

2.3.2.3 Natural Capital

The term "natural capital" refers to all environmental assets as they are defined in the SEEA CF, including ecosystem assets that are not included in the aforementioned components. The phrase "natural capital" frequently refers to a wide range of resources

that provide a variety of benefits, including ecosystem services. For instance, a forest is considered to be an ecosystem that produces wood but also cleans the air, filters water, reduces water runoff (preventing flooding), stores carbon (preserving the climate), and offers recreational opportunities. The word refers to the reserves of resources that can be employed at any moment to support a living. It is typically found in intangible form and is a part of natural resources like land, rivers, forests, atmospheres, and biodiversity.

The term "natural capital" refers to the stocks of natural resources that can be exploited to produce additional goods and services that could improve livelihoods. This group of materials includes a wide range of resources. Natural capital and the context of vulnerability are closely related within the framework of sustainable livelihoods. Many shocks, like forest fires, droughts, floods, and earthquakes, that decimate the livelihood strategies of the most vulnerable members of a society are also naturally occurring processes that ruin natural resources. Seasonal variations in the relative values of several natural capitals also frequently influence their timing.

Land and soils, food production, woodlands, marine and forest resources, water, air quality, erosion prevention, waste disposal, storm protection, water supply, and carbon storage and sequestration are a few examples of natural capitals and the services they provide.

According to Guerry *et al*. (2015), a natural asset is a group of natural resources found in the physical environment that people use to support their lives. According to Tyman and Slayer (2000), these natural endowments include land for farming and construction, cattle, forest resources, river and stream water for irrigation and fishing, and mineral deposits. Ellis (2000) claims that a natural asset represents both biological and non-

biological natural endowments, such as lakes, rivers, land, and economically significant trees, grasses, and shrubs that people employ to support their livelihoods and so improve livelihood outcomes.

A natural asset, broadly speaking, is a natural resource that households and individuals can use to generate income, which in turn contributes to the achievement of livelihood outcomes (Carney, 1998; DFID, 1999; 2001).

2.3.2.4 Financial Capital

It consists of the money that individuals or households utilize to accomplish their goals for a living. The most popular sources of funding include the credit system, remittances, business income, and employment salaries. According to Scoones (1999) and DFID (2001), financial assets are those that allow vulnerable individuals and households to invest and create income, hence ensuring the sustainability of their livelihood results.

It is made up of bank cash reserves, movable assets like cattle, and a variety of revenue streams that enhance the quality of livelihoods, including off-farm labor, government transfers, and remittances from family members (Bajwa, 2015). Financial assets, then, are a collection of the means by which a person or household generates income to support their way of life, makes investments to add to their asset base, and avoids (abstains) vulnerability associated with uncertain livelihood outcomes.

2.3.2.5 Physical Capital

It falls under the category of producer goods and basic infrastructure that individuals or households can use to alter their physical surroundings. Examples of these include new technologies such as tools and equipment (such as improved seeds, irrigation systems,

and farm assets) that enable people to meet their basic needs and operate more productively.

In order to support people's livelihoods, DFID and other organizations have created a Sustainable Livelihood Approach that takes these capital assets into account. This strategy has made the fight against poverty in developing nations its primary priority.

The producer products and essential infrastructure required to sustain livelihoods are considered physical capital. The infrastructure examines how environmental changes impact communication and the availability of essential services. The equipment and instruments that boost productivity are known as production items. Infrastructure elements that are usually necessary for sustainable livelihoods include access to safe and affordable energy, housing and secure buildings, clean and affordable energy, water and sanitation, and information and communication.

The term "physical asset" describes the necessary accessibility to amenities that families or people need, such as safe drinking water, transportation, decent housing, and access to markets, schools, and medical facilities (Samsudin, & Kamaruddin, 2013). Likewise, a physical asset denotes certain fixed details such as a production yard or market that are necessary for the creation of goods and services (Kataria, Curtiss, & Balmann, 2012). It also includes other essential physical assets that support sustainable livelihood outcomes, such as reasonably priced but efficient means of transportation, decent housing, a reliable source of energy, good roads to reach the market for income generation, and other essential physical assets (Bennett, 2010).

Differentiation activities in each location are based on the type of output: agricultural produce (growing crops or raising livestock); continuation (processing food or

contracting services to other farmers); or household involvement in other sectors to earn revenue (OECD, 2011). Sisay (2010) asserts that households diversify in order to improve their capacities and assets, realize economies of scope, address liquidity issues, and manage consumption risk and income flows. In an effort to lower risks, households try to diversify their sources of income, especially those related to the seasonality of rain-fed agriculture and the end of mineral exploitation (OECD, 2011). Diversifying their sources of income can also help rural residents become less vulnerable by assisting them in avoiding economic, environmental, and seasonal shocks (UN and NEPAD-OECD, 2011). In addition, they use it as a tactic to integrate activities that increase the household's wealth growth (Khatun & Roy, 2012). As a result, the assortment of livelihood diversification activities that a household chooses to engage in is intrinsically linked to its financial well-being.

According to Marcus (2007) and Einolf (2011), social involvement is primarily determined by three factors: health, marital status, and ethnicity. For this reason, group participation is crucial. While increased income and education create higher levels of civic participation, Principi *et al*. (2016) observe that health, education, and income are the most significant factors of volunteering in later life (Kaasa and Parts, 2008). Furthermore, men are often much more likely than women to participate in civic life (Christoforou, 2005). According to Ifeanyi-Obi & Matthews-Njoku's (2014) study, age, years of education, and monthly income are the main socioeconomic determinants influencing rural residents' choice of livelihood.

Certain assets might be shared by a larger user group, even though the majority of these assets are evaluated in terms of the household or its members. The emphasis on unique home livelihood strategies is not negated by this; rather, it serves as a reminder that

resource management solutions can be both aggregated and collective. These resources can be viewed from the perspective of the individual, the household, the group, and the community. It goes without saying that the asset base is essential to sustainable lives (Dorward *et al.*, 2001).

2.4 Theoretical Review and Conceptual Framework

The framework adopted in this study is the Sustainable Livelihood Framework by the Department for International Development (DFID, 1999).

2.4.1 Theoretical Review: Emergence and Critique of the Sustainable Livelihoods Theory

This section of the offers a brief review of the emergence of sustainable livelihoods as a focus for development; second, to summarise the critiques that emerged from the early 2000s; and third, to chart the shifts in economy, society and politics reflected in the turn from 'international' to 'global' development (Horner and Hulme, 2019, Horner, 2019).

Sustainable livelihoods: What is it and where did it come from?

Sustainable Livelihoods (SL) is closely associated with Robert Chambers. The foundational publication was a 1992 working paper that he co-authored with Gordan Conway: "Sustainable Rural Livelihoods: Practical Concepts for the 21st Century", published by the Institute of Development Studies. As they noted, this working paper drew on earlier work of an advisory panel to the World Commission on Environment and Development (WCED), and the resulting Brundtland report *Our common future* (WCED, 1987) anticipated the sustainable livelihoods 'turn'. But the Brundtland report does not define what comprises a livelihood, let alone a sustainable livelihood, although the report uses both terms. A second key publication that is sometimes regarded as

instrumental in setting out the sustainable livelihoods agenda is the first UNDP Human Development Report (1990). Like the Brundtland report, the 1990 *HDR* uses the term only in passing and provides no definition. Nonetheless, these important reports do provide two key ingredients: a concern for sustainability and the notion of capabilities. More broadly, the years from the late 1980s saw a coalescing of views about development, many of which came to be reflected in the SLA. Further, these were associated as much with development organisations like the UNDP and commissions such as the WCED as they were with academics working in the field of development studies. The SLA, therefore, emerges from and is rooted in dominant development thinking *and practice* at the time, which is relevant when it comes to considering some of the criticisms levelled at the SLA.

In their working paper, Chambers and Conway write (1992: 5, and see Chambers, 1995: 174, Scoones, 1998: 5) that a "livelihood in its simplest sense is a means of gaining a living". On the next page they provide a fuller 'working definition':

A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living: a living is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the short and long term (Chambers, 1995: 175).

The Chambers and Conway working paper does go further than the WCED report in turning an idea into an approach, not least in providing a working definition, although it was yet to become a framework, practice and a methodology. Curiously, given its

links to the Brundtland report, Chambers and Conway refer to socially, not environmentally, sustainable livelihoods.

The progressive transformation of the Sustainable Livelihoods Approach into the Sustainable Livelihoods Framework (SLF) occurred during the course of the 1990s as it was taken up by development organisations, both governmental and non-governmental: Oxfam in 1993, Care International in 1994, and the UK's Overseas Development Administration (ODA) in 1995 (Solesbury, 2003). The sub-heading of the Chambers and Conway paper provides an indication of its aims and, therefore, its intended audience: '*practical concepts* for the 21st century'.

The SLA was not, from the very start, politically progressive and when it was taken up by institutions of national and global governance, such as the UK's Department for International Development (DFID) in 1997, it was further de-politicised (De Haan, 2017). Early critics were quick to highlight that the approach reproduced a particular politics of development, rooted in the foregrounding of the poor as arbiters of their own fate, tending to underplay the structural factors underpinning rural poverty.

The transformation of sustainable livelihoods from an approach (SLA) into a framework (SLF) occurred with the publication in 1998 of a second IDS working paper, by Ian Scoones (1998). The visualisation of the framework placed 'institutions and organisations' at the centre of the diagram. In a later book, Scoones (2015) acknowledges that, at this point, the livelihoods "bandwagon had gained too much momentum and the critical friction of debate was lacking", lamenting that "there was little to argue with, it seemed" (page 37). A year later, DFID took this one step further, distilling out some of the nuance of Scoones' original diagram and turning his framework into something closer to a methodology (Carney, 1999).

The main critiques of the SLF have coalesced around overlapping areas: theory; method and scale. All of the above elements find their echo, individually, in other papers and books. That said, structuring our critique in this manner traverses' questions of method, approach and theory in a manner which is novel in its presentation and articulation.

An initial set of concerns foreground the absence of explicit theory in SL (e.g. Small, 2007). The approach is full of principles – it claims, for instance, to be participatory, holistic, people-centred, localist, and empowering – but there is little focus among proponents on the theoretical principles that underpin these methods and approaches. In terms of implicit theory, the framework's proliferation in the late 1990s drew on grounded theory and saw the emphasis on human capitals take on particular resonance, playing down a focus on institutions and socio-political processes (Scoones, 2009). Drawn from Sen's (1985) Human Capabilities approach, this theoretical underpinning situates the locus of analysis within the household, and beyond this, the individual. Structural determinants of poverty are under-addressed, both in mapping livelihoods and concurrently in devising development programmes. This is not made wholly clear however, with SLA-led analysis tending to obscure the theoretical choices made within its analytical approach. Arising from this, structural and political development issues are rendered technical, and poverty depicted as apolitical (Li, 2007).

Methodologically, the SLA was a departure from approaches that were prevalent at the time. It sought to illuminate how populations 'get by' through a people-centred, holistic, participatory and inclusive view of matters, seeking to understand what people have, what they do, why, and with what consequences for their quality of life. While this may seem rather run-of-the-mill today, at the time it was novel, even revolutionary. This strength, however, also leads to a key weakness: an unremitting focus, almost a

reification, of the local and by extension of community, and therefore a tendency to overlook how local livelihoods are also, and increasingly, embedded in and reproduced by networks and relationships that transcend the local.

Echoing the point made with regard to theory, this diverts attention from macro-processes and structural factors (Challies & Murray, 2011: 31), which are problematically reduced to a box labelled ‘context’ (Scoones, 2015: 38). The reasons why a household is poor or a livelihood vulnerable, or indeed rich and resilient, can only be fully discerned and understood in terms of processes that are situated at scales beyond the local, even if it is at the local where such processes and the conditions they produce are experienced (Carney, 2003: 23). the critiques notwithstanding, the SLF is the most convincing theoretical framework not just in academics but also practice. The DFID provided the most updated and concise version and that is why it is commonly used (Challies & Murray, 2011: 31).

2.4.2 Sustainable Livelihood Framework

The approach was utilized in the study to understanding the socio-economic and environmental effects of sand harvesting on livelihood security. This framework is helpful for comprehending the roles and dynamics of rural institutions in creating an environment that supports sustainable livelihoods, as well as how underlying constraints affect livelihoods and access to resources for livelihoods. The notion of ‘sustainable livelihoods’ was initially suggested by the Brundtland Commission on Environment and Development and then further broadened by The United Nations Conference on Environment and Development in 1992 (Krantz, 2001). Since then, some international organizations have modified their models or strategies in accordance with the idea (GLOPP, 2008).

The DFID Sustainable Livelihood Framework was modified for this study's needs. The Vulnerability Context, Livelihood Assets, Organizations and Institutions, Livelihood Strategies, and Livelihood Outcomes are the five sections that make up the framework, as shown in Figure 2.2.

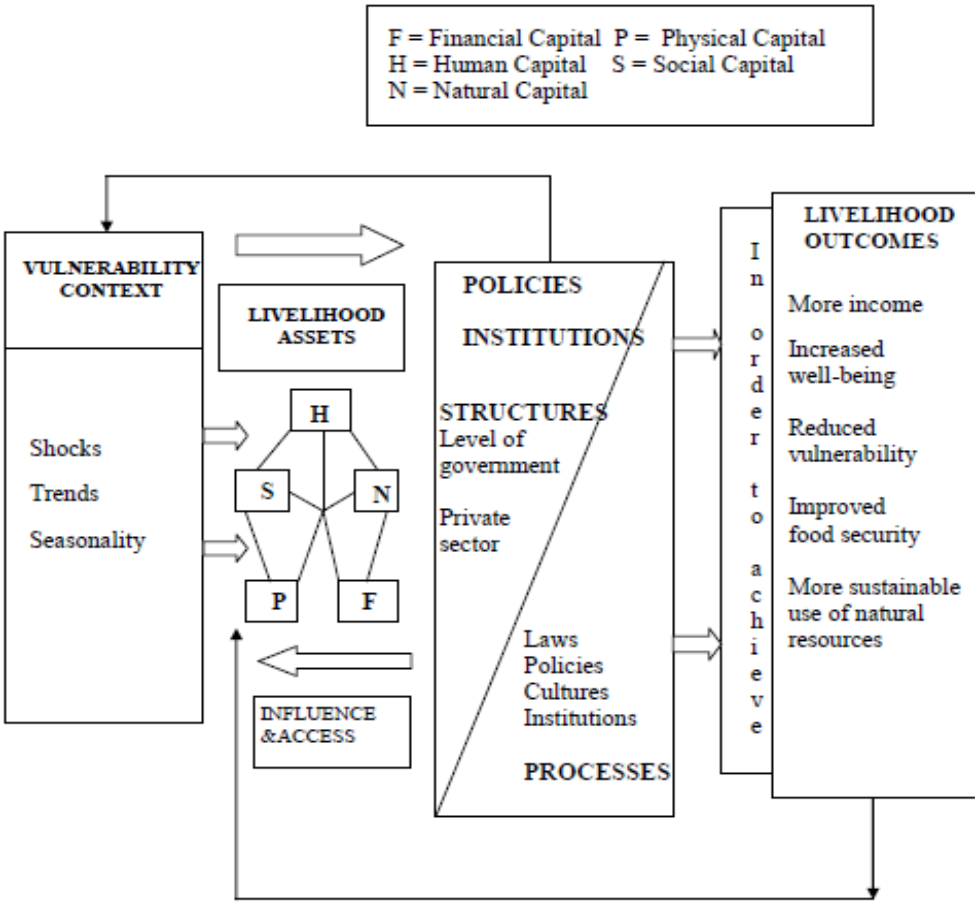

Figure 2.2: The Sustainable Livelihood Framework

Source: DFID (1999)

F = Financial Capital P = Physical Capital

H = Human Capital S = Social Capital N=Natural Capital

2.4.3 Conceptual Framework

To provide a conceptual framework that directed the investigation, the DFID Livelihood Framework model underwent additional modifications. The relationship between livelihood security and the social, economic, and environmental impacts of sand harvesting is depicted in Figure 2.3's conceptual framework. The DFID Livelihood Framework model was adopted with the supposition that households in the research region were originally faced with precarious situations or perceived potential in the new livelihood activity (sand harvesting). In this environment, the vulnerable conditions

included drought, landslides, pest assaults, war, and diseases that resulted in low productivity and low revenues. Opportunities also included the creation of jobs and faster, more substantial income from sand harvesting operations. Trends, shocks, and seasonality are all part of the environment of vulnerability and opportunity. The use of technology in agriculture and the rise in rapid and substantial revenue from sand harvesting are two examples of developments. Drought, flooding, unfavorable weather, and other natural disasters are examples of shocks that can result in low agricultural yields and low revenue.

Seasonality can also be associated with variations in weather that prevent activities, particularly farming, from being done. Some of these people took advantage of these vulnerabilities and possibilities by mining sand using their accessible livelihood assets, which include human, financial, physical, natural, and social capital. Human capital, including information, abilities, and energy, is needed by sand miners to start sand harvesting operations. To buy the tools needed for sand gathering, they also require financial resources. Natural resources, like the land used for mining sands, have grown extremely precious.

Physical resources like the equipment and technology required for the job as well as the routes for sand transportation also help with sand mining. Ultimately, social assets such as social networks, relationships, and leadership were necessary for the efficient operation of sand harvesting operations. The sand miners' exploitation of these resources for their livelihood has both beneficial and harmful implications. Increased revenues would result from more sand being extracted as a result of sand harvesting activities. Poverty would decline and livelihoods would improve as a result. An increase in sand mining activities will result in the availability and improvement of social

infrastructure, including roads, portable water, and facilities for education and health. Many of these mining operations would be conducted because sand mining contractors have unrestricted access to properties and because sand mining doesn't usually require sophisticated technology. The negative aspect of sand mining operations is the environment's deterioration and the issues that go along with it, like the extinction of wildlife.

The framework also links the devastation of agricultural fields, water sources, and farmer livelihoods to sand mining. More people are drawn into sand mining operations as a result of this predicament, which is also connected to job losses and rising poverty. Many local governments or organizations have an overall influence on the factors that led individuals to engage in sand mining, the assets that households have for their livelihood, and the activities that they engage in for their living. In order to promote sustainable growth, the county government enacts laws, rules, and policies that control the sand harvesting industry. They are in charge of preventing the overuse of the sand resources, shielding the public from the harmful effects of sand mining. It is important to remember that local government initiatives can have positive or negative effects. The results or accomplishments of livelihood strategies are known as livelihood outcomes (Rouse & Ali, 2001). It is important to realize that the appropriateness of the livelihood tactics used always affects how desirable the livelihood outcomes are.

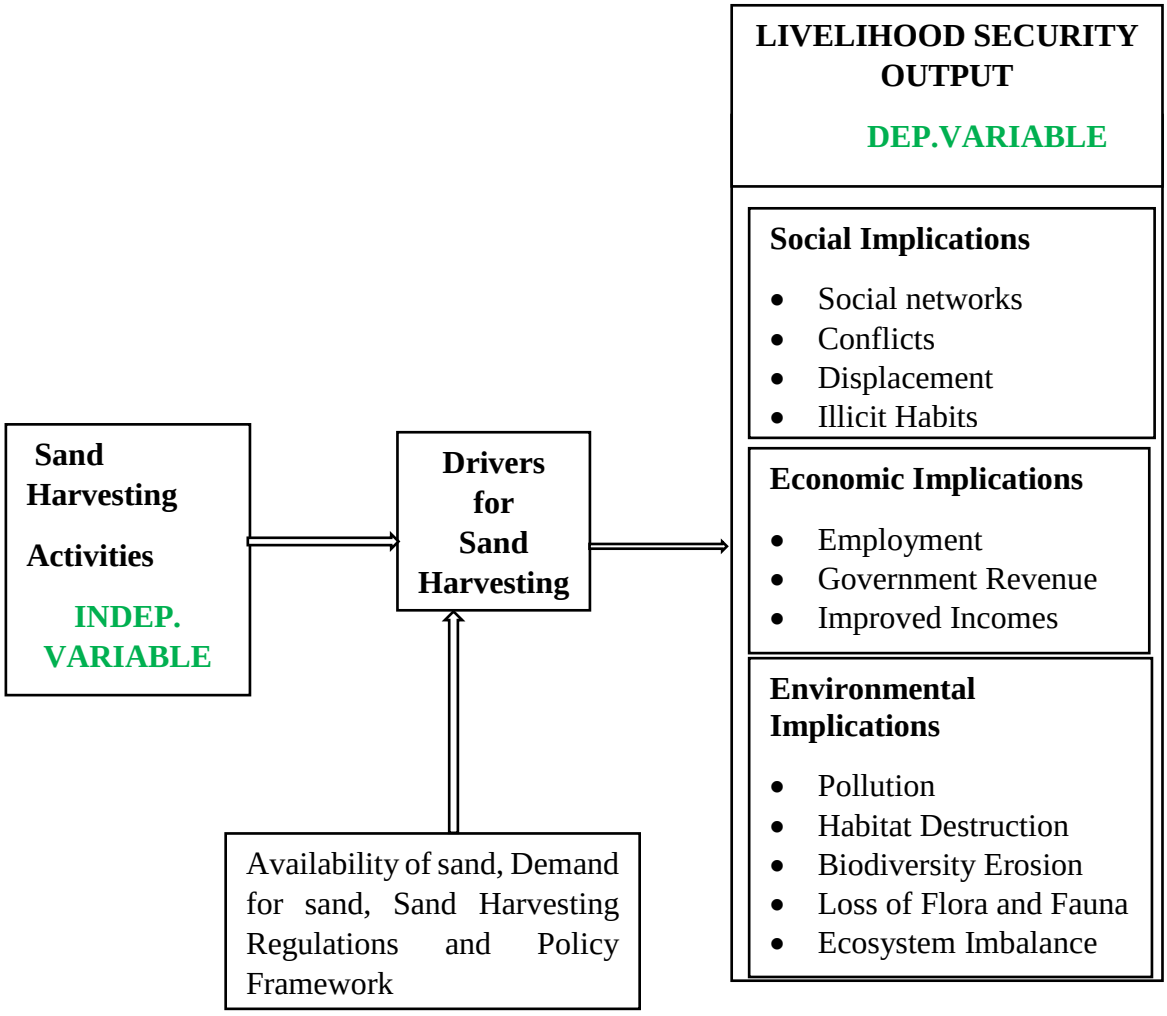

Figure 2.3: Conceptual Framework

2.5 Empirical Literature

2.5.1 Social Implications of Sand Harvesting and Livelihood Security

Processes and forms of social interaction, cooperation, competitiveness, conflict, and attempts to resolve them are examples of how sand mining has social ramifications (Koehnken *et al.,* 2020). Social ramifications include drug usage, prostitution, school dropout, and disputes between sand harvesters and the local community (Dongmo *et al.,* 2021). According to Ghanney (2020), sand mining activities can have positive, negative, or a combination of effects on the economy. Positive effects are those that

result from the mining process when lucrative or desirable outcomes are achieved. If undesirable or unforeseen consequences arise, it could be seen negatively. Positive impacts include, but are not limited to, interactions between sand miners in the form of increased cooperation and mutual assistance, information sharing, problem solving, maintaining good relations through frequent social gatherings, and healthy competition amongst miners to draw in customers (M Rais *et al* 2019). On the other hand, there are detrimental social effects such as prostitution, young marriages, disputes, and student dropout rates.

Due to the dredgers' usual destruction of bottom-dwelling animal habitat and deterioration of water quality, several Indonesian islands have vanished. According to Chris Milton (2010), Nipah Island vanished underwater in 2003 due to dredging along the Singapore-Indonesia border; today, its position is only marked by a few palm trees. According to a 2010 Grist article in the *New York Times*, erosion brought on by illicit sand mining has caused the disappearance of twenty-four small Indonesian islands since 2005. Since sand mining began an estimated two dozen small Indonesian islands have vanished. If dredging continues unchecked, at least 2,000 more Indonesian islands could disappear (Down To Earth, 2016).

The effects of aggregate mining on infrastructure—especially bridges—have been linked to incision that weakens supporting structures. According to Huang *et al*. (2014), a combination of sand mining and bank protection measures resulted in the unexpectedly high rates of incision in the underlying sandstone bedrock of five bridges across the Bachang river in Taiwan. Similar erosion occurred to weirs, which necessitate ongoing maintenance that is unlikely to be possible in the long run.

Mitigation measures including the construction of dams and other structures that disperse river energy are being investigated.

In California, bridges located upstream from aggregate mines have experienced comparable outcomes (Kondolf, 1993) owing to downstream sand mining, a bridge across the San Diego River on California Highway 67 had to be entirely replaced in 1981 at a cost of $3.3 million USD, while a bridge on California Highway 118 needed to be repaired for $700,000 USD owing to damage from an incision. These renovations would have cost more than $5 million USD in 2018. Rivers in Italy, France, Spain, Poland, and England have also been documented to have undercut bridges and weirs (Rinaldi, *et al.*, 2005). For extended periods of time, damage to bridges can have a daily impact on people's lives. When a bridge downstream of the Farraka barrage in India failed due to aggregate extraction, the residents were left with no other option than to go 50 km via slow ferry to cross the river.

Incisions can affect more than only weirs and bridges. Underwater cables and gas lines have occasionally been exposed, and irrigation channels and pumps may become inoperable due to the river level drop brought on by the incision (Rinaldi, *et al.*, 2005). In the Nogalte Stream in Spain, Ortega-Becerril *et al*. (2016) found a correlation between increased gravel mining and more severe and extensive flooding. The combination of a lower sediment load, channel incision from gravel mining, and land subsidence from ground water extraction led to a lower base level of the river, which the authors attributed to increased river energy and an increase in the distribution of flood waters. Similar to this, Nakayama & Shankman (2013) acknowledged that the area's flood risk was raised by extensive aggregate mining close to Poyang Lake's

outlet, but they also proposed that carefully choosing locations for aggregate extraction may have the reverse effect and reduce flood risk.

According to a study by Hackney (2021) on the effects of river sand mining in the USA, sand harvesting activities have killed both people and animals. The erosion and collapse of beachside homes and properties caused the aforementioned deaths and injuries since the action had unstable the surrounding areas' grounds. The results of the study showed that after seaside homes eroded and collapsed, other properties that were deemed worthy also suffered destruction. Sand gathering along the rivers has also led to instances of tension between the sand harvesters and the community. Disputes resulting from sand harvesting are frequently observed between the "exploited" (sand harvesters) and the "exploiters" (brokers, intermediaries, and transporters), the study claims. This contact frequently results in disputes. The likelihood that the subordinates (the sand harvesters) will challenge the legitimacy of the unequal allocation of limited resources increases with their awareness of their genuine collective interests. One weakness of the study was the lack of clarity in the dimensions utilized to assess the consequences of sand harvesting.

The United States of America (USA) has seen a sharp increase in sand harvesting, with annual estimates exceeding one billion dollars. Texas and Illinois own a large portion of the sand harvesting industry. Almost two thirds of the silica produced in the country comes from five states, including Wisconsin. Due to increased demand for silica sand from major oil firms, Wisconsin and other northern states saw an industrial sand harvesting boom in 2009 that has come to be known as the "sand rush" (Schreiber, 2012).

Concerns about quality of life and the risk of contracting silicosis have been raised by Wisconsinites in response to the recent surge in silica sand harvesting. According to Akgun *et al*. (2006), silicosis is caused by prolonged (chronic) or even more brief but intense exposure (acute) to high concentrations of respirable dust that contains a sizable amount of silica. In the United States, sand harvesting has also caused erosion and the collapse of oceanfront homes and properties because it destabilizes the surrounding land.

Some researchers estimate that almost 70% of the beaches on Earth could eventually disappear entirely. Numerous currently necessitate the frequent artificial replenishment of sand that is removed from other beaches, hence causing degradation (Schreiber, 2012).

Meng, Jiang, and Xie (2018) evaluated the Chinese community's reactions to commercial sand dredging operations. Concerning the effects of sand harvesting, the research discovered that the practice has led to social vices among the participating locals, including drug and alcohol misuse. Drug and alcohol abuse had caused families to become unstable as a result of harvesters' negligence. Examples of noise pollution from the activity were also disclosed; the noise had severely disrupted important activities in the vicinity, especially educational institution learning activities. The following interactions between sand miners have been shown to have positive effects on their social conditions: they cooperate and increase mutual assistance; they cooperate in sharing information; they work together to solve problems; they maintain positive relationships by regularly hosting social gatherings; and they engage in healthy competition to draw in customers.

According to the majority of respondents in a poll conducted by Singh, Pandey, and Shukla (2017) on the assessment of sand contamination in the sediment of the River Ghaghara in India, sand harvesting has a negative impact on education by causing insufficient water for schools. The respondents verified that young harvesters abused drugs and alcohol, and they thought that abusing drugs and alcohol would improve their capacity to work at the sand mining locations. It was also observed that the locals involved in the operation engaged in criminal conduct. The increased use of drugs and alcohol in the sand mining industry was explained by a lack of financial education regarding savings and investments from the mines; consequently, youths increased disposable income made it easier for them to engage in social issues like drug abuse and prostitution in the sand mining industry. The study also found that the employment generated by sand mining contributed to a decrease in rural areas' rates of suicide and crime. The study only received 40% of the respondents' responses, which is insufficient to support the findings to a sufficient degree.

A study by Schrecker, Birn, and Aguilera (2018) on the impact of extractive industries on health was done in the Netherlands. Among the reported discoveries was the discovery that the employment generated by sand mining has contributed to a decrease in crime and suicide rates in rural regions, as well as an increase in living standards that has managed the frequent syndrome of rural-to-urban migration. Additionally, the pits left behind from sand mining operations functioned as water storage facilities and mosquito breeding grounds, creating a risk to public health and safety. As a result of the challenging working conditions, health issues like malaria, stomach disorders, hernias, and physical and sexual weakness were prevalent. But because the study was limited to a single company, it seemed overly simplistic.

Results on the effects of sand mining in Austria listed by Rascher, Rindler, & Sass (2018) revealed that conflict has arisen between groups vying for these dwindling resources due to resource depletion and environmental deterioration. Furthermore, after the sand harvesting operation, ambient air pollution was also prevalent. This led to unfavorable health conditions and increased the incidence and severity of respiratory illnesses and disorders. Children are among the most sensitive demographic groups, making them more susceptible. Additionally, exposure to high levels of air pollution may negatively impact children's everyday academic performance. Hospital admissions, death rates, absenteeism, and cognitive deficiencies in children have all been impacted by ambient air pollution. Displacement is a primary social consequence throughout the mining development phase. According to Raises *et al*. (2019), displacement is typically followed by the loss of material possessions, access to natural resources, social networks, and cultural identity. This impoverishment primarily impacts marginalized populations and indigenous peoples. Effectively managed resettlement procedures and follow-up can lessen the effects of displacement (Dongmo *et al.,* 2021).

Acero Archipelago research by Borges *et al.,* 1992 Portugal discovered in the last quarter of the 20th century that sand harvesting had an impact on the social and economic development of the archipelago. This led to an acceleration of coastal development, which included the construction of buildings and communication infrastructure, both of which required large volumes of sand. Natural resources that are suitable for aggregate in building are in short supply due to the limitations imposed by the local geology. As a result, beaches and dunes were utilized in construction as the main sources of aggregate, taking advantage of the lack of regulations governing these

kinds of harvesting activities and the existence of appropriate coastal management plans.

Because it increases their purchasing power, sand harvesting, like any other economic activity, can assist the locals in meeting their fundamental requirements. According to a 2012 study by Deller and Schreiber on franc sand harvesting and community economic development, communities that rely more heavily on franc sand harvesting for employment have more negative effects following mine closure than positive effects during mine operation, such as difficulty paying for essential medical care. The study also showed that sand harvesting can, in many cases, lead to well-paying jobs and a decrease in poverty levels. However, it seems that sand harvesting activities are linked to lower community health standards overall. The study came to the conclusion that there is more consistent evidence that harvesting has a positive impact on employment, health, and income growth rates than that there is weak evidence that counties that rely more heavily on harvesting for employment will typically have slower rates of population growth (Deller and Schreiber, 2012).

The effects of beach and dune mining along Puerto Rico's coastline were revealed in September 2018. The lack of the protective effect that the mined-away dunes would have offered to several locations along the north shore increased much of the coastal damage caused by Hurricane Maria. In areas that were formerly shielded by tall, vegetated dunes, waves and high water reached inland. All throughout the world, the Puerto Rican narrative is being replicated. Just when we most need these landforms, we are eliminating sources of beach sand and coastal sand. Storm intensity is increasing along with sea level rise, which is predicted as a result of global climate change and, in particular, higher ocean temperatures. Sand dunes and beaches provide vital, albeit

transient, protection from storms and the rising sea level along the world's many thousands of miles of shoreline. Furthermore, the global tourism economy suffers when beaches and coastal dunes disappear (Pilkey, *et al.*, 2020).

Tesi, Tesi, and Enete (2018) evaluated the socioeconomic effects of river sand mining along the Warri River in Delta state, Nigeria, among other places. Due to its association with social vices like prostitution, which in turn facilitated the spread of sexually transmitted infections (STDs) like HIV/AIDS, sand mining has been linked to detrimental effects on the populace. Due to the activity, a large number of kids had quit school to pursue mining careers; kids as young as 15 years old were discovered in the mining sites. In addition, the absence of clean drinking water and poor hygienic conditions inside mining regions led to a high rate of waterborne illnesses among the mining community. As a result, mining was seen as a very dangerous industry because miners had to learn their trade by doing. Thus, by strengthening social networks, community organizations contribute significantly to the development of social capital. As a result of the services they offer, these organizations can also contribute to the development of positive connections (Smith, 2016). This suggests that people will probably gain social capital by their membership in a community group if they are already involved for other reasons. Additionally, organizations can give people access to chances, such informing them about employment openings (Greenberg *et al.*, 2017). Participation in the local community and associated institutions through local partnerships contributes to the ongoing development of social networks.

The loss of Cambodia's wetlands has an impact on the way of life for the local populations that live in and around these ecosystems, which supply fish and space for the cultivation of food plants (Beckwith, 2020; Vichea, 2018). Wetlands in Phnom Penh

have historically been filled in with sand to make way for real estate development projects. These initiatives are frequently entangled in corruption (Rainsy, 2020). The contract to fill in Boeung Kak Lake in northern Phnom Penh and develop a real estate project was given to Shukaku Inc., a company owned by a senator of the ruling Cambodian People's Party, for just USD 79 million, which is significantly less than market value, and without holding an open tender. This case has gained notoriety. Then, 20,000 people were forced to relocate due to the land reclamation project (Suseno, 2019). A compensation package was offered to the displaced people, although many claimed it fell short of what they had been receiving from the marsh for their livelihood. Before the project started, the lake's residents weren't consulted, and when they complained, they were confronted with bulldozers and acts of violence from the police (Suseno, 2019).

According to a study conducted by Bosco & Sumani (2019) on the potential environmental and socioeconomic effects of sand and gravel mining in Ghana, sand and gravel harvesting has improved the harvesters' standard of living by lowering the country's poverty rate, but it has also had unfavorable effects like increased risk of death and injury from conflicts between sand harvesters and the local community. The study's shortcomings include its failure to distinguish between the elements that were used to measure the outcome variables and its discussion of implications that touched on social, economic, and environmental issues all at once. In order to investigate the ecological and social effects of gravel mining in the East Gonja district, Manga et al (2013) carried out research. He found that the district's fertile farmlands were becoming smaller due to the effects of gravel mining. Of the total responders, 33% were in favor of this. In addition to their obvious detrimental effects, abandoned quarry pits would retain

puddles of unclean surface runoff and operate as mosquito breeding grounds throughout the rainy season.

The effects of mining for riverine sand in Uganda were examined by Koehnken, Rintoul, and Acreman in 2020. Results indicated that 35.8% of participants strongly agreed that households were eating better than they had before they started harvesting sand. An insignificant 3.4% of respondents strongly disagreed that the families were eating better than before they started a sand harvesting business, while 28.2% of respondents agreed that the families were able to eat better than before they started a sand harvesting business. The study also found that one economic activity that can raise the standard of living for locals in a particular area is sand collecting. The study found that well-managed sand harvesting has the potential to improve people's quality of life in the areas where it is practiced. Further, it is made clear that social scientists do think that meaningful advancement depends on the mass economy's processes being strengthened, especially at the family unit level. However, the element of the activity's consequences on the environment was left out of the study.

The results of a survey conducted in East Africa by Ongoma, Chen, and Omony (2018) demonstrate the seriousness of mining, which endangers the region's social processes in addition to the environment. The study found that certain social factors, such as a scientific community that produces reliable warnings of environmental risk, support the learning process contained in classical environmentalism. As a result, they claimed that there is a connection between school achievement and ambient air pollution. Human actions like sand collecting directly contribute to environmental damage. These impacts have disastrous repercussions on learning and general academic performance in pupils as well as the environment. Children's cognitive ability can be restricted by health

decencies, ranging from ordinary ailments to early health difficulties. On the other hand, favorable environmental factors can have a significant impact on how well kids learn.

According to a survey by Kiprotich (2017) on the socioeconomic and environmental effects of sand harvesting in semi-arid areas of Kenya, sand harvesting has helped to lower poverty rates among harvesters by giving them a source of income and job opportunities. On the other hand, other detrimental societal issues were also mentioned, such as disputes between the community and the harvesters. Other vices that resulted from the activity were drug and alcohol misuse, as well as prostitution. Other outcomes of the conflicts that were mentioned included: disputes between various youth groups; conflicts between the authorities and sand harvesters; tension; miscommunication among harvesters; lack of job opportunities; insecurity; sand harvesting without a license; destruction of farms; failure to pay land owners; and refusal by land owners to sell sand (Kiprotich, 2017).

Similar to this, Isere, Mugatsia, and Agevi (2022) in the Kenyan context stated in their study that although sand harvesting has grown to be a substantial national development activity, its unsustainable collection has had a considerable negative impact on livelihood and the environment. They contend that sand extraction from rivers or streams can harm aquatic ecosystems, lower the quality of the water for customers downstream, and destroy subterranean aquifers. In addition, it results in the loss of agricultural land and other hazardous effects like the creation of deep craters and hollows that frequently collapse, injuring and killing both humans and animals. Additionally, it was discovered that miners were discarding garbage in open pits and riverbeds, which contaminated the surrounding area. The already severe injuries

combined with the noise and dust pollution from tractors, lorries, and dump trucks transporting sand and gravel cause too much anxiety and pain for the locals, who find it difficult to sleep at night as the vehicles chug their way to and from the mining sites. This is consistent with a study by County and Nthambi (2015) on the environmental effects of sand harvesting in the Kathiani Sub-County of Machakos County. The study's head teachers were interviewed, and the results showed that the study was hampered by a lack of water, time lost looking for water, noise from lorries, flooding that rendered the roads impassable, a lack of focus, and waterborne illnesses that caused coughing in the students.

As stated by Maya and Padmalal (2014). In contrast to many other Kenyan counties where sand is mined, Makueni County has seen a notable rise in the number of conflicts involving sand harvesting. "Critical levels with very heavy security implications" have been reached by these cases (Government of Kenya, Office of the Prime Minister, 2012:11). For instance, in sand-related confrontations on December 14, 2011, in Kitovo village in Makueni County, one guy lost his life and another nearly lost both arms (You Tube, December 15th, 2011). According to the January 2012 Makueni County Early Warning Bulletin, fighting in the Nzaui and Mukaa areas had resulted in four fatalities, the burning of trucks and motorcycles, theft of property, rapes, and the forced evacuation of some households from their settlement areas in order to find safety (Government of Kenya, Office of the Prime Minister 2012:11).

The development of COVID-19 has brought more attention to the spread of disease. Insofar as mining produces regions of standing, frequently stagnant water, sand mining is not an exception. Such environmental instability in Kerala, India, may be linked to viral epidemics like the Nipah virus. As noted by Damayanti Datta (2018), “Kerala is

particularly vulnerable to infectious zoonotic diseases since the 1970s: from Bird Flu to Swine Flu, SARS to MERS, Ebola to Zika and finally the Nipah outbreak" in 2018. The malaria vector mosquito, Anopheles sp., may have its hatching grounds in the stagnant pools left over from sand mining, according to a 2017 Science magazine article. Kindu *et al*. (2018) and Torres *et al*. (2017)

With the construction of new buildings and infrastructure, Grenada's need for sand is only growing (Coastal Care, 2013). Sand mining supports the building industry at the expense of the environment and the travel and tourism economy. Sand mining not only endangers the environment but also the country's cultural legacy. Numerous ancient sites in Carriacou, an island belonging to the Grenadines and a dependency of Grenada, have been severely damaged by widespread sand mining. These sites are essential resources for learning about the ways in which past island populations dealt with natural calamities. The effects of sand mining on ancient sites in Carriacou were documented in 2003 by a group of archaeologists led by Scott Fitzpatrick.

2.5.2 Economic Implications of Sand Harvesting and Livelihood Security

For many people worldwide, sand mining is a significant source of both income and employment opportunities (Hackney *et al.*, 2021). Sand resources are under tremendous strain because to the increasing demand, especially in developing and rapidly developing countries like China and India where economic growth demands rapid expansion in infrastructure and building projects (He, Wang, & Yan, 2021). According to a UN estimate from 2020, most people living in arid and semi-arid regions were employed in the sand mining industry. It is also thought to have made a substantial contribution to the improvement of livelihoods and the economic growth of numerous countries. According to UNEP (2019), for instance, nations like Germany, Turkey,

India, Italy, Belgium, and others made over $31 billion in revenue from the export of sand worldwide in 2019. This suggests that the value of sand extends to the development of jobs. Both adults and children are employed as a result of the activity; adults are primarily employed as truck drivers, while children are engaged as sand loaders. The substantial revenue generated by sand mining operations contributes to the beneficiaries' ability to maintain their standard of living.

In Guangzhou, He, Wang, and Yan's (2021) study aimed to determine the spatiotemporal patterns and factors that drive ecosystem service value. The study's findings demonstrated how sand mining has aided in the nation's economic progress, notably in the expansion of the building sector. Since sand is one of the primary raw materials utilized in the construction industry, this was accomplished by creating a local supply of raw materials. Construction industry growth has resulted in the development of important infrastructure, including schools, hospitals, homes, and roadways. The study found that the construction sector was the backbone of economic expansion and is now regarded as a major growth engine and development indicator on a worldwide scale. On the other hand, the study's data collection methodology was unclear.

According to a study by Palma, Dias, and Freitas (2021) on the history of human intervention in Portugal's beach-dune ecosystem, sand mining contributed to the nation's economic growth in the twenty-first century by accelerating coastal development, which included the construction of buildings and communication infrastructure, both of which required a significant amount of sand. The results also revealed that sand is utilized in electronics, water filtration, aeronautics, glass and tile manufacturing, and the building industry.

Because it increases their purchasing power, sand harvesting, like any other economic activity, can assist the locals in meeting their fundamental requirements. According to a 2012 study by Deller and Schreiber on franc sand harvesting and community economic development, communities that rely more heavily on franc sand harvesting for employment have more negative effects following mine closure than positive effects during mine operation, such as difficulty paying for essential medical care.

The study also showed that sand harvesting can, in many cases, lead to well-paying jobs and a decrease in poverty levels. However, it seems that sand harvesting activities are linked to lower community health standards overall. The study came to the conclusion that there is more consistent evidence that harvesting has a positive impact on employment, health, and income growth rates than that there is weak evidence that counties that rely more heavily on harvesting for employment will typically have slower rates of population growth (Deller and Schreiber, 2012).

In the Australian setting, Koehnken & Acreman (2020) examined the effects of riverine sand mining. One of the main conclusions was that, in many mining areas, mining had produced a means of subsistence. Since sand is frequently used to make plaster, mortar, and concrete, it was noted that sand mining is a short- to medium-term activity that is dependent on supply and demand. As a result, sand became more and more in demand as roads, shopping centers, factories, bridges, homes, and mines were built. As a result, it was seen that communities benefited from sand harvesting when it was going on and suffered harm when it was stopped. This is also supported by Naveen (2012), who observes that sand harvesting occurs on the Kurnell Peninsula, where the harvesters use the money, they make to invest in businesses, send their kids to school, and build

structures. Despite the positive effects of sand harvesting on people's lives, it has also resulted in permanent sand loss in certain areas and habitat destruction.

The global sand seas in the USA were assessed by Ahlbrandt & Thomas (2021). The results showed that a wide range of industries, including building and construction, glassmaking, electronics, and aeronautics, are the main sources of the need for sand. However, development and the reclamation of waste land accounted for the majority of its usage. It was also mentioned that mining was necessary for robust structural building, employment generation, economic growth, and government income collecting.

In 2018, Schrecker and Aguilera assessed the impact of the extractive industries in the Netherlands. The research indicates that the rising cost and growing demand for river sand for construction projects have made river sand harvesting a topic of interest in recent years. The report states that it is frequently expected that off-shore sand gathering will replace beach sand harvesting. They suggested that before attempting any river sand collecting, extensive research be conducted.

According to research by Filho, Hunt, and Gavriletea (2021) on the UK's unsustainable sand usage, sand mining negatively affects macroinvertebrates. The study also discovered that human population suffers when the river channel is changed, enlarged, and prolonged and when macroinvertebrate species decline in places where mining is occurring. Due to increased mining, sand mining reduced the variety of fish found in water pools, shallow river sections, and downstream areas, which exacerbated the turbidity of the water. But the report also noted that sand is used in a variety of industries, including hydraulic fracturing, glassmaking, water purification, and building.

In contrast, Singapore's massive land reclamation project primarily depends on sand imported from other Southeast Asian nations. Despite its modest size, Singapore was the world's top importer of sand in 2013 (UN Comtrade, 2019). Between 2007 and 2017 (Lamb *et al.*, 2019b), Singapore bought 80.22 million metric tons of sand that was mined from Cambodia's coasts, contributing to Cambodia's ranking among the top ten global sand exporters by volume up until that point (UN Comtrade, 2019). Less than three million tonnes were shipped to Singapore during the same time period, according to official trade statistics from Cambodia (Thul, 2017). This disparity was covered in a 2017 report by Mother Nature Cambodia, an NGO that has previously released studies outlining the detrimental effects of coastal sand extraction on society and the environment (Boyle, 2017).

Only a small percentage of the sand extracted in Cambodia is exported. Large amounts of river sand are necessary for Cambodia's expanding cities to remain viable. For individuals who move to metropolitan areas, the 1990s' explosive economic expansion has offered the prospect of more economic opportunity (Peou, 2016). Simultaneously, many people are driven from their traditional homelands by environmental degradation and a lack of opportunities in rural areas (Reddy and Sarap, 2017). For instance, the fast-growing commercial fishing industry, sand mining, and climate change are causing dwindling fish stocks in small-scale fishing communities. Because of this, people who live in fishing areas go for jobs elsewhere and transfer money to their relatives who are staying at home (Asif, 2020).

In other regions, escalating droughts and deteriorating soil conditions are forcing farmers to give up on their fields (Reddy and Sarap, 2017). People are drawn to big cities by the prospect of better income. The average monthly income of urban

households in Phnom Penh was USD 700 in 2017, which was significantly greater than the average monthly income of rural households, which was USD 430 (Sok and Chhinh, 2018).

One of the industrial areas that helps Indonesia's economy grow is mining (Suseno, 2019). According to data from Statistics Indonesia (2021), mining and other sector exports were USD 14,041.5 million in June 2021, making up 14.47% of Indonesia's total export earnings. According to Tots *et al*. (2012), this industry not only boosts government revenue but also creates new economic opportunities that enhance societal welfare.

An estimated 3 million tons of sand are needed annually in Karela for construction purposes, according to research conducted in River Pariyar, Karela, India by Binoy *et al*. in 2002. The extraction and distribution of sand from rivers has grown into a thriving sector that employs thousands. Over 60,000 registered laborers in the state are estimated to have direct employment prospects due to sand mining.

Musa (2020) observed that the primary source of building materials in Ghana was sand harvesting in his research on the sociological and ecological effects of sand and gravel mining. He claims that sand is a major component used in Ghana's construction industry to build roads, bridges, and homes. Over time, sand has become more important to Ghana's industrial output. The investigation also showed that youngsters as young as 14 had been forced to work as child labor as a result of the activities. The kids had turned to gathering sand to try and help their parents' put food on the table. The survey found that jobs related to sand collecting were more plentiful. In addition, it was discovered that many in Ghana's coastal regions were either unemployed or underemployed, which forced them to take jobs as tally clerks, sand loaders, and

transporters of sand in order to make ends meet. Because of this, uncontrolled sand harvesting earned a minimum salary of US$55.47 per day, while sand loaders and carriers earn US$2.16, US$1.54, and US$2.16 per day, respectively. The contractors made more money than the loaders, as evidenced by the significant profit margin. The survey also found that the continuous building and housing projects in almost all urban areas were to blame for the increased demand for sand and stones. This is corroborated by (), who points out that sand mining in Benin generates local cash and a variety of informal jobs, leading to subsequent socioeconomic prospects. In West Africa, a number of women and young people are running modest businesses in the sand and gravel mining industry, despite the fact that men still dominate this sector. The profession may be financially rewarding. For instance, the average pay for sand diggers is between US$87 and US$125 per truckload.

The socioeconomic consequences of sand and gravel mining in Lome, Togo, were assessed by Guerrera *et al*. (2021). The findings showed that sand and gravel mining played a significant role in the local economy of Togo. They also mentioned that historically, sand mining has been the second largest source of employment in rural areas of the country, behind agriculture. A significant portion of the local population, including managers, laborers, and truck drivers, were employed in this industry. The young people in Togo now have jobs thanks to the sand and gravel harvesting industry. The family used the money earned to pay for food and other necessities, such as children's tuition. The laborers had no assurance of assistance in the event of an accident and labored in substandard conditions with antiquated equipment (shovels, hoes, and buckets). According to the study, sand harvesting from rivers can provide a feasible alternative means of subsistence in locations where there is a shortage of water because it can replenish itself. This is also supported by (Ayenagbo *et al.*, 2011), who pointed

out that the sand harvesting sector in Togo, together with related transportation and related service sectors, has long played a significant role in the local economy. Sand harvesting has historically been the second-largest source of rural employment in Togo, after agriculture. In Togo, the collecting of sand has given young people jobs. Social and economic factors that might enhance social conditions include income and the creation of local revenue; the majority of this revenue is utilized to provide for the fundamental necessities of the family, such as food, children's tuition, and even entertainment.

According to Bello, Okechuku, and Okindele's (2022) study on the environmental effects of sand harvesting in Nigeria, there are major environmental risks as a result of sand harvesting. It frequently resulted in soil degradation, the loss of biodiversity and agricultural land, as well as an increase in human poverty. The study claims that since the need for sand in the construction and infrastructure development industries is growing, sand harvesting activities are therefore turning into environmental problems. The investigation found that the nation's sand harvesting practices were widespread, largely unsupervised, unregulated, and occurring at an alarming rate. However, the influence of environmental degradation on the economy which is included in this study—was not examined in this study.

According to a 2019 study by Bosco & Sumani on the potential socioeconomic and environmental effects of sand and gravel mining in Ghana, sand has historically contributed more to the country's industrial production. 2018 saw the discovery that sand harvesting had had detrimental effects recently, both in Ghana and globally. The study found that the effects included loss of agricultural land, degradation of the land, and biodiversity loss. The study recommended that in order to enable enforcement at

all levels, practical and unambiguous legislation be established in a participatory manner. In several parts of Ghana, such as the coastal districts close to Accra, sand harvesting has also considerably worsened coastal deterioration. As a result, the Ghanaian government was compelled to spend millions of dollars to stop sea level rise (Mensah, 2002).

It was shown in a study by Igbayiloye & Bradlow (2021) on evaluation of the institutional and legislative framework governing the mining sector in South Africa that farmers had been experiencing water scarcity as a result of sand harvesting. The natural flow of surface water during the monsoon season caused layers of sand to accumulate along the river's course. The layers create a mushy surface that has an impact on the aquifer. Effective control of sand resource extraction is necessary to maintain groundwater supplies without compromising aquifer levels. Rainfall, which is influenced by a variety of factors such as soil type, physical attributes, land topography, and vegetation cover, is the main source of groundwater recharge. In addition, sand is a component of 80% of concrete roads and 90% of asphalted sidewalks, walkways, and patios. The study also demonstrated the significance of sand mining in developing nations like South Africa, where housing and infrastructure were required to guarantee improved living circumstances for all residents.

According to Dongmo *et al*.'s research report from 2021 on the socioeconomic effects of sand harvesting in Cameroon, the industry played a significant role in the people' economic standing. In fact, for a long time, agriculture in rural areas was the primary employer, with sand gathering coming in second. The study revealed that since the nation's independence, the industry has largely been very valuable. Sand mining could therefore help the people living in rural areas to develop. It was also demonstrated that

this delicate sector significantly contributes to the development of rural areas and is linked to the reduction of poverty in many parts of the world, mostly in developing nations. In addition to giving thousands of people living in rural areas jobs, the enterprise has made a significant financial contribution to programs promoting rural communal welfare, education, construction of roads and bridges, and agriculture.

According to the results of a survey conducted in East Africa by Ongoma, Chen, and Omony (2018), mining has a significant negative impact on the environment and food security. Landowners distribute their land for financial benefit, not giving much thought to how mining operations may affect nearby populations or the ecosystem. The report goes on to say that while sand harvesting aids in the development of infrastructure and structures, it also has detrimental repercussions such as severe habitat degradation and the permanent loss of sand in certain locations. Another land-related livelihood activity that the respondents assessed as "severe" is the creation of sand dust. They contend that the region's population's agricultural activities are negatively impacted by sand harvesting dust, which also pollutes the air and has an adverse effect on health.

Gedela, Subhani, and Bahurudeen (2021) conducted research in Tanzania on the conservation of riparian areas' vegetation, animals, and land cover as well as the sustainable management of the effects of sand harvesting. Sand harvesting has an economic impact, according to the research. It has been discovered that sand mining improves the development of infrastructure, including highways. Regarding the detrimental effects of sand harvesting, the study suggested that while it is not possible to entirely stop sand harvesting, new laws and policies should be developed by the government and other relevant parties in order to promote sustainable harvesting by finding a balance between environmental preservation and commercial profits. The

study concludes that in order to meet human need, sand must be mined; but, in order to assure economically and environmentally sustainable exploitation, this requires efficient and effective resource management.

In Machakos County, Kenya, Gichimu & Chepkorir (2022) assessed the socioeconomic and environmental effects of sand mining. According to the findings, sand mining, quarrying, and agriculture were the county's three primary economic sectors; among these, sand mining was shown to be the primary source of income for the majority of the local population. The county council received money from sand mining as well, as levy fees are collected on trucks that transport sand. Sand scoopers and the ladies who prepare food for the temporary workers were thus given employment chances by sand mining. It was discovered that the majority of sand mining occurred around river catchment areas. Nevertheless, the extraction of sand has resulted in environmental issues including water scarcity, which have impacted farming practices. The crops that were farmed in the region, such as cassava, kales, potatoes, cowpeas, chickpeas, and mangoes, were not receiving enough water.

Gitonga, Agwata, and Gathura (2017) evaluated additional variables influencing sand harvesting in Kenya's Machakos County. The report claims that Machakos County has abundant sand resources, which significantly support both local livelihoods and the nation's economic growth. The study claims that as sand is a building material, it is required for many of the nation's construction projects. There is now more strain on the supply of sand due to the rising demand for sand. However, despite the detrimental effects on the ecosystem, unsustainable mining practices continue to be used.

Gathogo and Amimo (2017) conducted a study on the social-environmental effects of river sand mining in Kitui County, Kenya. The benefits of sand harvesting were shown

to include jobs for the villagers, but the amount of money given to them was still insufficient. They emphasized further that although the local community receives relatively little benefit from sand harvesting operations, more harm could result if land is destroyed and the river system is deteriorated. The study also suggested safe and sustainable ways to regulate sand harvesting operations, including making it mandatory for all residents to participate and for laws and regulations to be strictly enforced in order to protect the ecosystem. For this reason, it is imperative that water sources and agricultural land be shielded from destructive operations like sand mining in order to ensure the survival of both the current and future generations. They also mentioned how little this activity benefits the local population. Their meagre pay is insufficient to maintain the natural resource.

Isere, Mugatsia, and Agevi (2022) noted the following in their study on the effects of sand harvesting on river water quality and riparian soil physico-chemical properties in Kenya: sand mining is done in many areas of Kenya in an intensive and unregulated manner, which has had negative effects on the sustainability of the environment and human livelihoods. According to the report, sand mining in Eastern Kenya created thirty thousand jobs. They went on to say that individuals will still work in the business in spite of the risks.

Kiprotich (2017) investigated how sand harvesting along the Kerio River in Kenya's Kerio Valley affected local livelihoods. The study claims that Kenya's sand transportation and harvesting industries have long contributed significantly to the growth of the regional economy. The survey also revealed that while men predominate in the industry, a handful of women are involved in small-scale businesses related to the sand harvesting industry. The report claims that the nation's sand harvesting

industry has greatly increased young employment. The creation of income and local revenue, which is utilized to cover the most basic needs of the family, such as food, children's school fees, and even entertainment, are other benefits linked with sand harvesting.. According to his research, sand extracted from farms in Kenya's Eastern regions—Machueni, Machakos, and Kitui—produces higher-quality sand than sand extracted from the Rift Valley, which is primarily mined along riverbeds.

Similar to this, Isere, Mugatsia, and Agevi (2022) in the Kenyan context stated in their study that although sand harvesting has grown to be a substantial national development activity, its unsustainable collection has had a considerable negative impact on livelihood and the environment. They contend that sand extraction from rivers or streams can harm aquatic ecosystems, lower the quality of the water for customers downstream, and destroy subterranean aquifers. In addition, it results in the loss of agricultural land and other hazardous effects like the creation of deep craters and hollows that frequently collapse, injuring and killing both humans and animals.

Mwaura (2013) conducted a study on the impact of sand harvesting on economic growth in Kenya, using Machakos County as a case study. The study found that harvesting sand and gravel on agricultural land is an alternative livelihood activity for rural people in many areas along river banks, and it is currently a source of income for many rural communities in Machakos County. To make the activities as beneficial to them as feasible, only improvements need to be made.

According to Mutiso's (2012) study, sand harvesting has a negative impact on students' education and school attendance in primary schools in the Kathiani district. This is because the majority of students participate in sand harvesting activities during school hours. Additionally, the study discovered that students often begin to drop out at

standard six and peak at standard seven, just prior to entering their final year of primary school. At standard eight levels, teachers reported a 66.25% increase in dropout rates. The involvement of students in sand harvesting operations led to the incidence of dropouts.

The sand industry in the valley supports large swaths of the local population in addition to young laborers, landowners, and distant extractive agents. Through the sand business, the elders of the Kitet Maasai have made arrangements to address a variety of demands. For instance, unmarried or childless women known as rikiriko or widows are allowed to collect 50–100 KShs (0,30-0,60 US$) at various river sites, and impoverished families with expenses like hospital bills are also provided for through a fund allocated by elders (Bachmann, et. al., 2024). Women without a steady source of income are also given the opportunity to cook and sell food to loaders.

2.5.3 Environmental Implications of Sand Harvesting and Livelihood Security

The type of mineral being mined, the method, the equipment, the chemicals employed in their processes, and the sensitivity of the water resources, aquatic species, and their habitats all affect how mining activity affects the environment in a given area (Jain *et al.*, 2016). The majority of the negative ecological effects of sand mining are related to soil erosion, vegetation loss, landscape degradation, biodiversity loss, grazing land loss, dust pollution, noise pollution, and the loss of economically significant trees. The construction of mines and mining infrastructure has an adverse effect on the environment and public health due to soil, water, and air pollution, as well as noise from blasting. Additional infrastructure built to support mining has an adverse effect on the environment. According to He, Wang, and Yan (2021), sand mining has a positive impact on development and building, but it also permanently removes sand

from riparian areas and severely damages habitats. A depression is made in the riparian zone by the collection of sand. Interference with sand, a banker for various creatures, results. Using a hand shovel to manually harvest sand disturbs the natural ground, causing the top soil to become loose and increasing the risk of soil erosion. Rich soil is flushed down the valley by soil erosion, leaving behind barren ground that is unsuited for farming, which in turn renders the soil infertile. Some species live in the sand that is taken from the earth. Satellite images clearly show the scars left by open pit mining operations on the terrain (Thompson, 2017). Excavated pits and ditches left behind by sand mining operations leave the environment ugly and make the area unsuitable for any kind of useful use (Adedeji, 2014).

By speeding up flow rates and hastening bank erosion, aggregate mining can eliminate formerly useable land. Due to erosion brought on by aggregate extraction in Turkey's Lower Sakarya River, private land was lost, and as a result, the landholders sued the mining firm (Isik, *et al.,* 2008). Similar effects of mining were explored by Harvey & Lisle (1998), who also noted that once this area was destroyed, it was unlikely to be restored anytime soon.

In other ways, aggregate mining might decrease the amount of land accessible for other uses. Between 1985 and 2016, the Paraiba do Sul basin in southeast Brazil saw a substantial rise in the number of deep pools (from 54 to 316) and their area (615 ha to 3,876 ha) due to aggregate extraction. The area of land used for agricultural crops decreased from 24,131.4 ha to 13,780.8 ha over the same era due to an increase in aggregate mining and increased urbanization (Ronquim *et al.*, 2017), which had an effect on the lives of nearby farmers.

Sand mining has been connected to the loss of private land, detrimental effects on fish spawning, and an increase in drownings because of the altered river channel and flow dynamics in Turkey's Sakarya River (Isik, *et al.*, 2008). These effects led to legal action being taken against the miners.

In the Tato River region in northwest Iran, communities close to sand mining sites were surveyed by Farahani & Bayazidi (In Press). On a scale of 1 to 5, the respondents evaluated the costs and advantages of sand mining on the environmental, social, and economic fronts. The average results indicated that the costs were thought to be higher for the environmental and social aspects of the industry than for the economic aspects. Beyond just degrading the quality of building materials, the increasing entrance of saltwater during high tides linked to aggregate mining can have social effects. The most significant food-growing region in Southeast Asia has seen declines in drinking water quality and salinization of agricultural land as a result of such incursion in the Mekong Delta (Anthony *et al.,* 2015), while crop output in Sri Lanka has been negatively impacted (Pereira & Ratnayake, 2013).

A decline in the quality of the environment has affected Tunda Island in Indonesia negatively. According to Syahrial *et al*. (2020), Tunda Island, Serang, Banten's mangrove vegetation's environmental quality was around 73.74%, and it had deviated by 26.26% from its optimal state. Furthermore, the average mangrove diversity value was 1.20, suggesting that most species are unlikely to be disturbed because of the low diversity of mangrove forests and poor vegetative conditions.

The growing turbidity of water bodies is a result of sand mining-related environmental contamination. According to Teng *et al*. (2007), excessive turbidity levels hinder the growth of naturally occurring food sources like plankton by lowering their productivity

in terms of sunlight and water. Total suspended solids (TSS), which are made up of silt, fine sand, and microbes, are closely associated with water turbidity (Budianto and Hariyanto, 2017; Jiang *et al.,* 2021). The ecosystem's quality may be impacted by an increase in TSS concentration in water bodies, which could lead to the extinction of creatures, fish stocks, and microbiology (Jiang *et al.,* 2021; Saberioon *et al.,* 2020). According to Wahyudi *et al*. (2018), sea sand mining on Tunda Island has a negative ecological impact on coastal and marine ecosystems. According to a different study conducted along the Rhine, riverbank erosion is caused by the loss of silt (Kondolf, 1997). Numerous research have demonstrated that riverbank erosion is a result of sand mining in a number of different nations (Bandyopadhyay *et al.,* 2013; Gavriletea, 2017; Yao *et al.,* 2018). Riverbank erosion has a variety of implications. Erosion can lessen floodplains' capacity to hold water, which can raise the danger of floods in addition to increasing the risk of infrastructure collapse near riverbanks (Zhang *et al.,* 2013). The result of sand mining lowering the amount of silt in rivers is erosion. According to one analysis, the rate at which sediment may naturally refill the Mekong River is nine times slower than what is being taken out of it (Hackney *et al.,* 2020). Sand dredging reduces sediment loads overall, but it also causes localized increases in suspended sediment loads (Dai *et al.,* 2009). Because of the increased turbidity, light cannot travel as far through water. This thereby has an effect on phytoplankton, which in turn has an effect on species that feed on phytoplankton (Li *et al.,* 2019).

According to Singh, Pandey, and Shukla's (2017) study, "Assessment of Sand Contamination in the Sediment of River Ghaghara, India," excessive water flow beyond that needed for sediment transportation caused erosion throughout the river. The geomorphology, flow characteristics, and hydraulic state of the river were all impacted by sand extraction from the riverbed. Due to sand harvesting, riverbanks have collapsed

and been undercut, resulting in the loss of nearby land and/or buildings. Upstream erosion is caused by variations in flow velocity and channel slope, but downstream erosion is brought on by changes in the stream's enhanced capacity to carry loads as well as downstream changes in deposition patterns, channel bed characteristics, and habitat type. As a result, the rivers, sea, woods, and other environmental elements have suffered as a result of sand harvesting. The investigation found that unregulated and illegal sand harvesting in the rivers had been made possible by poor administration, unchecked corruption, and illicit sand harvesting, endangering the rivers' very life. This is further demonstrated by Padmalal *et al*. (2007), who found that anthropogenic causes, such as the indiscriminate mining of building grade sand, had an impact on the rivers on the southwesterly coast of India. For instance, the seven rivers that drained the catchments of the Vembanad Lake were primarily impacted since they supplied the materials needed to build Kochi City, one of the fastest-developing urban-cum-industrial centers in the world. The amount of stream mining was almost 40 times greater than the established sustainable levels, which had an impact on the condition of river beds and seriously harmed the ecology of the river environment.

Bagchi (2010) talked about how stream mining has a negative influence on Indian rivers in terms of environmental degradation of the land and surface. Access ramps to the riverbed cause harm to general ecosystems as well as the banks of rivers. Soil erosion occurs as there is disturbance of groundwater and changes in river courses. When sand is consistently removed from river beds, the water flows faster, eroding the banks and beds. According to Kondolf (2007), the river bed can spread out for many kilometers upstream and downstream as the velocity rises. Alluvial water tables may drop as a result. According to Stebbins (2006), stock piling and dumping of excess mining material at mining sites results in instability, significant alterations to channel

morphology, a decreased water table, and sedimentation at mining sites, all of which contribute to the degradation of aquatic and riparian habitat.

Numerous studies conducted in India have identified numerous consequences resulting from sand collecting. According to a research conducted on the Ithikkara River in the Kollam area, of the 25 freshwater fish species found there, sixteen are threatened, primarily as a result of habitat degradation brought on by sand mining. Unrestricted sand extraction and associated disturbances in the Kulsi River, Assam, were shown to be contributing contributors to the fall in the population of river dolphins, according to another study conducted there. Additional investigations have revealed that unlawful sand extraction was occurring along the Shimsha River's banks close to Kokkare Bellur in Bangalore. The environmental implications of mining river sand from the Pamba river were depicted by Padamalal *et al*. (2008), who also emphasized the necessity of controlling mining operations in a way that is environmentally benign.

Uncontrolled sand mining on the banks and beds of India's rivers has resulted in their current state of degradation, which severely affects their ability to support the current levels of economic activity. Thus, extensive sand collecting has taken place. According to The Washington Post, India has the largest construction industry in the world, accounting for 9% of its $2 trillion USD GDP, behind only China and the United States. The nation intends to invest $500 billion USD in infrastructure development, with $500 million USD set out specifically for the construction sector. In India, sand harvesting has had a significant impact on infrastructure. One example is the harvesting that occurs at the base of a major railway bridge that runs north from Mumbai. A little island in the Vaitarna River has totally vanished as a result of sand harvesting in this area, endangering the safety of both long-distance and short-distance commuters. In several

regions of India, extensive sand harvesting has also compromised the integrity of railroad and road bridges (Meli, 2017).

Mangrove trees are starting to disappear as sand dredgers in Narangi, north of Mumbai, sever delicate creeks. Too much sand mining caused river water to engulf rice farms in many parts of India, according to farmers. According to fishermen, it is killing fish, and several riverbank communities are experiencing well dry-ups. This puts the locals in danger of losing their farms and means of subsistence (Sreebha and Padmalal, 2011).

Kuttipuran (2006) provided evidence in support of this impact by pointing out that the loss of ecosystems and flora is typical in the vicinity of Indian rivers, creating an unsightly sight that detracts from the surrounding area's natural attractiveness. Pereira (2012) acknowledged that the illegal construction of roads, storage docks, and other infrastructure for the convenient mining, storing, and transportation of sand from rivers is causing the degradation of mangrove forests in India. Mumbai's soil is now more susceptible to flooding as a result of this. According to Aromolaran (2012), agricultural land is losing its nutritional status and its surface and structure, resulting in land degradation in rural communities.

Morocco has some of the biggest sand mining enterprises in the world along its coastline. The erosion of dunes and sand mining have left the coast with lunar-like landscapes, devastated the littoral marine ecology, and put nearby wetlands in jeopardy. Additionally, mining operations lower the beaches' attractiveness as tourist destinations and make coastal infrastructure more susceptible to storms and sea level rise (Pilkey *et al*. 2007). Mined beaches and dunes have a severe detrimental economic impact on the nearby communities by reducing high-quality tourism and coastal beauty. For example, sand mining in Morocco has left some beaches devoid of sand, leaving only exposed

rock outcrops. As a result, a significant portion of the Moroccan coastline has seen a significant shift in tourism (Pilkey *et al.*, 2022).

In the United States of America, open pits have been left surrounding growing metropolitan centers as a result of pit sand and gravel mining operations (Draggan, 2008). Because of the open trenches that are left on the ground in Nigeria, scenes of accidents involving children and grazing animals are frequent. Lawal (2011) talked about how human activities like mining for sand and gravel in Nigeria cause environmental depreciation. Important timber and fertile land are lost, and habitat changes upend ecosystems and wipe out native species. An increase in turbidity has a significant effect on aquatic animals and the fauna. As a result, before mining, a preliminary assessment on the kind of vegetation present and any potential effects is required (Lawal, 2011).

Commercial gravel extraction to supply aggregate to the building sector has increased recently, especially in the East Gonja District (EGD) and the Northern Region of Ghana. Due mostly to the extinction of commercially significant trees that are native to the area, this has significantly exacerbated desertification and land degradation. This method leaves behind a lot of gullies and bare soil, both of which can hold water during rainy seasons. This may lead to detrimental effects on the ecosystem in addition to health issues for the local communities (Musah, 2009).

During the rainy season, water builds up in the open pits, causing household animals to drown. Sand barges in India pose a threat to fishermen's livelihoods since they frequently ruin their nets (Pereira, 2012). India has also reported fatalities, which had an effect on the country's potential for tourism, agriculture, and fisheries. In the Palakkad District of India, mishaps involving youngsters drowning in open pits filled

with water as they attempt to swim are prevalent, according to Bagchi (2010). This results in the land's potential for recreational use being lost. Farms surrounding Harare now have holes and pits due to over mining caused by massive building (Lupande, 2012). Animals and cattle in Botswana are at risk from pits dug by miners. Large open holes left by land surface disturbance are difficult to economically and physically remediate after mining (Wokorach, 2002).

Schaetzl (1990) described some of the detrimental effects that mining for sand and gravel has on the ecosystem in the different states in the United States. He pointed out that in Michigan and California, the loss of sand in the streambed and along the coast results in the enlargement of river mouths and coastal inlets, as well as the deepening of rivers and estuaries. He went on to say that over mining puts subterranean pipelines, bridge piers, and bridges at risk of excavation. According to Goddard (2007), the excavation and processing of gravel significantly degrades picturesque landscapes. Excessive mining exacerbates exposed hillside and coastal erosion, builds up saltwater up rivers, and makes coasts more susceptible to severe weather.

Stebbins (2006) came to the realization that because all species need particular circumstances to enable their long-term survival, valuable timber resources and wildlife habitats are destroyed. Native species found in streams and rivers have developed special adaptations to pre-human environments, favoring certain species over others. Fisheries production, biodiversity, and recreational opportunities are all lost as a result. Large predatory fish and the intricacy of the environment are reduced as deep pools fill with gravel and silt. Fish passage between pools is hampered by braided flow or subsurface intergravel flow in riffle zones, which is caused by the shallow streambed caused by channel enlargement (Stebbins, 2006). Deforestation, habitat damage, and

biodiversity erosion are all consequences of mining operations (Saviour, 2012). Stebbins (2006) emphasized how mining has destroyed the soil profile and structure in the United States. Mining operations that are on-going completely remove vegetation and destroy topsoil and subsoil, which lowers the number of animals. Saviour (2012) talked about how topsoil mining in India is severely destroying native vegetation and soil profile, which has an impact on local flora and wildlife.

According to a research by Filho, Hunt, and Gavriletea (2021) on the unsustainable use of sand in the UK, sand mining alters the structure of rivers, raises turbidity, and harms macro invertebrates. The study also discovered that human population suffers when the river channel is changed, enlarged, and prolonged and when macro invertebrate species decline in places where mining is occurring. Due to increased mining, sand mining has also resulted in a decline in fish species in shallow water pools and downstream river sections, which has raised the water's turbidity. But the report also noted that sand is used in a variety of industries, including hydraulic fracturing, glassmaking, water purification, and building.

It was estimated in China that the lake is used to harvest about 236 million cubic meters of sand each year. But the ecology pays a heavy price for the extraction. There are several instances all throughout the world, such as Lake Puyong, that demonstrate the detrimental effects that sand mining operations have on the ecosystem. Even while mining already significantly alters the ecosystem, the consequences could be disastrous in the absence of appropriate laws and regulations (He, Wang & Yan, 2021). The study also divided the effects of sand on the environment into three categories: physical, chemical, and biological. Effects on the physical environment include lowering and broadening of riverbeds. Reduced water availability as well as air, soil, and water

pollution are effects on the chemical environment. Because of the negative consequences on the natural ecosystem, there are biological effects such as decreased organism variety and density. The detrimental impacts on the ecosystem were ascribed to the lack of significant policies encouraging the ethical mining and use of sand.

Similarly, according to Hackney's (2021) study on the effects of river sand mining in the USA, the physical effects of sand mining included altering rivers, making the river habitable for aquatic habitats, changing the shape of river beds and floodplains, and eroding groundwater reserves and water quality. Fish diversity and abundance in mined areas have decreased, and riverside flora has been lost as a result of sand mining. Unsustainable sand mining will undoubtedly contribute to bank erosion and shrinking, sinking deltas with the loss of agricultural land, homes, and infrastructure, including roads, dikes, and bridges, by sucking too much sediment out of the world's rivers. However, other effects may not be directly linked to sand mining because rivers are affected by so many different factors, including dams (Hackney 2021). Loss of dunes may change the freshwater table, allowing salt contamination from seawater incursion (salinization) to affect the freshwater supply. Sand mining has the potential to hasten the infiltration of saltwater inland, rendering wood and agricultural land adjacent to shorelines—particularly those surrounding bays and lagoons—unusable for cultivation. The salinization of groundwater, which has contaminated several freshwater wells and rendered at least 25% of the agricultural land in Hyde County, North Carolina, near to Pamlico Sound, is an example of the effects of saltwater intrusion. Beach and dune mining also disrupts marine life by raising water turbidity in the near-shore ocean and affecting creatures that feed on filters (Pilkey *et al.*, 2020).

In 2018, Schrecker and Aguilera assessed the impact of the extractive industries in the Netherlands. The research indicates that the rising cost and growing demand for river sand for construction projects have made river sand harvesting a topic of interest in recent years. The report states that it is frequently expected that off-shore sand gathering will replace beach sand harvesting. They suggested that before attempting any river sand collecting, extensive research be conducted. They went on to say that the power of storm waves is distributed by offshore sand banks, coral reefs, and sea grass beds. If significant amounts of sand are taken from offshore sand banks in places where replenishing is not possible, significant coastal damage would arise in the case of a strong storm.

Results on the effects of sand mining in Austria listed by Rascher, Rindler, & Sass (2018) revealed that conflict has arisen between groups vying for these dwindling resources due to resource depletion and environmental deterioration. Furthermore, after the sand harvesting operation, ambient air pollution was also prevalent. This led to unfavorable health conditions and increased the incidence and severity of respiratory illnesses and disorders. Children are among the most sensitive demographic groups, making them more susceptible. Additionally, exposure to high levels of air pollution may negatively impact children's everyday academic performance. Hospital admissions, death rates, absenteeism, and cognitive deficiencies in children have all been impacted by ambient air pollution. Channel cutting causes lateral instability in the form of rapid stream bank wear out and channel expansion, in addition to vertical instability in the channel bed. When a bank collapses due to the failure of the mechanical qualities of the bank composition to support the weight of the material, vertical cutting lengthens the height of the stream bank. The streambed becomes silted as a result of channel widening when sediments fill deep pools. Elevating the river bank

and widening the channel additionally intensifies temperature fluctuations in the stream, and channel instability hastens the downstream movement of sediments.

The UN report (2020) on the state of the world commission on environment and development states that irresponsible sand and gravel extraction has put tremendous strain on the environment, particularly major rivers, endangering the wellbeing of riverine ecosystems, with small river catchments typically suffering the most. The surrounding riverine ecosystem and river water quality are being deteriorated by the prevalent practice of sand-harvesting rivers. Water bodies that supply water to nearby populations due to mining operations are consistently being reported as being damaged, contaminated, or drying up. By altering chemical parameters including turbidity, TSS, magnesium, and iron, sand harvesting also changes the physio-chemical composition of river water, endangering aquatic and human life.

According to a 2019 UNEP research on human vulnerability to environmental change, sand harvesting can limit animal variety, degrade riverine flora, induce erosion, and pollute water sources. The ecosystem of the dunes and beaches along the coastal zones is also affected. Sand is being pumped into biota by offshore sand extraction, harming the coastal ecology. Water tables in the surrounding areas sink as a result of sand mining, but sand aquifers aid in replenishing the water table (Dongmo *et al.,* 2021). In addition to endangering bridges, sand mining turns riverbeds into sizable, deep holes. This causes the groundwater table to fall, which dries out the drinking water wells on the embankments of these rivers. The research goes on to say that sand being scooped out of river beds speeds up water flow, disrupts flow patterns, and eventually erodes river banks. In addition to these consequences, there are additional related off-site effects, like Sand functions as a sponge, helping to replenish the water table. As a result,

as it gradually disappears from the river, the water tables in the surrounding areas drop, negatively affecting people's everyday life and sometimes their means of subsistence.

According to coauthor Nelson Rangel-Buitrago, mining for dune sand can pose a threat to plant species' ability to survive. Astragalus trifoliatus, the endemic La Hierba de El Tabo dune plant, is restricted to the Las Cruces dune system in the Valparaiso region of central Chile. As a result, dune mining, which is entirely legal in Chile, is putting it in grave danger of going extinct. The potential extinction of a rare species of Acacia tree in southern coastal India, the Vachellia bolei, is another uncomfortable ecological consequence of illicit sand mining, pollution, and development (Kumar, Kathiresan, and Arumugam, 2019). Matt Davis (2019) criticizes the negative impacts of sand mining on wildlife in a different paper. For example, the destruction of its nesting places by sand mining has put the gharial crocodile in India in danger of going extinct, and the Ganges River dolphin may also be in danger of disappearing.

The frequent unlawful practice of mining sand from beaches and dunes has corrupted numerous municipal governments. This has led to the rise of local sand maffias, who occasionally use violence to defend their claimed mining rights, among other things. In India and Southeast Asia, there is particularly considerable opposition to anti-mining legislation (Pikley *et al.,* 2020).

According to Will's (2020) research, sustainable river mining of aggregates in developing nations results in environmental devastation, the eradication of various organisms, and the destruction of fish spawning and nursery areas, all of which alter the composition of aquatic communities. Respondents also assessed the creation of sand dust as "severe." The dust from this activity impacts the health of the rural population as well as their ability to engage in agriculture. The amount of air pollution caused by

dust from mining sites varies depending on a number of factors, including the local microclimate, the size, chemistry, and concentration of dust particles in the surrounding air. In addition to being an annoyance (due to its accumulation on surfaces) and potentially harmful to health, especially for those with respiratory issues, dust pollution can also physically harm nearby plants by obstructing their internal structures and abrading their leaves and cuticles. Additionally, dust pollution can have chemical effects that could affect the plants' long-term survival.

According to a 2019 study by Bosco & Sumani on the potential socioeconomic and environmental effects of sand and gravel mining in Ghana, sand has historically contributed more to the country's industrial production. 2018 saw the discovery that sand harvesting had had detrimental effects recently, both in Ghana and globally. The study found that the effects included loss of agricultural land, degradation of the land, and biodiversity loss. The study recommended that in order to enable enforcement at all levels, practical and unambiguous legislation be established in a participatory manner. In several parts of Ghana, such as the coastal districts close to Accra, sand harvesting has also considerably worsened coastal deterioration.

According to a study by Igbayiloye and Bradlow (2021) on an assessment of the regulatory, legal, and institutional framework of the mining industry in South Africa, overexploitation of sand has a negative impact on the environment. For example, sand mining has resulted in river bed lowering, erosion of river banks, reduced water quality, loss of habitats, and biodiversity. Along with the deterioration of riparian vegetation and the demolition of roads, buildings, and other infrastructure, sand mining has also resulted in increasing erosion. They contend that the reduction in groundwater table caused by sand harvesting operations has detrimental effects on farming operations

because it makes it more difficult for irrigation systems to access water. Because of the polluting of river water and the lowering of the ground water table caused by sand mining, there is now a lack of drinkable water. Additionally, the productivity of the fishery had suffered as a result of it.

Deforestation and biodiversity erosion are consequences of sand harvesting operations. In order to determine the environmental effects of mining generally on the soils surrounding mining locations in Botswana, Ekosse (2004) carried out research. The Kgwakgwe Manganese Mine environs were the focus of the investigation. In order to ascertain the impacts of the mining operation, the chemical characteristics of the soils and plant leaves surrounding the mining regions were examined. Dead zones are created by soil demineralization and contamination of the surrounding environment. Plant growth was seen to be stunted when the soils became polluted. Sand mining close to the ocean allows saltwater to seep in, a process known as salinization (Pereira, 2012).

According to Bello, Okechuku, and Okindele's study from 2022 on the environmental effects of sand harvesting in Nigeria, there are major environmental risks as a result of sand harvesting. It frequently resulted in soil degradation, the loss of biodiversity and agricultural land, as well as an increase in human poverty. The study claims that since the need for sand in the construction and infrastructure development industries is growing, sand harvesting activities are therefore turning into environmental problems. The study also showed that the degradation of the region's topography due to sand harvesting has a negative impact on the environment. The investigation found that the nation's sand harvesting practices were widespread, largely unsupervised, unregulated, and occurring at an alarming rate. However, the influence of environmental degradation on the economy which is included in this study—was not examined in this study.

Aromolaran (2012), who conducted research to look at how sand mining operations affected rural residents in Ogun State, Nigeria who lived on agricultural land, echoes this. Although many individuals agreed that sand had beneficial purposes, the detrimental effects on their land outweighed the advantages. Lawal (2011) emphasized that as demand rises in several states within Nigeria's industry and building sectors, sand mining is quickly turning into an ecological issue. The mining process devalues the environment because it is carried out both legitimately and illegally.

According to the results of a survey conducted in East Africa by Ongoma, Chen, and Omony (2018), mining has a significant negative impact on the environment and food security. Landowners distribute their land for financial benefit, not giving much thought to how mining operations may affect nearby populations or the ecosystem. The report goes on to say that while sand harvesting aids in the development of infrastructure and structures; it also has detrimental repercussions such as severe habitat degradation and the permanent loss of sand in certain locations. Another land-related livelihood activity that the respondents assessed as "severe" is the creation of sand dust. They contend that the region's population's agricultural activities are negatively impacted by sand harvesting dust, which also pollutes the air and has an adverse effect on health. Consequently, one of the main causes of air pollution is dust from sand harvesting sites, albeit the degree of the pollution varies depending on the local microclimate, the amount of dust in the surrounding air, the size, and the chemical makeup of the dust particles.. Dust can have physical effects on the environment and surrounding plants, such as blocking and damaging their internal structures and abrasion of leaves and cuticles, as well as chemical effects that may affect long-term survival. Air pollution is not just an annoyance and may have negative health effects, especially for those with respiratory issues.

In Uganda, Koehnken, Rintoul, and Acreman (2020) evaluated the effects of riverine sand mining. They claim that changing the form and contour of the channel bed and harvesting or dredging materials below the current stream bed have a number of negative effects. These effects include altered channel morphology, expanded channel slope, and deterioration of the channel bed and banks. As a result, the aforementioned effects could cause neighboring land and/or structures to sustain damage as well as undercut and crumple river banks. Increases in channel slope can also cause upstream erosion, as can variations in flow velocity, downstream erosion brought on by the stream's increased carrying capacity, and downstream erosion resulting from modifications to deposition sites. In addition to wearing out the streambed completely to the depth of excavation, persistent harvesting may have an unstable effect on bridges and other infrastructure. Water tables close to the channel bed are lowered as a result of changes in the stream bed and ecosystem caused by bed degradation and bed coarsening, which leads to channel instability.

Gedela, Subhani, and Bahurudeen (2021) conducted research in Tanzania on the conservation of riparian areas' vegetation, animals, and land cover as well as the sustainable management of the effects of sand harvesting. The study outlined a number of detrimental effects of sand harvesting, including the following: removing sand from rivers causes them to widen and deepen, which may eventually have a negative effect on the amount of water in the rivers. The study results indicate that when the sand resource is used irresponsibly, artificial streamlets invariably arise. Additionally, open regions are mined for pit sand and gravel, which exposes deep pits that are dangerous for livestock as well as humans. Furthermore, unchecked mining may result in environmental deterioration and soil erosion. Additionally, it was discovered that miners were discarding garbage in open pits and riverbeds, which contaminated the

surrounding area. The already severe injuries combined with the noise and dust pollution from tractors, lorries, and dump trucks transporting sand and gravel cause too much anxiety and pain for the locals, who find it difficult to sleep at night as the vehicles chug their way to and from the mining sites.

Sand is harvested in Kenya using the open cast method because of its nature and existence, which makes the instances of environmental degradation caused by sand harvesting more noticeable and reflected in the waterways of most nearby environments, according to a study by Mutisya (2006) on the environmental impacts and the socioeconomic impacts of sand harvesting in semi-arid areas. The study confirms that soil erosion has been brought on by sand harvesting in many areas of Kenya, especially in Machakos County, which is the primary source of sand utilized in Nairobi's building industry. Additionally, sand harvesting has a negative impact on the quantity and quality of water and disrupts the aquatic ecology. The transportation of sand by trucks has accelerated soil erosion and disrupted soil stability, resulting in environmental deterioration. The accumulation of sand in the region has severely damaged surface areas by removing vegetation and robbing them of potential agricultural land.

According to Kiprotich's (2017) research on the effects of sand harvesting on livelihoods along the Kerio River in Kerio Valley, Kenya, indiscriminate sand extraction has severely strained the environment, particularly in large rivers, endangering the wellbeing of riverine ecosystems. Small river catchments have typically suffered the most damage. The quality of river water and the surrounding riverine environment is still being deteriorated by the prevalent practice of sand-harvesting rivers. Contamination caused by water bodies that supply populations

nearby with water drying up due to mining activity. By affecting chemical factors including turbidity, magnesium, and iron, sand harvesting alters the physio-chemical composition of river water and puts aquatic and human life at danger.

Similar to this, Isere, Mugatsia, and Agevi (2022) in the Kenyan context stated in their study that although sand harvesting has grown to be a substantial national development activity, its unsustainable collection has had a considerable negative impact on livelihood and the environment. They contend that sand extraction from rivers or streams can harm aquatic ecosystems, lower the quality of the water for customers downstream, and destroy subterranean aquifers. In addition, it results in the loss of agricultural land and other hazardous effects like the creation of deep craters and hollows that frequently collapse, injuring and killing both humans and animals.

The goal of Gitonga, Agwata, and Gathura (2017) was to identify the variables influencing sand harvesting in Kenya's Machakos County. According to the study, sand harvesting raises living standards for those who live along riverbanks and is economically advantageous, but it is not easily sustainable in the long run if appropriate measures are not taken to reduce environmental issues that could foreshadow agricultural activity. Agriculture is crucial because it produces enough food to feed the local population and improves health care. The analysis proved that there had been serious environmental damage caused by sand harvesting. The report lists the drying of aquifers, erosion of riverbanks and beds, air and water pollution, a drop in the water table, and the extinction of priceless animal and tree species as the most significant environmental effects. Therefore, for sustainable sand harvesting, the study suggested participatory sand harvesting.

Mwangi (2007) talked on soil mining's potential benefits and drawbacks as a threat to Kenya's ecology. On rivers, beaches, and plain areas, sand mining and gravel extraction are carried out both legitimately and unlawfully. In support of Mwangi, Wachira (2009) reported on a case study survey on sand mining in Kenya's Machakos District, which is growing as a result of the building industry's need for soil. According to the survey, almost two hundred thousand tonnes of soil are mined and collected year for use in building. Trucks carrying earth go over Mombasa and Thika highways, severely damaging streams in the Machakos and Mwala Districts. Every thirty minutes, five trucks pass at a time.

2.5.4 Regulations and Policy Frame Work for Sand Harvesting

Currently Kenya does not have a national policy or law that directly regulates sand harvesting. The major concern is that sand is a resource that contributes to economic growth of the rural areas contributes to environmental degradation of river drainage basin (Arwa, 2012). With Kenya experiencing huge growth in real estate development which contributes to overall economic growth, effective policies are required to manage sand harvesting which is an important component in the construction process. In Kenya, Under the Environment Management and Coordination Act, sand harvesting requires a proper environmental impact assessment and the approval of a technical sand harvesting committee (IRIN, 2012). However, a lack of resources and interference from political leaders has reportedly hindered these regulations (IRIN, 2012). In addition, sand is not classified as a mineral under harvesting act cap 306 or subsidiary legislation. This means the commissioner of mines through the act does not regulate sand extraction.

Pursuant to the dictates of the Kenyan constitution 2010, article 69, the obligation to respect the environment lies with everybody. The constitution thus, brought with it systems for mineral management. It advocates for sustainable and productive management of land resources, as well as sound conservation and protection of ecologically sensitive areas. The public is encouraged to participate fully at the stage where management strategies are being laid, and at the same time being keen on protection and conservation of the environment, genetic resources and biological diversity. The government is expected to put in place systems and structures of environmental impact assessment, environmental audit and monitoring of the environment; and vote off the processes and activities that are likely to destroy the environment. Therefore, it is an obligation for the government of Kenya to ensure that there is clear policy framework put in place to guide all sand dealers in natural resources utilization and protection of the environment.

Similarly, the National Environmental Management Authority (NEMA) has developed a draft guideline for extraction of sand resource as a temporary solution. NEMA (2007) developed guidelines to provide procedure to streamline sand harvesting in the country with the view of making it sustainable industry that supports economic development for enhanced livelihood while safeguarding the environment. The guidelines were launched on 26th October 2007 by the Minister for Environment and Natural Resources at Mlolongo Township during stakeholder forum that comprised owners of Lorries, transporters, loaders and land owners. NEMA has therefore, sought to streamline sand harvesting activities in the country to ensure environmental protection through (1) conducting Environmental Impact Assessment (EIA) in sand harvesting areas before harvesting, (2) designation of authorized sand harvesting sites on riverbeds, lakeshores, seashores, farms, Government or Trust land, (3) providing procedures in collaboration

with relevant Lead Agencies. Equally, the Kenya's Vision 2030 agenda was started by the Kenyan government with the aim of accomplishing the growth rate of the economy by 10% at the end of year of 2030. Under the social pillar, one of the principal plans championed for by Vision 2030 is the effective and efficient use of natural resources.

The Land Act of 2012 puts clear guidelines for protection of natural resources. The act mandates the commission to make rules and regulations for the sustainable conservation of natural resources. The commission also is expected to put mechanisms to safeguard the ecological communities and their environment; provide monetary and/or material support to communities and individuals to invest in income generating natural resource conservation programs; deduce measures to facilitate the access, use and co-management of forests, water and other resources by communities who have customary rights to these recourses; prepare procedures for the registration of natural resources in an appropriate register; provide clear structures on the involvement of all concerned parties in the management and utilization of natural resources; and arrange for clear systems to see to it that benefits are shared to the affected inhabitants of that region.

According to the County Government Act (2012), county governments are expected to invest returns of sand sales in activities that lead to conservation of the environment and in the development of local community projects within the County. This has not been the case in West Pokot County as evidenced by the recent rampant destruction of roads, river banks, farm lands, fauna and flora among others. There is also no known project funded by the County Government from the proceeds of the sand harvesting activities in the region that can support the economy of the local community.

The ever-increasing interest in sand mining and dumping of sand in shallow waters of many rural rivers and the growing concern for the environment point to the need for management policies that govern the extraction and dumping of sand. Such concerns are also consistent with a global concern for managing environmental consequences associated with mining industries in general (Hassan & Ibrahim, 2012; Warhurst, 2001)

The main area of concern has been how to regulate and provide guidelines and procedures to mitigate the potential socio-economic and environmental damage and enhance the benefits from these activities (Trop 2017; UNEP 2019; Uscinowicz *et al*. 2014). Developing effective guidelines to govern sand extraction is critical to fostering environmentally responsible practices among the sand extractors to minimise the negative impacts on the environment (Vintró, Sanmiquel & Freijo 2014). The major aim of this analysis was to identify regulatory areas of concern associated with sand mining that can be used as important precepts in developing an effective regulatory and policy framework for the industry.

According to Green (2012), in South Africa, a regulatory system has been designed to govern all mining operations with three main themes, which include mineral regulation, environmental regulation and land use planning regulation. However, the regulatory framework is not doing well in terms of serving the three most important objectives, including conserving the resource; permitting an ordered and sustainable exploitation of the resource; and mitigating the environmental impacts associated with sand mining.

The economic development strategies pursued by the government of Kenya over the past decades since independence did not prioritize the development of the Country's mining and mineral resources sector and the development of the Policy further took into account global trends and international best practices relating to the mining industry in

areas such as technology, investments, financing mechanisms and developing mineral markets with due regard also being accorded to regional and local issues affecting the mining and mineral resources sector.

In the recent past, it has been observed that apart from management and systematic mining practices there is an urgent need to have a guideline for effective enforcement of regulatory provision and their monitoring. Therefore, there is a need to develop a sand-mining-industry-specific code of conduct that should punish bad behaviour and reward good practice. Such a code of conduct should be complemented by the introduction of accountability frameworks that will allow sand minors to adopt environmentally responsible practices (DID, 2009). This can be done through introduction of community-wide environmental training programmes to help sensitise sand miners on benefits associated with protecting the environment. Environmental awareness and training may also help in calculating a culture of environmental consciousness by sand minors and the surrounding communities at large. The need to adopt sustainable practices in the sand mining business should be the main emphasis in such training and environmental awareness programmes.

Environmental consequences of floodplain extraction, for example, can be reduced by developing guidelines that require such sand mining activities to be set back from the main channel. There is also an urgent need to develop guidelines that require the maximum depth of floodplain extraction to be maintained above the channel and this practice alone may help limit environmental degradation and morphological consequences that are associated mostly with floodplain extraction.

Discouraging crossing of active channels by heavy equipment may limit compaction of the river bed. This can only be made possible by developing guidelines that would

restrict sand extraction activities to only one side of the active channel. The problem of soil and riverbed erosion can be minimised by developing policy guidelines that require the side slopes of floodplain excavation to be located within an acceptable range. Sand management may also be improved by adopting extraction policies aimed at reducing negative impacts. This can be done, for example, by discouraging mechanical means of sand extraction in certain sections of the river system where the associated river ecosystem is deemed to be very fragile. Manual means of sand extraction may instead be promoted subject to continuous monitoring targeted at matching extraction rate with the replenishment capacity of the river system.

Kuttipuran (2006) has noted that reliance on concrete structures in the construction industry can be lowered if households are encouraged to use wood as an alternative resource. Other long-term measures would include exploring other employment generation methods so as to limit the involvement of communities in sand mining activities. But in the recent past, it has been observed that apart from management and systematic mining practices there is an urgent need to have a guideline for effective enforcement of regulatory provision and their monitoring.

Generally, the aforementioned studies did not bring out clearly the holistic social, economic and environmental impact of sand harvesting on people's livelihoods. This study endeavours to fill this gap by identifying the multiple implications of sand harvesting on livelihoods in West Pokot.

2.6 Literature Review Gap

Sand harvesting has social ramifications including drug usage, prostitution, school dropout, and disputes between sand harvesters and the local community (Dongmo et al., 2021); it has positive, negative, or a combination of effects on livelihoods in a

society (Ghanney, 2020). The knowledge gap here was that there is scanty information available/little empirical studies done on this in West Pokot.

Where it is well structured, Sand mining is a significant source of both income and employment opportunities (Hackney et al., 2021), but under tremendous strain. The gap in the current study was that harvesting was yet to be structured and to bear significant economic gains in the study area.

90% of sand in Kenya comes from rivers (Padmalal and Maya, 2019), but most of the harvesting is open and uncontrolled. The knowledge gap here is that Kenya has no national policy or law that directly regulates sand harvesting (Arwa, 2012).

2.7 Chapter Summary

Sand is a natural resource that exists at valley bottoms of rivers, oceans and seas. It is cheap and heavy resource consisting of very small pieces of rocks and minerals, as a result of weathering that forms beaches and deserts. As a natural resource it has utility and it can be extracted for use in concrete, glass, asphalt and electronics. The mining method depends on its location at or beneath the surface, and whether the resource is worth enough money to justify extracting it. Each mining method also has varying degrees of impact on the surrounding landscape and environment. Sand harvesting is in great demand due to increased demand in the construction industry and with great livelihood benefit. The Kenyan Government and the Kenya's National Environment Management Authority (NEMA) recognize sand as 'an important natural resource whose demand has greatly risen. The increased demand has been precipitated by the pressure to build infrastructure in order to support international competitiveness, rapidly developing economy, industrial development, population growth, and increasingly high standard of living. Socio-economically, sand harvesting is a source

of livelihood through the provision of incomes and employment opportunities. It is also associated with some negative social and economic impacts which threaten the livelihood security. The social, economic, and environmental impacts trigger conflict, depletion of sand in riparian areas and major habitat destruction. From the literature, the missing link identified are the policy and regulatory guidelines and procedures to mitigate the potential socio-economic and environmental damage and multiply the benefits from sand harvesting.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Overview

This chapter presents the process that was involved in carrying out a study. Key issues discussed include: the study area, research design, research paradigm, research approach, target population, sampling techniques, sample size, research instruments, data collection techniques, validity and reliability of research instruments, data analysis techniques, and the ethical considerations.

3.1 Study Area

The study was conducted in West Pokot County, which is one of the 14 counties in the Rift Valley region. It is situated in the North Rift along Kenya's Western boundary with Uganda border. It borders Turkana County to the north and north east, Trans Nzoia County to the south, Elgeyo Marakwet County and Baringo County to the south east and east respectively. The County lies within Longitudes 34° 47'and 35° 49'East and Latitude 1° and 2° North and covers an area of approximately 9,169.4 km2. The County economy is principally driven by agriculture and livestock rearing (County Integrated Development Plan (CIPD), 2018).

3.1.1 Population Density

According to 2019 census, the total population of West Pokot County stood at 621,241. This population comprised of 307,013 males and 314,213 females. The County has a density of 56 people per square km and a total of 93,777 households. The annual growth rate of West Pokot County is 3.1% with an age dependency ratio of 100:122. The County inter-censual growth rate is 5.2 percent which is higher as compared with the

national average of 3.0 percent. The County population is projected to grow to 987,989 and 1,338,990 in 2022 and 2030 respectively (West Pokot Spatial Plan, 2018-2028).

3.1.2 Climatic Conditions

According to CIDP (2018), the County has a bimodal type of rainfall. The long rains fall between April and August while the short rains fall between October and February. There is, however, great variation in the total amount and distribution of the rainfall received in the county. The lowlands receive 600 mm per annum while the highlands receive 1,600 mm per annum. The County experiences great variations in temperature with the lowlands experiencing temperatures of up to 30^0 C and the highlands experiencing moderate temperatures of 15^0 C. These high temperatures in the lowlands cause high evapotranspiration which is unfavourable for crop production. The high-altitude areas with moderate temperatures experience high rainfall and low evapotranspiration hence suitable for crop production.

3.1.3 Oil and Other Mineral Resources

According to CIDP (2018) the County mineral potentials remain untapped (County of hidden treasures). The unexploited minerals include: limestone, gold, and ruby. Additionally, it is noted that massive limestone deposits are found in Sebit, Ortum, Muino, and Alale. The report further indicates a proposed cement industry is to be established in Sebit to fully exploit the limestone deposits. In addition to these potentials, the County has prospect of oil reserve in parts of Pokot North and Central. All these minerals in the County have the potential of generating additional revenue to the County government and improving the livelihoods of the residents. There is need for the County government to enter into private public partnership (PPP) with investors

and other stakeholders to be able to explore and tap these natural resources CIDP (2018).

3.2 Characteristics of the Area under Study

Sand harvesting is carried out in most parts of the county but is mainly in West Pokot sub-County (Spatial Plan: 2018-2028). This study focused on three sand harvesting sites found which include Serewo, Kanyarkwat and Mtembur.

Riwo Ward is one of the County Assembly Wards in Kapenguria Constituency with an estimated population of 27,527 and the Ward Area in Sq. Km (Approx.): 736.40. The County Assembly Ward Description Comprises of Adurkoit, Kanyarkwat, Katikomor, Kreswo, Chepkram, Kamayech, Mtembur, Serewo, Kitalakapel, Kongelai, Poole, Simatwa, Chemakeu, Chesira, Emboasis and Miskwony sub–Locations of West Pokot County.

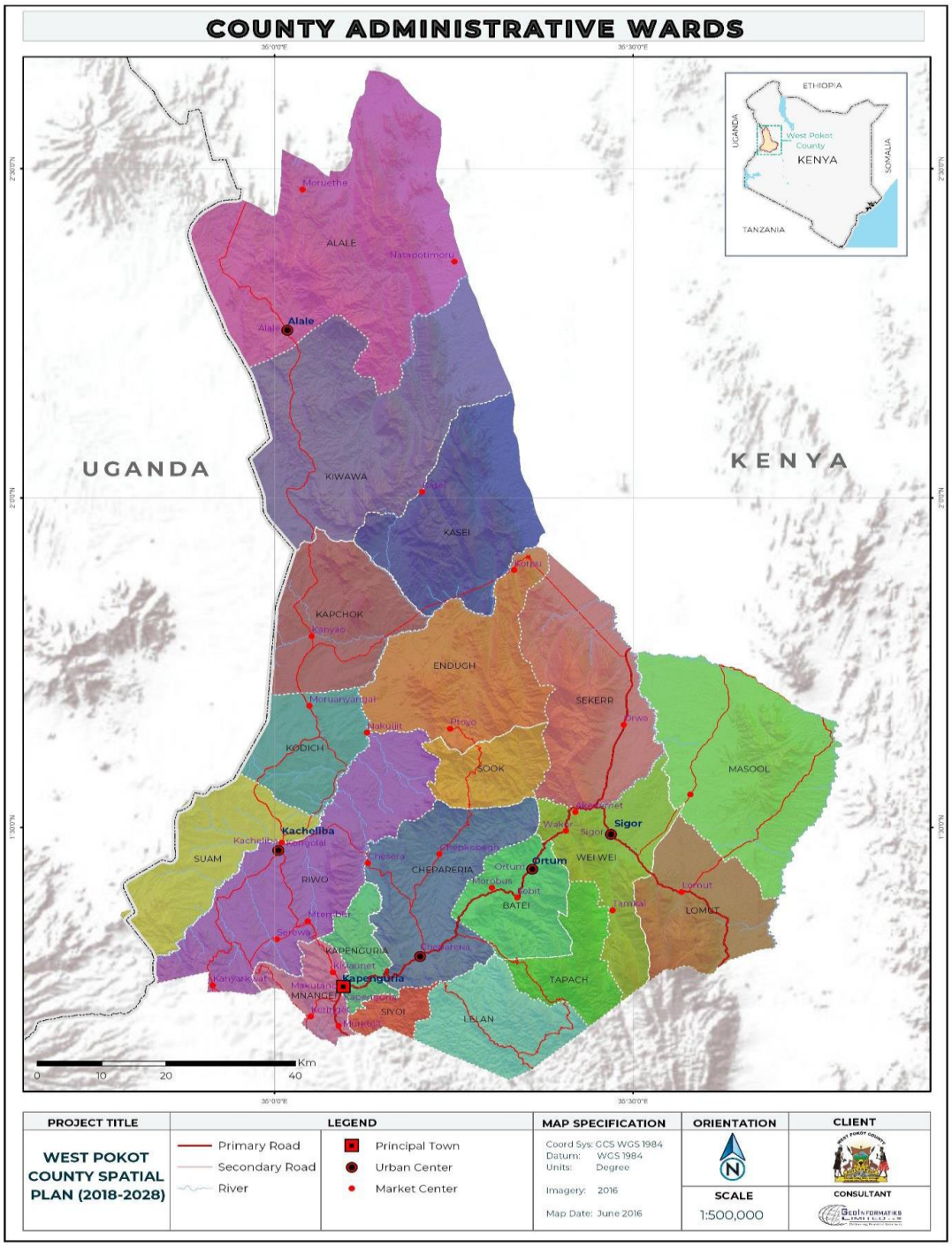

Figure 3.1 West Pokot County Administrative Wards

Source: ©Geoinformatiks Ltd, 2018 in County Spatial plan (2018-2028)

West Pokot County was chosen based on two reasons. First, from a feasibility study I had carried out with National Construction Authority, the area was found to have the best sand in the region. Secondly, the gradient of West Pokot facilitated natural occurance of sand, thus, the focus of the study.

3.3 Philosophical Paradigm

Generally, in social research, the term "paradigm" is used to refer to the philosophical assumptions or to the basic set of beliefs that guide the actions and define the worldview of the researcher (Lincoln *et al.,* 2011). Creswell and Clark (2011) opine that "Worldview," is a synonym for paradigm and is described as "a way of thinking about and making sense of the complexities of the real world". To them there are several paradigms or worldviews that structure and organize modern social work research which includes post positivism, constructivism, participatory action frameworks, or pragmatism. Further, they argue that the paradigms are all essentially philosophical in nature and encompass the following common elements: axiology; beliefs about the role of values and morals in research, ontology: assumptions about the nature of reality; epistemology; assumptions about how we know the world, how we gain knowledge, the relationship between the knower and the known and methodology the shared understanding of best means for gaining knowledge about the world.

3.3.1 Pragmatism Worldview

The study adopted the pragmatic world view. Pragmatism embraces the use of mixed methods and models because it provides an efficient and applied research philosophy, rather than focusing on methods, researchers emphasize the research problem and use all available approaches to understand the problem (Tashakkori and Teddlie 2010). It entails the importance of focusing attention on the research problem and furthermore, using pluralistic methods to derive knowledge about the problem (Creswell, 2013). Through pluralistic approach it is possible to use several approaches for data collection and analysis. Pragmatics "recognise that there are many different ways of interpreting the world and undertaking research, that no single point of view can ever give the entire picture and that there may be multiple realities" (Saunders, Lewis & Thornhill, 2012).

This study was anchored on pragmatism paradigm. Pragmatism was suitable for this study because it is not fixed to any one system since it draws freely from both qualitative and quantitative assumptions and it allows the researcher the freedom to choose the approaches, techniques and procedures that sufficiently guided the conduct of the study.

In addition, pragmatic philosophy has its priorities on the practicality and application of research, to solve human problems. The pragmatic theory insists on constant empirical verification of phenomena in order to ascertain the legitimacy of facts, since it is only through such investigations that the intricacies surrounding the social-economic and environmental implications of sand harvesting can be unravelled. Consequently, the adoption of the philosophy for the present research was partly informed by the realisation to address the social, economic and environmental issues affecting sand harvesting regions. It was necessary that the study results be practically focused by using the findings to develop recommendations to issues affecting people's livelihoods.

Further justification for adopting the pragmatic philosophy and using a mixed method approach for the present research derives from the fact that even though researchers usually present sharp distinctions between inductive and deductive (or qualitative and quantitative) research, the actual research processes, from the stage of research design, data collection, presentation of research results, analysis, discussions and conclusions, do not follow exclusively either of the above approaches (Morgan, 2007). In fact, the research process involves back and forth drawing on the elements of induction and deduction. This drawing on both elements of induction and deduction is called abductive reasoning and is grounded in the philosophy of the pragmatic approach to research (Morgan, 2007). According to Creswell (2003), mixed methods approach is

kin to the repetitive processes that every researcher goes through in drawing on quantitative and qualitative tools, techniques and methods to enable them to find answers to their research questions.

Lastly, it can be argued that pragmatist management researchers can be compared to architects. In the same way architects use whatever materials and methods needed to build the building pragmatist use whatever combination of methods necessary to find the answers to research questions. At the same time, they use a method or combination of methods that advances a specific research in the best possible manner (Saunders *et al*, 2012).

3.4 Research Approach

There are three main research approaches which include quantitative, qualitative and mixed methods. The study applied the mixed method approach.

3.4.1 Mixed Method Approach

The mixed methods include both quantitative and qualitative approaches. Quantitative approach is characterized by an objective positivist search for singular truths that relies on hypothesis, variables and statistics. On the other hand, qualitative approach rejects positivist rule and accepts multiple realities through the study of in-depth cases and can be accessed as being subjective. (Cavana *et.al*. 2001; Creswell, 2008; Neuman, 2007). The advantage of adopting this strategy is that the biases of the quantitative and qualitative approaches can be minimized (Greene, 2008). The possibility of using numerical information for drawing broad conclusions and deep descriptive text on contextual issues enables mixed methods research to produce results that are certainly distinctive from those of the mono research approaches (Sosulski & Lawrence, 2008).

Due to the complexity of issues involved in sand harvesting, a pluralistic method, and for that matter a mix research approach is deemed to be the ideal research approach.

Mixed methods can be used in one of three distinct manners: (a) sequentially where either the quantitative or qualitative approach implementation constitutes a distinct and a different study; (b) in nested fashion where one of the conventional methods becomes the main research approach while the other knowledge claim is more limited in use; and (c) fully integrated where all of the methods are completely combined and simultaneously utilized to investigate the research questions throughout the course of the study (Sosulski and Lawrence, 2008). This study adopted fully integrated approach. Which means the research employed all the relevant quantitative and qualitative elements to address questions of the study at all phases of the research. This is because the intricacies surrounding every stage of the inquiry required that relevant methods are complementary and concurrently utilized to attain a detailed, comprehensive and trustworthy construction of the experiences of the research participants in statistical and deep descriptive data forms as progress will be made throughout the study. Almalki (2016) argues that mixed methods is suitable to any research as it provides comprehensive information, which is not possible to obtain in using singular approach. According to Hlacomb and Hickman (2015) researchers need to use mixed methods design to address complex issues in research like assessing the social –economic and environmental implications of sand harvesting on livelihoods.

According to Creswell (2006) choosing the mixed methods approach relates to three decisions which include: the timing of the use of data collected (i.e. the order in which the data will be utilized) the weight of both qualitative and quantitative approaches (i.e.

the emphasis given to each) and the approach to mixing both datasets (how the two datasets will be related or connected).

3.4.2 Timing

Determining the timing of the quantitative and qualitative methods in crucial when using mixed methods. Bryman & Bell (2015) opines that the concept of timing is discussed in relation to the time the data sets are collected. It refers to the sequence decision, which method precedes which.

In studying social-economic and environmental implications of sand harvesting in West Pokot County, the researcher collected both strands of qualitative and quantitative data at about the same time with equal priority given to both methods. Analysis of both sets of data was kept independent with the intention to merge the data during the overall interpretation. At the end of the study, the researcher looked for convergence, contradictions or relationships between both sets of data.

3.4.3 Weighting

Apart from the timing or sequence decision, the researcher must determine the relative weighting of both approaches in the study. Creswell, (2006) argues that it is essential to consider the relative importance or priority of the quantitative and qualitative methods to answer all possible questions posed by the study. The main question being whether the qualitative or quantitative method is the primary gathering tool or do they both assume the same weight. This choice is also referred to as the priority decision (Morgan, 1998; Bryman & Bell, 2015). The study assumes that both methods assume the same weight.

3.4.4 Mixing

According to Creswell (2009), data for a study can be mixed at data collection, analysis, interpretation or at all the three stages. Data can be merged by embedding one data type on another, transforming and or integrating two different data types together or they can be presented separately and then connected to answer a particular research question(s). In addition, Greene (2015) opines that mixed methods research can be integrated at the levels of method, methodology, and paradigm. In this view, equal-status mixed methods research designs are possible, and they result when both the qualitative and the quantitative components, approaches, and thinking are of equal value, they take control over the research process in alternation, they are in constant interaction, and the outcomes they produce are integrated during and at the end of the research process. The study was based on the assumption that collecting diverse types of data best provided a more complete understanding of a research problem than either qualitative or quantitative data alone and therefore both data collected through the survey in order to generate results to the population and through open ended interviews and focused group discussions (FGD's) to collect detailed views from participants was collected simultaneously. This means that the researcher employed all the relevant quantitative and qualitative elements to address questions of the study at all phases of the research.

3.5 Research Design

The study adopted a descriptive survey design. The process of descriptive survey is used to do collection of data in order to respond to queries that involve the position of the subject under study. Descriptive survey design was useful to enable the researcher gather both qualitative and quantitative information, interpret, summarize, and present for the purpose of clarity Oramide, Jacob and Pillay (2023). Critical to its application

was the process triangulation where mixed methods in sampling, data collection and data analysis were employed. The purpose is to overcome weaknesses in using one method with the strength of another. The findings were integrated during the interpretation phase of the study. Usually, equal priority is given to both approaches (Creswell, 2019).

3.6 Target Population

According to Asiamah *et al*. (2017), a target population is a group of individuals or participants who satisfy the study's particular relevance and interest requirements. The target population in the study comprised of all the 9995 households in the major three sand harvesting areas in Serewo, Kanyarkwat, and Mtembur in West Pokot County. The study population included households' heads, government officials from NEMA, County Natural Resource Officer, County Revenue Officer, 3 land owner's - one from each region, 3 Chiefs, and 3 drivers one from each site and 3 chairpersons from the community groups in the study areas.

3.7 Sampling Procedure and Sample Size

According to Asiamah *et al*. (2017), a sample is a representation of the entire population that has been chosen as representative of the larger population and possesses the necessary knowledge. As a result, data is generated from this last set of people. The act of choosing certain components from the population to represent the full population is known as sampling (Kumar *et al.,* 2019). The researcher used this procedure to choose the informants and respondents who gave the data.

3.7.1 Sample Size Determination

The study employed Robert Krejcie and Daryle Morgan's Table (1970) to determine the sample size. This is a Table of predetermined population and their corresponding

recommended sample sizes. According to 2019 census, the estimated number of households in the three sub locations stood at 9995. For this study, the corresponding sample size for the 9995 households were 368 as indicated in Table 3.1 below.

Table 3.1: Robert V. Krejcie and Daryle W. Morgan's Table (1970) for Sample Size Determination

N	*S*	*N*	*S*	*N*	*S*
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Note.—*N* is population size. *S* is sample size.

Source: *Krejcie & Morgan, 1970*

Based on the above table, one uses the total population (N) to determine the corresponding sample size (S) that is already predetermined, therefore a sample size of 368 was drawn from the corresponding population of 9995 and was proportionately divided based on the population in the 3 sub locations as indicated in Table 3.2.

Table 3.2: Proportionate Sample Size Distribution

Regions	Number of households Population	Proportionate sample size Sample
Serewo	3775	139
Mtembur	3254	120
Kanyarkwat	2955	109
Total	9995	368

Source: Researcher 2022

3.7.2 Sampling Techniques and Procedures

The study employed simple random, systematic and purposive sampling.

3.7.2.1 Simple Random Sampling

Simple random sampling technique was employed to choose household heads (or his/her deputy when the head was absent) who was willing to participate in the study. A household consists of person or group of persons who live together in the same house or compound, share the same housekeeping arrangements and are catered for as one unit.

3.7.2.2 Systematic Random Sampling

The first household was selected randomly in a specific ward, and then every subsequent X^{th} household was selected for the interviews since the households are sparsely distributed. The X range varied in each of the three study locations. In this study, systematic random sampling was considered when choosing the specific households in each of the three study sites. A total of 368 households were selected

using this method. A homestead arrangement was considered as one household to overcome errors of duplication of responses due tocommon characteristics within households in the same homestead.

3.7.2.3 Purposive Sampling

Purposive sampling, also known as judgment sampling, involves selecting informants on purpose based on their personal attributes. It is a non-random technique that does not require a predetermined number of informants or underlying ideas. In other words, the researcher determines what information is necessary and then searches for sources—people with knowledge or experience—who can and are ready to supply it (Bernard 2002, Lewis & Sheppard 2006).

Purposive sampling technique was used to select the three sites for the investigations. One of the advantages of adopting the purposive sampling technique is that it enables the researcher to select only the important characteristics needed for the study. In this study, because of the need of understanding social-economic and environmental implications of sand harvesting on livelihoods security, the priority was on choosing sites where sand harvesting is mainly done. Purposive sampling was also employed to select the 12 key informants for the study based on the purpose of the study, knowledge, experience and the researcher's own judgment, and they were selected based on the in-depth information they held on issues under study. The information gathered from the key informants was used to synchronize with data gathered from the households. The method was also to select the 18 participants in the 3 focused group discussions.

3.8 Data Collection Techniques

The study employed the use of the following data collection techniques: a questionnaire, key informant interviews, focus group discussions, and direct

observation. While the questionnairee generated largely quantitative data, direct observation, key informant interviews and focused group discussions provided in-depth qualitative data.

3.8.1 The Questionnaire Method

The quantitative data was obtained through administration of a closed-ended questionnaire. A questionnaire was administered to household's heads in the study three locations. The questionnaire was useful in gathering views on the community's perception about the entire process of sand harvesting in the study area. The questionnaire was structured using the Likert format with a five-point response scale. According to Zikmund *et al.,* (2013) likert scales with five-point or more are desirable than those that are shorter because they offer more variance, more sensitive and have a higher degree of measurement and information.

The closed-ended question items were used because they are easier to analyse; since they are in an immediate usable form, easier to administer because each item is followed by alternative answers. It was also possible to use a questionnaire because they were literate. The questionnaire was divided into different sections based on the research objectives. The instrument in this study had items that were constructed by the researcher and reliability test was done using Cronbach's' alpha to validate the instruments. They were distributed to the respondents by the researcher and research assistant. A total of 368 copies of the questionnaire were distributed by the help of a research assistant.

3.8.2. Key Informants Interview

Twelve (12) Key informants were purposively selected for interview by the researcher. They included, one representative from NEMA, one County Natural Resource Officer,

one County Revenue Collection Officer, 3 Assistant Chiefs, 3 drivers and 3 chairpersons from the community groups in the study areas. The interview was conducted on different dates and time depending on prior appointment.

3.8.3. Direct Observation Method

Direct observation was employed throughout data collection period. This gave the researcher an opportunity to observe the actual situation in the sand harvesting sites and use the observations to verify or clarify or collaborate information gathered using the other methods. The purpose of the observation was primarily to add naturalistic depth to the interview, to give first-hand situational accounts existing on the ground and to provide an internal validity check from a second source of ethnographic data for corroboration. Observations were direct and were captured by use of photographs. This happened during visits to various places in the three study locations. The researcher observed the people involved in sand harvesting activities, the way sand harvesting was done, the topography of the place, social amenities available, economic activities around the sand harvesting area, evidence of environmental degradation like erosion, the status of infrastructure and how sand was transported.

3.8.3 Focus Group Discussion (FGD)

The views, thoughts and experiences were sought through discussions. This was conducted by holding three focus group discussions comprising of eight to ten participants in the three locations at different days of prior appointment. The focus group discussion provided an opportunity for the researcher to explore and understand the diversity about social, economic and environmental implications on livelihoods. This also allowed the researcher to be exposed to many views held about the county government role in regulating the sand harvesting for environmental sustainability. A

total of three FGDs were conducted. One was with village groups and leaders that control mining areas, another with the sand scoopers and drivers, then the last was with women who sell food stuff to sand workers: drivers and scoopers.

3.8.3 Document Review

According to Blaxter, Hughes & Malcolm (2001), documents help a researcher confirm, modify or contradict his/her findings, enables a researcher to focus attention on analysis, interpretation and compliment data where they do not constitute primary data themselves. Yin (2014) argues that documents help researchers reconstruct past events as well as ongoing processes that are often relatively accurate and it also reflects a certain kind of rationality at work. Taylor (2002) and Creswell (2009) identify common documentary sources for research as public documents like government surveys, legislation, historical records, print media content and private documents such as journals, diaries or letters. These materials were useful in literature review and in discussion of the findings.

3.9 Reliability and Validity of Research Instruments

3.9.1 Reliability and Validity in Quantitative Research

In this study, content validity was established; which refers to the degree to which an instrument measures the subject matter and behaviours the researcher wishes to measure (Oso and Onen, 2008). To establish content validity, the expert judgment method was used, this is where raters/experts review all of the questionnaire items for readability, clarity and comprehensiveness and come to some level of agreement as to which items should be included in the final questionnaire (Sangoseni, Hellman & Hill, 2013). The questionnaire was given to the two supervisors and experts who have

undertaken studies on sand harvesting, sustainable development or resource management.

The other types of validity that was assessed in the questionnaire is face and construct validity. Face validity is achieved when others agree that it looks like it does measure or manipulate the construct of interest (Sangoseni, Hellman, and Hill, 2013). The experts looked at the items in the questionnaire and agreed that the test is a valid measure of the concept which was being measured just on the face of it. Construct validity is the extent to which it really measures (or manipulates) what it claims to measure (or manipulate) (Sangoseni, Hellman, and Hill, 2013).

To achieve reliability of the questionnaire pilot testing was done. The pilot test sort to answer the question; does the questionnaire consistently measure whatever it measures? According to Dikko, (2016) a pilot test of questions helps to identify unclear or ambiguous statements in the research protocol while Van Wijk and Harrison (2013) believe that pilot studies can add value and credibility to the entire research. In essence, a pilot study helps to ascertain how well a research instrument will work in the actual study by identifying potential problems and areas that may require adjustments. In this research, the pilot study was done in Tamkal harvesting site in Sigor region in order to test reliability of the instrument, the developed questionnaire was given to 25 respondents. The same questionnaire was administered to the same group of respondents after a period of two weeks. Data collected from pilot test was analysed using SPSS (Statistical Package for Social Sciences), coefficient of Pearson's product moment for the test-retest was computed in order to establish the extent to which the contents of the questionnaire are consistent in eliciting the same responses every time the instrument is administered.

In addition, reliability is a measure of the degree to which a research instrument yields consistent results or data after repeated trials (Samuelson, 2010). It also implies the extent in which measures are free from random error. Random error affects the reliability of a measure and the extent to which it indicates the extent of the unreliability. In this study the reliability was determined by use of Cronbach alpha coefficient, which was used to assess the internal consistency or homogeneity among the research instrument items (Sekeran, 1992). Generally, studies with an α between 0.80 & 0.95 are considered to have very good reliability because it implies very minimal error hence the results are replicable (Zikmund *et al.,* 2013) although coefficients of 0.62 are acceptable in social science research (Hair *et al.,* 2010). A Cronbach Alpha of more than 0.70 was targeted for the reliability of the instruments in this study.

3.9.2 Reliability and Validity in Qualitative Research

The concepts of reliability and validity are viewed differently by qualitative researchers. In other words, these terms as defined in quantitative terms may not apply to the qualitative research paradigm. The question of replicability in the results does not concern them (Glesne & Peshkin, 1992), but precision (Winter, 2000), credibility, and transferability (Hoepf, 1997) provide the lenses of evaluating the findings of a qualitative research. While the credibility in quantitative research depends on instrument construction, in qualitative research, “the researcher is the instrument" (Patton, 2002). Thus, it seems when quantitative researchers speak of research validity and reliability, they are usually referring to a research that is credible while the credibility of a qualitative research depends on the ability and effort of the researcher. Although reliability and validity are treated separately in quantitative studies, these terms are not viewed separately in qualitative research. Instead, terminology that encompasses both, such as credibility, transferability, and trustworthiness is used.

Trustworthiness in this study was achieved by applying Cuba's five strategies "Model of Trustworthiness", which consists of credibility, transferability, dependability, conformability, and authenticity (Tobin & Begley, 2004). This was applied as a measure to ensure consistency, trustworthiness, data quality, and to safeguard what the participants communicated during their interviews and FGD in order to present an accurate reflection of their views.

Credibility*:* This deals with the concern of whether an explanation is credible. Credibility was established in various ways such as member checks, peer debriefing, extended commitment, and constant inspection (Tobin & Begley, 2004). Furthermore, member checking was ensured through conducting a follow-up interview with participants and offering them an opportunity to comment on the findings. Triangulating the source of data or using peer or external audit account strategies served to confirm the accuracy of the findings of the study and as a means of validating the accuracy of the accounts (Creswell, 2009). During field work, a longer period was spent on the site as the researcher felt that this ultimately increased the trustworthiness of the report.

Transferability*:* Refers to the generalization of the research investigation. In a naturalistic study, this only concerns a case-to-case transfer. Qualitative inquirers need to recognize that the similarity is considerably different in qualitative investigation, as there is no single right or true interpretation in the naturalistic paradigm (Tobin & Begley, 2004). Don Moyer (1990) argues that rejection of usual viewpoints of generalization is necessary, as naturalistic investigations of human beings have personal meanings, which are essential.

Dependability: This was achieved by assessing the consistency of the research process and documentation, and ensuring that the results are traceable and noticeable (Tobin & Begley, 2004). Creswell (2009) states that various rigorous approaches are recommended to ensure that the findings of a study are correct by making sure that the mistakes are corrected through rechecking the transcripts after transcription.

Conformability: This was dealt with during the data analysis and was not supported by the inquirer's opinion, but clearly results from the recorded data. The imperfections were also addressed by introducing authenticity as a fifth criterion.

Authenticity*:* This was illustrated by analyzing and identifying unique themes or characteristics during the investigation in order to understand the phenomenon being studied. To determine whether the results are precise the researcher employed member reviews by presenting the final report or established themes to participants in order to verify the findings.

3.10 Data Analysis

3.10.1 Descriptive Statistics

Zikmund *et al., (*2010) states that descriptive statistics involves transformation of raw data into a form that would be easy to understand since it provides insights of the characteristics of the samples. The study therefore used descriptive statistics which described and compared variables numerically in form of frequency distributions, mean and standard deviations. The mean, which indicates the average performance of a group on some measure of a variable, and the standard deviation, which indicates how spread out a set of scores is around the mean, that is, whether the scores are relatively homogeneous or heterogeneous around the mean Additionally, the study used measures

of variability to see how spread out the scores of each variable that is Kurtosis and other measures of variability such skewedness (Samuelson, 2010). The analysis was done using Statistical package of social sciences (SPSS) version 24 which was considered appropriate because it provided several transformations and manipulation of the data set.

Further, the study used cross tabulations this is because cross tabulation offers a simple method of grouping variables, which minimizes the potential for confusion or error by providing clear results. The use of cross tabulation makes it easier to interpret data and enables the researcher to gain better and deeper insights of the relationship of the variables.

The study performed cross tabulations to establish the relationship among study variables by use of frequencies, pearson Cramers's V coefficient and the Chi Square. The Cramers's V coefficient is a method for determining the strength of association between two categorical variables each of which is measured as binary. The Chi-Square statistic was analyzed through use of test statistic, df and significance value (the p-value). Chi-square tests determine whether or not two variables are independent. If the variables are independent (have no relationship), then the results of the statistical test will be "non-significant" and we are not able to reject the null hypothesis, meaning that we believe there is no relationship between the variables at $P>0.05$. If the variables are related, then the results of the statistical test will be "statistically significant" and we are able to reject the null hypothesis, meaning that we can state that there is some relationship between the variables. The Chi Square explains whether there is a statistically significant association between the two variables. The descriptive statistics analyzed provided a basis for inferential analysis

3.10.1.1 Logistic Regression

Logistic regression is used to predict a categorical (usually dichotomous) variable from a set of predictor variables. It is often chosen if the predictor variables are a mix of continuous and categorical variables. For a logistic regression, the predicted dependent variable is a function of the probability that a particular subject will be in one of the categories (for example, the probability that one is a member of a social group or not).

Membership to a social group was coded = 1, non-membership to social group = 0. The regression model predicted the logit, that is, the natural log of the odds of being a member of a social group or otherwise against the benefits associated with this membership. The general logistic regression is given by;

P (Event) = where

$$\pi=b_0 +b_1x_1 \text{ ---------- (1)}$$

Where $\hat{y}$ is the predicted probability of the event which is coded with 1 (membership to a social group) rather than with 0 (not a member of a social group). The predictor variables (X_i) were; Gender stakeholder involvement whether direct or indirect, membership to a cooperative group, membership to a self-help group, benefits for school fees access, farm input access, welfare support, credit access and beginning of sand prices.

Reparametrizing the model,

$$Y=b_0 +\beta_1X_1+ \beta_2X_{2+\ldots\ldots} BnXn \text{ ---------- (2)}$$

Applying the natural log

$$\text{Logit}(y) = \text{natural log (odds)} = \ln = Z = \beta_0 + \beta_i X_i \text{ ---------- (3)}$$

In order to conduct the logistic regression, a model specification test was conducted to establish whether the logistic regression was the best model to fit in the data.

3.10.1.2 Correctional Analysis

In a correlation analysis, two sets of measurements are obtained on the same individual variables or pairs of individual variables matched in the same way. In this study correlation was done to establish whether there was an association between the variables of interest. The values of the correlation coefficients vary from a value of +1.00 to a value of -1.00 which represents extremely perfect relationships. When independent variables are highly correlated, it becomes difficult to establish the effect of each independent variable on the dependent variable (Hair *et al.,* 2010).In this study Pearson Product Moment Correlation was used to test the association between the variables. The direction and strength of the relationship between the independent variables (social, economic and environmental) and the dependent variable (livelihood) was examined using Pearson Product Moment Correlation analysis.

3.10.1.3 Structural Equation Model

Multiple regression technique was used to show the number of variations explained by the independent variables on the dependent variable through the coefficient of determination (R2). Hypothesis testing was tested using a Structural model analysis.

3.10.1.3.1 Partial Least Squares Structural Equation Modelling (PLS-SEM)

Generally, PLS-SEM estimates partial model structures by combining principal components analysis with ordinary least squares regressions (Mateos-Aparicio, 2011). According to Hair *et al* (2017b) PLS-SEM is referred to as variance-based, since it

accounts for the total variance and uses the total variance to estimate parameters. This study adopted, PLS, based structural equation modelling for the data analysis. Hair *et al.,* (2014) opines that this method is useful for causal-predictive analysis and does not involve assumptions of homogeneity in variances and covariance of the dependent variable. It also can simultaneously test the structural and the measurement models, providing a complete analysis for the interrelationships. The model was appropriate because it makes minimal demands on the data distributions, sample size, and measurement scales (Hair *et al.,* 2014).

The study used SMARTPLS 3 software to establish the existing relationship between key latent variables that affect livelihoods using the partial least square structural equation (PLS-SEM) modelling method. The path model's analysis consists of the structural model and the measurement models. While developing the path model, the sequence of the constructs and the relationships between them was observed to ensure that they represent the hypotheses and their relationship to the theory being tested.

3.10.1.3.2 Specification of the Measurement Model

According to Jarvis *et al.,* (2003) the measurement models represent the relationships between constructs and their corresponding indicator variables however measurement model misspecification is a threat to the validity of SEM results. Therefore, confirmatory tetrad analysis was conducted to ascertain the correct measurement model specification. Confirmatory tetrad analysis allows distinguishing between formative and reflective measurement models Gudergan *et al.,* (2008). Additionally, a bootstrapping method was used to determine the significance levels of the loadings, and path coefficients (Gholami, Sulaiman, & Ramayah, 2013).

3.10.1.4 Qualitative Analysis

Thematic Analysis of the qualitative data proved effective for this study and therefore, was adopted. Jwan (2010), define thematic data analysis as a technique that involves searching for themes of relevance to a research topic under which data from different sources can be organized in a four step-coding system. Although a lot of analysis is essentially thematic, most scholars claim thematic analysis is only operative when researchers talk of "themes emerge from data" because themes are the product of our cognitive constructs and interpretations.

In this study, qualitative data with the answers and responses of all the information provided by the key informants and the focus groups were analysed by creating categories and themes that answer the research objectives. In addition, data from observation and photography was presented through pictures and it provided the researcher an opportunity to directly share reality on matters related in the sand harvesting areas. Since the study adopted the mixed approach, the data collected from quantitative and qualitative methods were completely combined and simultaneously analyzed.

3.11 Ethical Considerations

Ethical considerations in research are critical and important endeavor that require the researcher to protect the dignity of their subjects and publish well the information that is researched (Fouka & Mantzorou, 2011). Ethics are the norms or standards for conduct that distinguish between right and wrong. They help to determine the difference between acceptable and unacceptable behaviour. Ethical considerations are important in research because ethical standards prevent against the fabrication or falsifying of data and therefore, promote the pursuit of knowledge and truth which is the primary goal of

research. It is also critical for collaborative work because it encourages an environment of trust, accountability, and mutual respect among researchers.

Researchers must also adhere to ethical standards in order for the public to support and believe in the research. Because ethical considerations are so important in research, many professional associations and agencies have adopted codes and policies that outline ethical behaviour and guide researchers. These codes address issues such as honesty, objectivity, respect for intellectual property, social responsibility, confidentiality, non-discrimination and many others. These codes and policies provide basic guidelines. The study was undertaken bearing in mind all the ethical concerns and attempt to uphold them. The following logistical and ethical issues were considered: informed consent, privacy and confidentiality, anonymity and researcher's responsibility.

3.11.1 Informed Consent

In order to obtain informed consent and assent, the researcher employed plain language and provided the respondents with comprehensive information about the nature, goal, procedures for gathering data, and scope of the study before it started. The participants were made aware of their freedom to withdraw from the study whenever they want to and to cancel their consent to participate at any time without incurring penalties. All participants gave their informed consent before any data was collected.

3.11.2 Privacy and Confidentiality

Participants, particularly those who were interviewed, were given the assurance by the researcher that the information they provided would be kept private and utilized exclusively for academic purposes. A letter explaining the goal of the investigation and

the researcher's plans to protect respondents' privacy, confidentiality, and identity was sent to them along with the questionnaire.

3.11.3 Anonymity

The respondents in the questionnaires were asked not to write their name anywhere or leave any identifying characteristics on the questionnaire.

3.11.4 Researcher’s Responsibility

The researcher ensured the information obtained was kept confidential, and was used purposely for academic reasons; and before collection of data, the researcher sought approval for the study from the Board of Post-Graduate Studies through the Dean, School Arts and social sciences (Moi University) and research authorization and permit were also obtained from the National Commission for Science, Technology and Innovation (NACOSTI).

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.0 Overview

This chapter entails data presentation, analysis, and interpretations based on the research objectives. The main objective of this study was to examine the social, economic and environmental implications of sand harvesting on livelihood security in West Pokot County, Kenya. The specific research objectives that provided the field study framework were to;

i. Examine the social implications of sand harvesting on livelihood security.
ii. Assess the economic implications of sand harvesting on livelihood security.
iii. Determine the environmental implications of sand harvesting on livelihood security

4.1 The Response Rate

A total number of 368 questionnaires were proportionately distributed to 139 households in Serewa, 120 in Mtembur and 109 in Kanyarkwat. 362 questionnaires out of the 368 that were distributed were retrieved. Therefore, this makes the response rate of 98.3 % though; out of the 362 collected questionnaires only 354 were found to be useful for further analysis. 8 questionnaires were excluded from the analysis due to incompleteness and problems of outliers as explained in Table 4.1. The remaining questionnaires accounted for 96.1% of valid response rate. The response rate in research is a significant concern in a study because it ensures the questionnaires collected are valid for data analysis and the results are representative of the target population (Hair *et al.,* (2010).

Table 4.1: Response Rate

No	Response	Frequency	Percent (%)
1.	No. of distributed questionnaires	368	100
2.	Complete and returned	362	98.3
3.	Unusable questionnaires	8	2.17
	Incomplete and ineligibility Univariate and a multivariate	6 2	1.63 0.54
4.	Returned and usable questionnaires	354	96.1

Source: Researcher, 2022

4.2 Preliminary Analysis Tests

In this study data coding, screening, missing value analysis and the assessment of outliers was carried out to prepare data ready for analysis

4.2.1 Data Coding and Screening

The survey data was screened for a number of potential problems in relation to missing data according to guidelines provided by Tabachnick and Fidell, (2013). The returned questionnaires (362) were keyed into Statistical Package of Social Science (SPSS) Version 23. Each item/question was coded and given a name based on its main variable initials and under the same latent construct. Eight questionnaires that were left blank or had large missing data were discarded and were not included in the analysis.

4.2.2 Missing Values Analysis

Steps were taken by the researcher to prevent the problem of missing data right from the field of data collection in an effort to decrease their rate. Each questionnaire was thoroughly checked upon receipt to make sure that all the questions were properly answered. The variables with missing values were ignored and retained since they had missing values of 5% or fewer cases as suggested by Tabachnick and Fidell (2013).

4.2.3 Analysis of Outliers

Further, data screening involved the treatment and assessment of outliers. Outliers are extreme scores or values of data sets that may significantly affect the analysis and the result of the study (Hair *et al.,* 2010). A total of 2 cases were identified using standardized values as potential univariate outliers while using standardized variable values (z-scores) threshold of more than 3.0 and less than -3.0 being considered outliers by Tabachnick and Fidel (2013). The univariate outliers were deleted from the dataset because they could affect the accuracy of the data analysis technique

4.3 Demographic Profile of Households

This section focuses on the demographic profile of the study participants that provides significant information in articulating the set objectives. In line with this, the gender, age, educational levels, household size and range of income of the household were analyzed. The demographic profile of the respondents provided significant information that acted as intervening variables to the study.

4.3.1 Stakeholders Involvement

The study sought to establish whether the household heads were directly or indirectly involved in sand harvesting activities. The findings indicate that majority 195(54.8%) were not directly involved while 161 (45.2%) were directly involved. Those who were directly involved include the land owners, sand harvesters, loaders and those who were indirectly involved include transporters, the County Government, brokers, business activities around the sand harvesting sites, sand harvesting community organizations. From the focus group discussions, it was noted that the stakeholder involvement was not limited to the community members. Some of the site owners, loaders and transporters were non-residents.

4.3.2 Gender of the Household Heads

The study considered gender of participants and their role in sand harvesting activities since socio-economic and environmental activities affect males and females disproportionately. The intention was to assess the differential opportunities and roles that both male and female play in sand harvesting process.

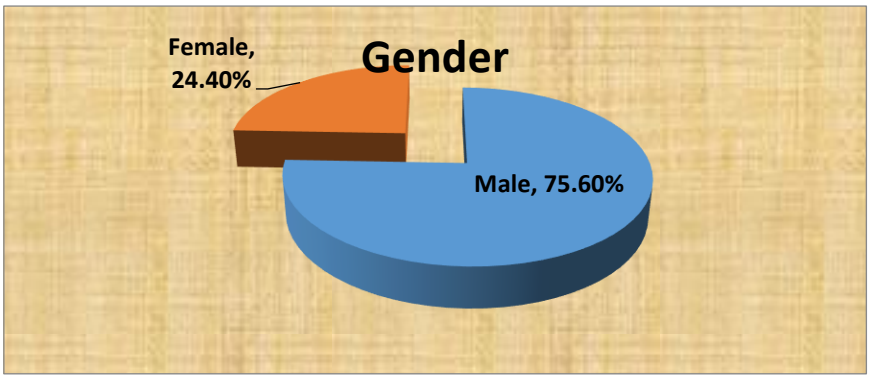

Figure 4.1: Gender of the Household Heads

Source: Researcher, 2022

The survey data as indicated in Figure (4.1) shows that, majority of household heads who participated in the study were men as compared to women. The findings of the study imply that the study was inclusive and that the views of both genders were incorporated in the study to establish the socio-economic and environmental effects of sand harvesting. Additionally, more males took part in the research because sand harvesting is a male dominated activity according to the Pokot culture.

4.3.2.1 Gender and Location

Further, the study conducted a cross-tab analysis to establish how gender determines stakeholders Involvement per location.

Table 4.2: Gender and Location

Stakeholders Involvement						Chi Square			Cramers's V coeff	
Direct	Gender	Serewa	Mtembur	Kanyarakwat	Total	Value	DF	Sig	Value	Sig
	Male	60 (45.5%)	35 (26.5%)	37 (28%)	132	1.099b	2	.577	.083	.577
	Female	15 (51.7%)	5 (17.20%)	9 (31%)	29					
Indirect	Male	38 (27.7%)	63 (46%)	36 (26.3%)	137	8.569c	2	.014	.210	.014
	Female	20 (34.5%)	14 (24.1%)	24 (41.4%)	58					

Source: Researcher, 2022

The cross-tabulation results indicated that there were more male than females who were directly involved in sand harvesting in Serewa compared to Mtembur and Kanyarakwat. The FGD discussion in Serewa revealed that men are directly involved in sand harvesting because they mainly harvest and load the sand into the trucks. It was also observed during the data collection that Serewa had more trucks coming to collect sand as compared to Mtembur and Kanyarakwat this could be attributed to a better road network, price and quality of the sand.

The study further sought to establish the relationship between gender and location of participants in the study in terms of involvement. The results for direct involvement show that the chi square value was not statistically significant (χ^2=, 1.099b df= 2, p=.0577). The cramer's V coefficient measure of association between variables was moderate and the association was not significant (r = .34, p= 0.056). This indicates that gender did not play a significant determinant for direct involvement.

For those who are indirectly involved, the test for independence of relationship (chi square value) was statistically significant (χ^2=8.569c, df= 2, p=.021) with the association being low but significant (r = .022, p=0.014). This shows that gender was a significant determinant for those who are indirectly involved. It can therefore be

concluded that gender was a significant determinant for those who were indirectly involved in sand harvesting activity as compared to those directly involved. The key informant interviews revealed that women are denied direct participation in the sand harvesting activities by the patriarchal norms and thus they find entry through the community-based organization membership and other service industries. Additionally, the FGD at Kayarakwat revealed that socio cultural beliefs in the community does not allow women to engaged in heavy manual work like sand scooping but they can support men by cooking meals for them at the sand harvesting site.

4.3.3 Age of the Household Heads

The age of the respondents plays a significant role in the engagement and has an implication on the decision making and investment capacity in sand harvesting activities.

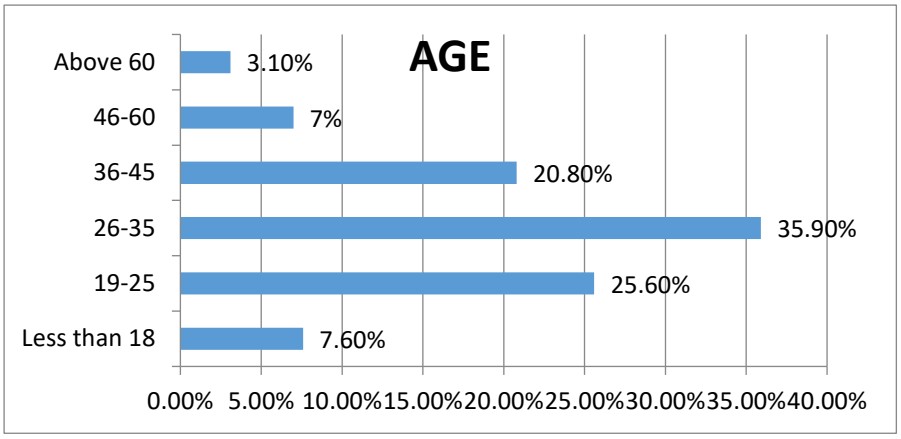

Figure 4.2: Age of the Household Heads

Source: Researcher, 2022

The 26-35 and 36-45 age groups had a high frequency. This implies that it is mostly the youthful segment of the population engage in sand harvesting activities, the majority of the household heads belong to the productive age category. This further implies that they can engage in longer labour hours which enables them to harvest and load the sand

in the trucks. The FGD revealed that most youths engage in sand harvesting activities due to unemployment and low rate of transition to high school and colleges. A study by Hackney (2021) revealed that the major socio-economic factors that affect livelihood choice of rural dwellers are age among other variables.

4.3.3.1 Age and Stakeholders Involvement

The study sought to establish the relationship between age of respondents and their location in terms of whether they were directly or indirectly involved in sand harvesting activity.

Table 4.3: Ages and Location

SI						Chi Square			Cramer's V co-eff.	
Direct	**Age**	**Serewa**	**Mtembur**	**Kanyarkwat**	**Total**	**Value**	**DF**	**Sig**	**Value**	**Sig**
	Less than 18	2 (16.7%)	1 (8.3)	9 (75%)	12	24.252[b]	10	0.007	0.388	0.007
	19-25	18 (45%)	8 (20%)	14 (35%)	40					
	26-35	34 (56.7%)	14 (23.3%)	12 (20%)	60					
	36-45	10 (33.3%	13 (43%)	27 (23.3)	30					
	46-60	8 (53.3%)	3 (20%)	4 (26.7%)	15					
	Above 60	3 (75%)	1 (25%)	0 (0%)	4					
Indirect	Less than 18	3 (20%)	9 (60%)	3(20%	15	24.341[a]	10	0.006	.350	
	19-25	25 (49%)	7 (13%)	19 (37.3%)	51					
	26-35	14 (20.6%)	32 (47.1%)	22 (32.4%)	68					
	36-45	11 (25%)	20 (45.5%)	13 (29.5%)	44					
	46-60	3 (30%)	5 (50%)	2 (20%)	10					
	Above 60	2 (28.6%)	4 (57.1%)	1 (14.3%	7					

Source: Researcher, 2022

The table above illustrates the age and location relationship for the two categories of stakeholder's involvement (direct and indirect). In all the categories, Serewa's age bracket 26-35-years had the highest frequency (56.7%) for those directly involved in sand harvesting. The chi square value for test of independence for those directly

involved in sand harvesting revealed that the relationship was statistically significant. (χ^2= 24.252[b], df= 10, p=.007). The results further show that the Cramer's V coefficient of association was moderate (r= .3888, p=.007). Similarly, for the 'indirect category, there was a strong significant relationship between age and location. χ^2=24.341[a], df= 10, p=.006). This association was moderate and significant (r= .350, p= .008). This means that youthful age group found in the study area was relevant to the sand harvesting economic activities.

From the results, it is observed that there was a statistically significant relationship between age and the location of participants for both participants that were directly and indirectly involved. It is therefore concluded that age and location are highly related as given by the Cramer's V coefficient of association for both categories.

It was observed during the data collection exercise that the young population were engaged in the sand harvesting activities as shown in Plate 4.1 below.

Plate 4.1: The researcher and the youthful Sand Harvesters at Serewo
Source: Field Survey, 2022

From the key informant interviews, it was revealed that their high levels of child labour and school dropout levels in Kanyarkwat area as compared to Serewo and Mtembur. This attributed to the remoteness of the sand mines and the high poverty levels. The sand is cheap resulting into high demand and the area is endowed with many exit routes that facilitate for the evasion of the weighbridge points though the quality of the sand is not good. On the contrary, Mtembur area has the best quality of sand that attracts high prices and demand for the sand. Child labour is also high affecting school attendance.

4.3.4 Education Level of the Participants

The education level is a key determinant of acquisition and application of skills and knowledge. Education is a powerful factor in levelling the field of opportunity as it provides individuals with the capacity to obtain a higher income and standard of living. It is a means of improving people's welfare. Inequality declines as the average level of educational attainment increases, with secondary education producing the greatest payoff.

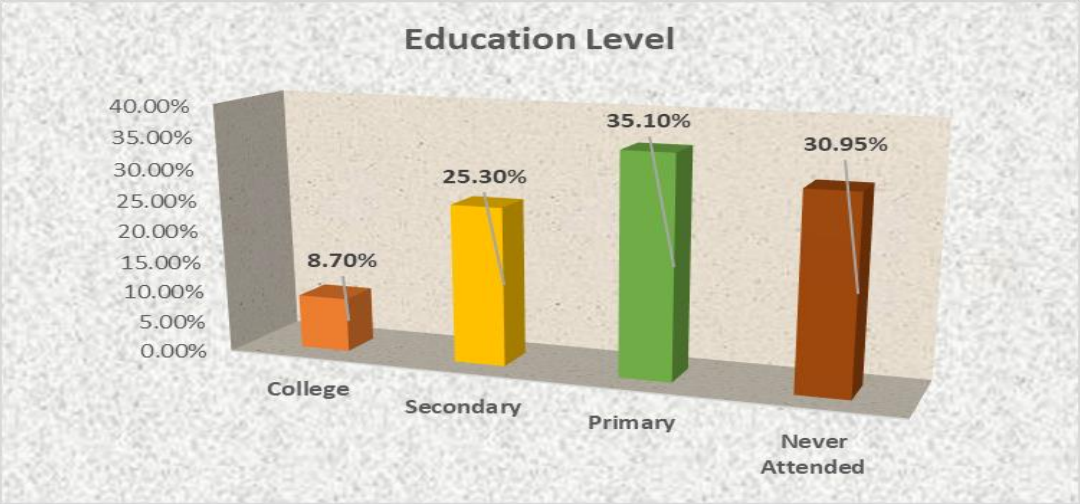

Figure 4.3: Education Level

Source: Researcher, 2022

The study revealed that the majority of the household's heads had attained basic education or had never attended school. From the key informant interview, it was noted that many youths have no formal education resulting to limited employment opportunities in the formal sector. Sand harvesting becomes the only available alternative which does not need any formal skills with less entry and exit restrictions. The determining factor is the application of the physical strength of the harvester

The Focus Group Discussion (FGD) at Mtembur revealed that the majority of the youths do not proceed to secondary or to college due to several reasons such as; poverty and low income, unemployment, low grades, early pregnancies and peer pressure which contributes to education apathy. The above view concurs with the findings by Tesi, Tesi & Enete (2018) that the operation of sand mining is relatively unsophisticated, rudimentary and does not require any form of education or special training.

4.3.4.1 Education and Stakeholders Involvement

The study sought to establish the relationship between level of education and location of respondents through their involvement (direct or indirect).

Table 4.4 shows the level of education against location of sand harvesting sites for the two main categories of involvement.

Table 4.4 Education and Location

SI						Chi Square			Cramers's V coeff	
Direct	Education	Serewa	Mtembur	Kanyarakwat	Total	Value	DF	Sig	Value	Sig
	Never Attended	19 (46.3%)	5 (12.2%)	17 (41.5%)	41	+10.563 b	6	.103	.256	.103
	Primary	23 (38.3%)	20 (33.3%)	17 (28.3%)	60					
	Secondary	21 (52.5%)	11 (27.5%)	8 (20%)	40					

	College	12 (60%)	4 (20%)	4 (20%)	20					
Indirect	Never Attended	15 (21.7%)	27 (39.1%)	27 (39.1%)	69	19.115c	6	.004	.313	.004
	Primary	13 (20%)	30 (46.2%)	22 (33.8%)	65					
	Secondary	23 (46%)	17 (34%)	10 (20%)	50					
	College	7 (63.6%)	3 (27.3%)	1 (9.1%)	11					

Source: *Researcher, 2022*

The findings indicate that the chi square results for those who are directly involved were statistically not significant. (χ^2=. 10.563b, df= 6, p=.103) implying that education and location were independent of each other. Further, the Cramer's V coefficient of association was low (r =.256.) and not significant (p=.103).

Findings for those who were indirectly involved revealed that the relationship between education and location was statistically significant (χ^2= 19.115c, df= 4, p=.004). Further, that the association among the variables was moderate and significant (r =.313, p= .004). This means that for those in groups or associations, education was not a determinant. However, for those who did the actual work in the sites, the level of education was significant favoring the least or never formally educated cohort/.

It was further observed that 38.3% of those who were indirectly involved had a primary level of education and were in Serewa. Additionally, 66.3 % of those who were indirectly involved were also in Serewa and had college level of education. The findings indicate that the level of education is a significant determinant of indirect involvement in sand harvesting activities. A key informant reiterated that the community members with high levels of education do not engage directly in sand harvesting, they form community-based organization, act as middlemen (brokers) and provide other services to the miners.

4.3.5 Marital Status

Marital status is an important aspect among households in the African society due to its influence on decision making, recognition, respect, involvement in community activities and asset endowment.

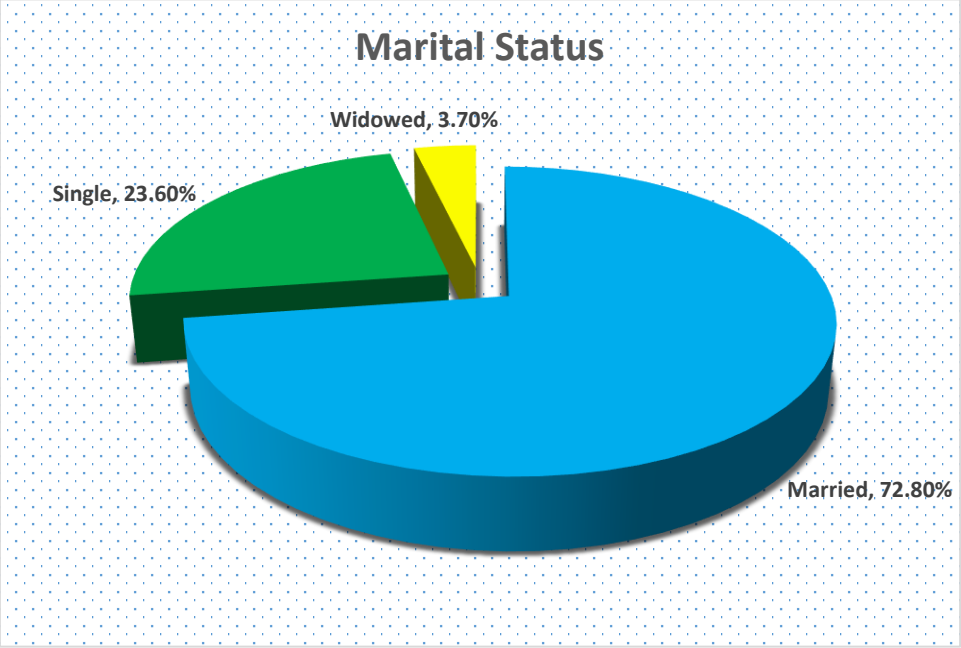

Figure 4.4: Marital Status

Source*: Researcher, 2022*

The study found out that over three quarters of the respondents were married. Involvement in sand harvesting activities for the married is driven by the fact that they have a family to cater for. The FGDs in all the three sites gave similar observations that men are the decision-makers in the households and they have greater access and control of incomes from sand harvesting activities and returns that translate into improved livelihoods. For a married woman there is high probability for them to benefit more due to the greater direct involvement of the man through ownership of the mines and the indirect involvement of the woman thus accruing double benefits. Such a household can have multiple benefits from community share, by virtue of owning the harvesting

site, participating in the scooping and loading of sand, and becoming a CBO member. A key informant pointed out the distribution benefits from the sand harvesting is shared to the community through CBOs. Community belonging is informed to a large extent by the members' marital status.

4.3.6 Household Size

The number of household members is an indicator of the dependency level and influences the households' ability to save and invest. In the African culture, a bigger size of the household is associated with wealth, labour security, respect and recognition (Regasa *et al,* 2019). The study sought to establish the household size.

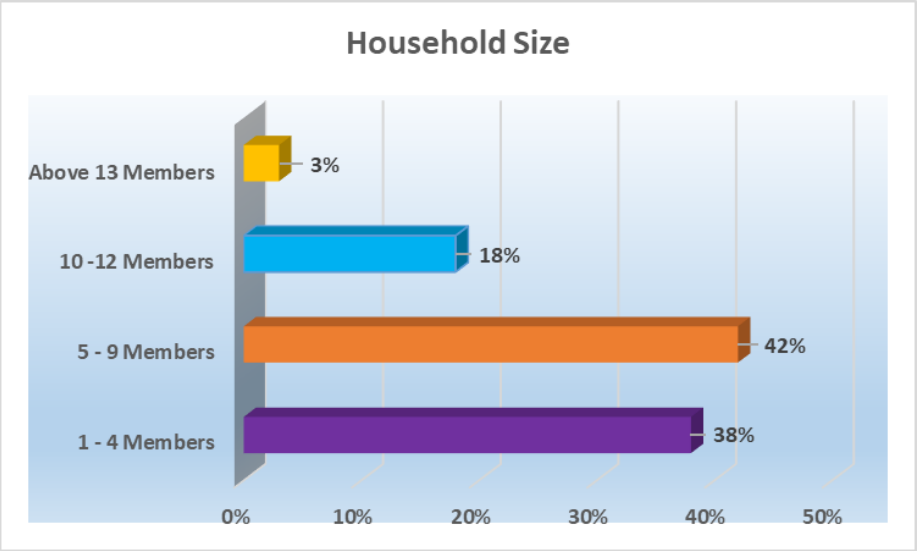

Figure 4.5 Household Size

Source: Researcher, 2022

The findings indicate that most of the household consist of 5 to 9 household members at 42%, 1-4 members at 38%, 10-12 members at 18% and those above 13 members at 3%. This implies high dependency though ideally; the large sized households are an incentive for the household heads to invest more working hours in sand harvesting in order to earn enough to sustain household demands. The large households guarantee

more labour for engagement in sand harvesting activities, and thus more returns. Bosco & Sumani (2019) observed that large family size has a significant relationship with a much greater risk of poverty and food insecurity. This can be related to the findings of this study where the majority of the households have a family size of between 5 and 9 family members which could be regarded as large family size.

4.3.6.1 Household size and Stakeholders Involvement

Table 4.5 illustrates the household size and location of sand harvesting relationship for the two categories of involvement.

Table 4.5: Household Size and Location

SI						Chi Square			Cramers's V coeff	
Direct	**Household**	**Serewa**	**Mtembur**	**Kanyarakwat**	**Total**	**Value**	**DF**	**Sig**	**Value**	**Sig**
	1-4	29 (43.9%)	17 (25.8%)	20 (30.3%)	66	3.815[b]	6	.702	.154	.702
	5-9	33 (48.5%)	17 (25%)	18 (26.5%)	68					
	10-12	13 (50%)	5 (19.2%)	8 (30.8%)	26					
	Above 13	0 (0.00%	1 (100%)	0 (0.00%)	1					
Indirect	1-4	23 (33.8%)	23 (33.8%)	22 (32.4%)	4.100[c]	6	.663	.132	.404	4.100[c]
	5-9	24 (30%)	33 (41.3%)	23 (28.8%)						
	10-12	9 (23.1%	16 (41%)	14 (35.9%)						
	Above 13	2 (25%)	5 (62.5%)	1 (12.5%)						

Source: *Researcher, 2022*

The findings revealed that households ranging from 10-12 persons had the highest frequency (50%) and were found in Serewa location. For those indirectly involved in sand harvesting, the highest frequency (62.5%) was found in Mtembur location with a family size of over 13 members. The Chi square test for independence of relationship for those who are directly involved revealed that a statistically insignificant relationship. (χ^2=. 3.815b, df= 6, p=.702). The results further revealed that the Cramer's

V coefficient of association was very low and not significant (r= .154, p=.702). For the 'indirectly involved category, the association between household size and location was not significant (Chi square value was χ^2= 4.100c, df= 6, p=.663) and this association was very low and not significant (r=. 132, p=. 404). The implication of these findings is that household size does not determine whether participants can be involved in sand harvesting activities directly or indirectly for all the locations.

4.3.7 Major Economic Activities

Economic activities have the greatest potential to serve as motors of economic growth, reducing poverty while improving income distribution. Households derive their source of livelihoods from various economic activities for survival.

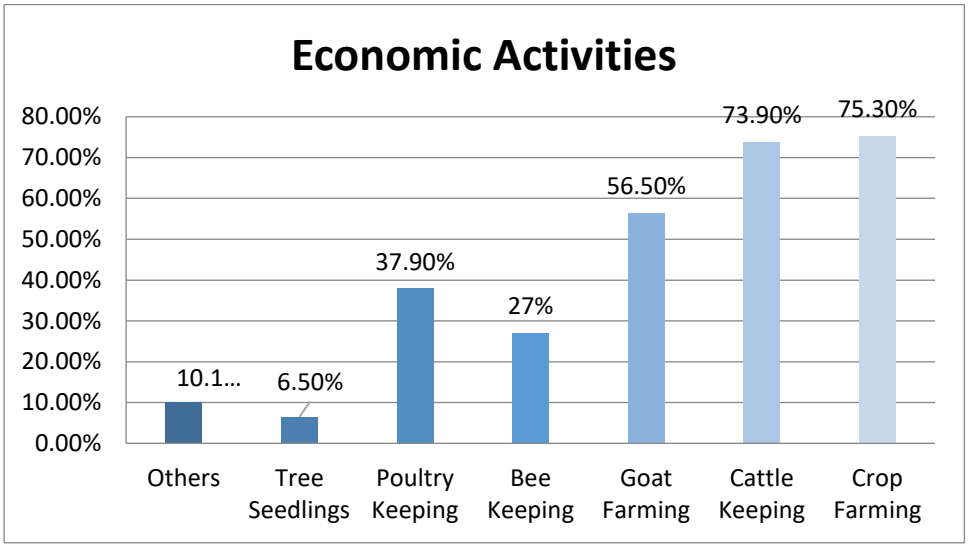

Figure 4.6 Economic Activities

Source: Researcher, 2022

The households engage in different economic activities as shown in Figure 4.6. Most households engage in crop farming and animal husbandry implying that households diversify their sources of livelihoods. The other economic activities engaged by the

households include charcoal burning, small scale business and casual labourers in other sectors.

> " *…….the money I get from the CBOs yearly I use for purchasing bee hives, pay school fees and… I have added more goats…..we are given free seeds from the County Government… sometimes we harvest very well other times we use as animal feeds…" FGD participant in Serewa 10th June, 2020.*

The findings are consistent with Koehnken, Rintoul & Acreman (2020), who opine that households diversify because of the need to enhance their capabilities and assets, realization of economies of scale, liquidity constraints and to stabilize income flows and consumption risk. According to OECD, (2011) households seek to diversify their livelihood to help reduce risks, particularly those associated with seasonality of rain-fed agriculture and termination of mineral extraction.

4.3.8 Range of Income

The range of household income informs household decision to invest in income generating

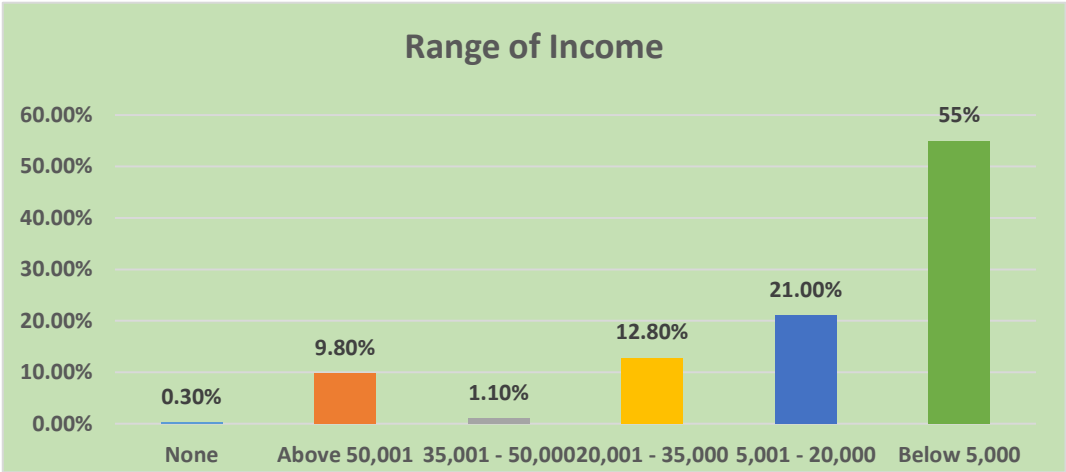

Figure 4.7: Range of Income

Source: Researcher, 2022

The findings indicate that majority earn below Kshs 5,000 per month from sand harvesting. The second categories earn between Ksh 5,000 to 20,000, the third category Ksh 20,000 to 35,000 and those who earn above Kshs 50,000 are landowners. From the FGD the general feeling was that the income earned was very low and yet they use a lot of their time and energy to harvest and load the sand. In addition, there is a lot of exploitation from the middlemen (brokers) who handle the cash on behalf of the site owners and other labourers.

4.3.8.1 Income and Stakeholders Involvement

Table 4.6 below illustrates the income and location of sand harvesting relationships for the two categories of involvement.

Table 4.6: Income and Location

SI						Chi Square			Cramers's V coeff	
Direct	**Income**	**Serewa**	**Mtembur**	**Kanyarakwat**	**Total**	**Value**	**DF**	**Sig**	**Value**	**Sig**
	Below 5,000	39 (41.9%)	28 (30.1%)	26 (28%)	93	7.972 b	8	.436	.223	.436
	5,001-20,000	24 (50%)	10 (20.8%)	14 (29.2%)	48					
	20,001-35,000	8 (66.7%)	1 (8.3%)	3 (25%)	12					
	35,001-50,000	8 (66.7%)	1 (8.3%)	3 (25%)	12					
	Above 50,001	2 (100%)	0 (0%)	0 (0%)	2					
Indirect	Below 5,000	22 (21.2%)	50 (48.1%)	32 (30.8%)	104	26.972c	10	.003	.372	.003
	5,001-20,000	10 (35.7%)	6 (21.4%)	12 (42.9%)	28					
	20,001-35,000	11 (35.5%)	17 (54.8%)	3 (9.7%)	31					
	35,001-50,000	1 (50%)	0 (0%)	1 (50%)	2					
	Below 5,000	13 (44.8%)	4 (13.8%)	12 (41.4%)	29					

Source: Researcher, 2022

The findings revealed that the highest frequencies for those who are directly involved with income ranging from 20,001-35,000(66.7%) were located in Serewa while those

indirectly involved with income ranging from 20,001-35,000(54.8%) were located in Mtembur location. The chi square test value for independence for those who are directly involved revealed that it was statistically significant (χ^2=.7.972b, df= 8, p=.436). The results further revealed that the Cramer's V coefficient of association was very low and not significant (r= .223, p=.436) but significant for those indirectly involved, (χ^2=26.972c, df= 10, p=.003). This association was moderate and significant (r=.372, p=. 003). The implications of the findings is that if one is directly involved location does not determine how much they earn from sand harvesting but for those who are indirectly involved location determines how much they earn. This means that the least income earners went to specific sand harvesting areas to access daily wage.

4.4 Social Implications and Livelihood Security

The first objective of the study was to evaluate the social implications of sand harvesting on livelihood security. Social ties in sand harvesting are essential in opening up livelihood opportunities. The study sought to establish the social group belongingness, reasons why some do not join the groups and membership benefits.

4.4.1 Social Group Belongingness

The results show that majority belong to self-help groups and community-based organizations such as Mesako CBO as shown in plate 4.2. The majority of the respondents belong to the self-help groups 172 (48.3%) due to the benefits that come along with being a member, for example the education bursary allocation for their children and free seeds.

Plate 4.2: Community Based Organization in Mtembur

Source: Field Survey, 2022

4.4.1.1 Reasons for not joining the Group

It was further established that the main reasons why some have not joined the social groups include lack of membership fee, social class and lack of identity cards.

According an FGD participant at Serewo,

> *"… I don't have identity card.... was denied entry into the welfare group , I am in process of applying for one though I have two children and am a resident in this community…"*(10th June, 2020).

Another respondent added that she could not join any group because she could not afford to raise the required registration fee of Ksh 1000. The FGD Mtembur revealed that the low-income levels act as a barrier to group inclusion because most groups charge membership fees and rotational funds to support members and those without identity cards cannot be recruited as members of any group since that is the main requirement for registration. Additionally, Kiprotich (2017) opines that ethnicity, marital status and health are the most important determinants of social participation in groups. Principi, *et al* (2016) notes that education, income, and health are the most

important determinants of volunteering in social groups while higher income and education foster higher levels of civic participation.

Table 4.7: Social Group Belongingness community

Social Group Belongingness	Frequency	Percentage (%)
Group		
Community Based Organization	151	42.4
Cooperative society	76	21.3
Self-help group	172	48.3
Welfare Group	126	35.4
Reasons for not joining a social group		
Lack of Identity Card (ID)	63	17.7
Ethnic Reasons	49	13.8
Social class	64	18
Lack of membership fee	99	27.8
Membership Benefits		
Welfare Support	214	60.1
Farm input access	201	56.5
Collective Bargaining power for sand prices	63	17.7
Credit Access	179	50.3
School fees access	190	53.4

Source Researcher, 2022

4.4.1.2 Membership Benefits

The study further revealed that the main membership benefits enjoyed in the groups include welfare support and farm inputs access however collective bargaining power for sand prices was ranked the least. The key informant interview with Mesako community-based organization chairman revealed that registered members received ksh 13,000 per child in the year 2020 for school fees and farm inputs. In addition, the group had bought a plot and constructed 12 rental units at Makutano from sand harvesting money collected.

These results agree with Field, (2017) findings that through social capital networks, individuals can access information to access services or goods in the society. According to Greenberg *et al.*, (2017) groups can provide access to opportunities, such as providing participants information about job openings and enhance social networks through involvement in the local community and affiliated institutions. They further pointed out that social group benefits conferred to individuals include: risk management, social insurance, and better management of shared resources through group action. The study observed that the benefits associated with collective bargaining power for sand prices was ranked the least yet it is considered very significant determinant of livelihood security. This can be attributed to the low entrepreneurial skills, ignorance and poor local leadership.

4.4.2 Social Capital and Benefits: Logistic Model

Logistic regression is used to predict a categorical (usually dichotomous) variable from a set of predictor variables. It is often chosen if the predictor variables are a mix of continuous and categorical variables. For a logistic regression, the predicted dependent variable is a function of the probability that a particular subject will be in one of the categories (for example, the probability that one is a member of a social group or not)

Membership to a social group was coded = 1, non-membership to social group = 0. The regression model predicted the logit, that is, the natural log of the odds of being a member of a social group or otherwise against the benefits associated with this membership. The general logistic regression is given by;

P(Event) = where

$$\pi=b_0 +b_1x_1 \text{ ---------- (1)}$$

Where ŷ is the predicted probability of the event which is coded with 1 (membership to a social group) rather than with 0 (not a member of a social group). The predictor variables (X_i) were; Gender, stakeholder involvement (direct or indirect), membership to a cooperative group, membership to a self-help group, benefits for school fees access, farm input access, welfare support, credit access and bargaining of sand prices.

Reparameterizing the model,

$$Y=b_0 +\beta_1X_1+ \beta_2X_{2+\ldots\ldots} \beta_nX_n \text{ ----------(2)}$$

Applying the natural log

$$\text{Logit } (y)= \text{natural log(odds)} =\ln = Z= \beta_0 + \beta_iX_i \text{ ----------(3)}$$

In order to conduct the logistic regression, a model specification test was conducted to establish whether the logistic regression was the best model to fit in the data.

Table 4.8: Model Test Specification

Specification Tests	Chi-square	df	Sig.
Omnibus Tests of Model Coefficients	123.246	13	.000
Goodness-of-fit Hosmer and Lemeshow Test	11.116	8	.195

Source: Researcher, 2021

The omnibus tests of model coefficient was statistically significant (χ^2 (356) = 123.246, df =13, p=.000<.05. The inferential goodness-of-fit test is the Hosmer–Lemeshow (H–L) test that yielded χ^2 (356) = 11.116, df =8, p=.195>0.05 and was significant ($p > .05$), suggesting that the model was fit for the data.

Table 4.9: Predicted Classification Table

Observed		Predicted		
		Memb1 Sand Harvesting Group		Percentage Correct
		YES	NO	
Memb1 Sand Harvesting Group	YES	82	69	54.3
	NO	33	172	83.9
Overall Percentage				71.3

Source: Researcher, 2022

The model was able to predict 71.3% correctly. From the Table 4.9, 172(83.9%) stated that they did not belong to a sand harvesting group while 69(54.3%) indicated that they belong to a sand harvesting group. A research hypothesis posed to the data was that "the likelihood that a member who belongs to a sand harvesting group is likely to benefit from this membership. Benefits accruing from membership of a sand harvesting group was considered a strong indicator of livelihood security.

4.4.2.1 Logistic Regression Analysis

A binary logistic model was fitted to the data to test the research hypothesis regarding the relationship between the likelihood that a participant who belongs to a sand harvesting group is associated with benefits (livelihood security). The results of the logistic regression analysis are shown in the table below

Table 4.10: Dependent Variable Encoding

Original Value	Internal Value
YES	0
NO	1

Source: Researcher, 2022

The value for not being a member of a sand harvesting group was coded as 1, while that of one who belongs to a sand harvesting group as 0. Membership to a sand harvesting group was therefore used as the reference category.

Table 4.11: Parameter Coding

		Frequency	Parameter coding		
			(1)	(2)	(3)
Level of education	Never Attended	110	1.000	.000	.000
	Primary	125	.000	1.000	.000
	Secondary	90	.000	.000	1.000
	College	31	.000	.000	.000
Stakeholders Involvement	Direct	161	1.000		
	Indirect	195	.000		
Gender	Male	269	1.000		
	Female	87	.000		

Source: Researcher, 2022

Dummy variables for categorical variables in the equation were given as shown in the table above. From the table, on 'level of education' a participant with a college level was taken as the reference category while female was

Table 4.12 Variables in the Equation taken as a reference category for gender.

Variables in the Equation

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
Gender (1)	.025	.324	.006	1	.938	1.025	.543	1.936
Stakeholders Involvement (1)	-.813	.268	9.203	1	.002	.444	.262	.750
Cooperative Group	1.970	.384	26.374	1	.000	7.173	3.382	15.216
Self Help Group	.665	.322	4.255	1	.039	1.944	1.034	3.657
Welfare Group	-.601	.362	2.759	1	.097	.548	.269	1.114
School fees Access	-.156	.199	.612	1	.434	.856	.579	1.265
Farm input Access	1.668	.406	16.859	1	.000	5.304	2.392	11.763
Welfare Support	-.291	.405	.517	1	.472	.748	.338	1.652
Credit Access	.449	.338	1.768	1	.184	1.567	.808	3.039
Bargaining	-.446	.351	1.618	1	.203	.640	.322	1.273
Constant	-4.223	1.014	17.354	1	.000	.015		

Source: Researcher, 2022

The Binary logistic regression is given by -4.223-0.025 Gender-0.813: Stakeholders Involvelemnt-1.97; Cooperative group-0.665; self-help group-0.601; welfare group-0.156; school fees access+1.668 farm input access-0.291; Welfare Support+0.449; Credit Access-0.446; bargaining sand Price. From the table, it's observed that stakeholders' involvement, membership to a cooperative group, self-help group and benefits from input access are significant predictors of non-membership to sand harvesting groups. The other indicators such as; benefits from school fees access, welfare support, credit access, sand prices bargaining and gender did not significantly determine the output in the equation. From the logistic regression, it was observed that stakeholder involvement, welfare group benefits, and sand price bargaining had a negative impact on livelihood security. Membership to cooperative groups and benefit from farm inputs had a positive relationship on livelihood security.

All the 10 predictors explained 71.3% of the variability of non-membership to community-based organization for livelihood security. The odds ratio (OR) for stakeholder's involvement is 0.444 at 95% Confidence Interval. This implies that a non-member of a community-based organization is 0.444 times likely to get credit access as compared to a member of a sand harvesting group (Exp(B)= 0.444). Similarly, a non-member of a sand harvesting group is 7 times likely to be a member of a cooperative group as compared to a member of a sand harvesting group (Exp(B)=7.173). Additionally, a non-member to a sand harvesting group is 5 times likely to get farm input access compared to a member. Further, a non-member to a sand harvesting group would be about 2 times more likely to be a member of a self-help group compared to a member (Exp(B)=1.994). However, non-membership to sand harvesting groups proved to be an insignificant determinant of various outcomes of livelihood security. These were; gender, benefits of school fees access, welfare support, credit access and bargain

of sand prices. For these indicators, the p-value was statistically significant. It can therefore be concluded that social capital in the form of belonging to a sand harvesting group was effective for very few indicators in the study area. The model correctly predicted 54.3% of cases of membership to a sand harvesting group and 83.9% of cases of non -membership to a sand harvesting group, giving an overall percentage correct prediction rate of 71.3%.

A key informant indicated that the CBOs have not prioritized credit access to members, members prefer to access credit from other sources like the cooperative societies. Decisions in the CBOs annually on sharing the benefits. Earlier, decisions were made to pay fees for needy students, purchase seeds for members, build rental houses and increase the number of livestock for members. Ongoma, Chen, & Omony (2018) found out that social capital has a strong and positive contribution to household income, and the positive contribution of social capital to the general (the poor) household's income is greater than that of the rich household's income. According to Abenakyo *et al*. (2008) social capital is an important characteristic of a community and is one of the components of the asset pentagon of the sustainable livelihood framework. Positive relationship between level and dimension of social capital and access to livelihood assets implying that strengthening social capital is a powerful way to improve communities and requires consistent and effective approaches to build and reinforce social and human capital.

4.4.3 Sand harvesting and Schooling

Schooling serves different needs within the community and diverse social groups, primarily for economic, social and political functions. The study sought to establish the effect of sand harvesting activities on schooling.

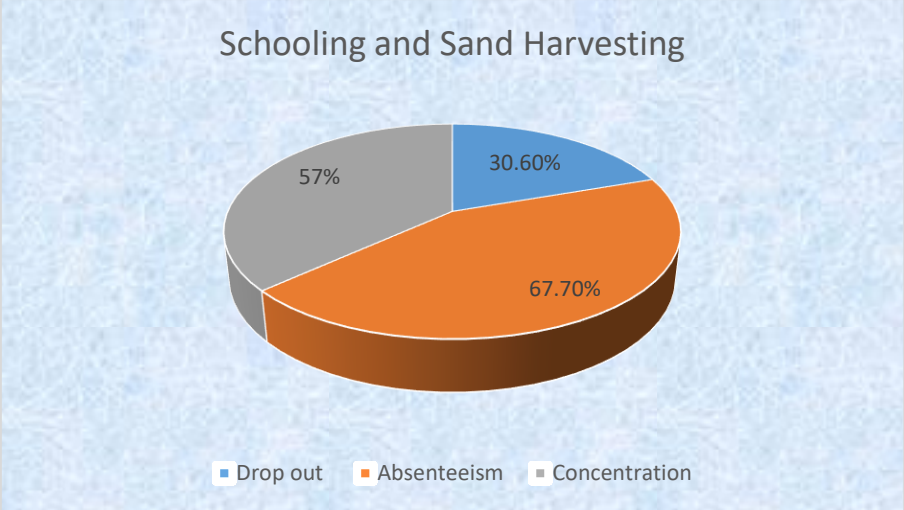

Figure 4.8 Schooling and Sand harvesting

Source: Researcher, 2022

The findings indicate that sand harvesting activities have contributed to school dropout 109(30.6%). Through the FGD it was confirmed that sand harvesting has caused many children as young as 15 years to drop out of school to engage in harvesting due to the fact that there is quick money that is associated with sand harvesting activities and they lured through peer pressure into the sector. It was observed that in the sand harvesting sites school going children engage in the scooping and loading of sand as shown in the plate.

Plate 4.3: A Minor Cleaning a Truck in a Harvesting Site Mtembur

Source: Field Survey, 2022

The findings further indicate that sand harvesting activities have led to increased absenteeism among the school going children at 241(67.7%). The increased absenteeism rates can be attributed to the engagement in sand harvesting activities by the school going children especially boys who are involved in the scooping, loading and truck washing and the girls are lured into prostitution and other service activities like provision of meals.

The study also found out that sand harvesting has led to lack of concentration by students in class 205(57%) this can be attributed to the noise made any trucks especially in schools near the roads. According to WHO (2015) noise-induced complications hinder the teacher-student communication and eventually affect the learning process. They argue that on average, children who are exposed to noisy learning environments have lower assessment scores on standardized tests.

4.4.4 Social Ills and Sand Harvesting

The section describes the social ills emanating from of sand harvesting activities and their effect on livelihood security.

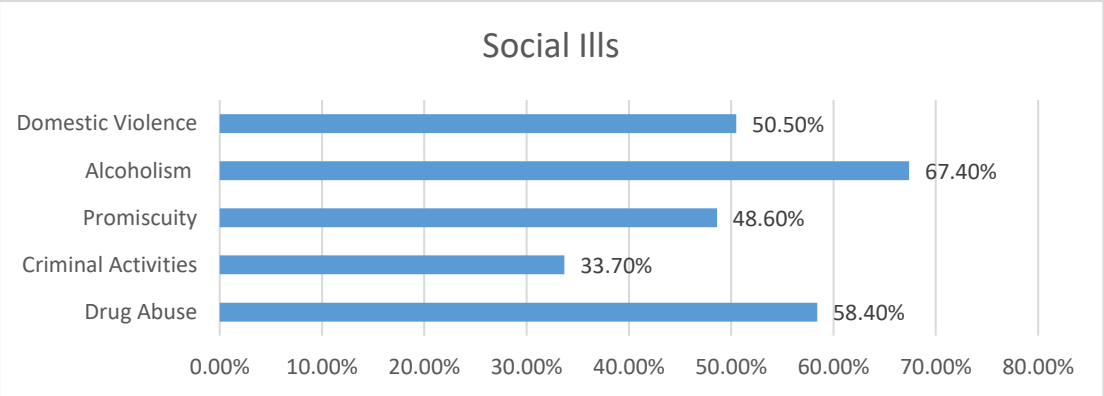

Figure 4.9 Social Ills

Source: Researcher, 2022

The findings indicated that engagement in sand harvesting activities contributed to drug abuse among the youth 208(58.4%), upsurge of criminal activities 120 (33.7%), promiscuity, prostitution and early marriages 173(48.6%), increased incidences of alcoholism 240(67.4%), increased domestic violence 180(50.5%) and family breakdown 147(41.3%).

Based on the key informant and focus group discussions, sand harvesting was affecting the social life of the community; school dropouts were of chief concern with negative effects on the teenagers and youths. Even though, the money acquired from sand harvesting by the young boys did not help them much, as they ended up in alcoholism and prostitution. The girl child suffered from early pregnancies and marriages in the region.

4.4.5 Conflict and Sand Harvesting

Conflict over natural resources can be a major obstacle to people's livelihoods and security. There are various sources of conflict for example the growing competition, management of the resources, structural causes and development pressure. The study sought to establish conflicts associated with sand harvesting.

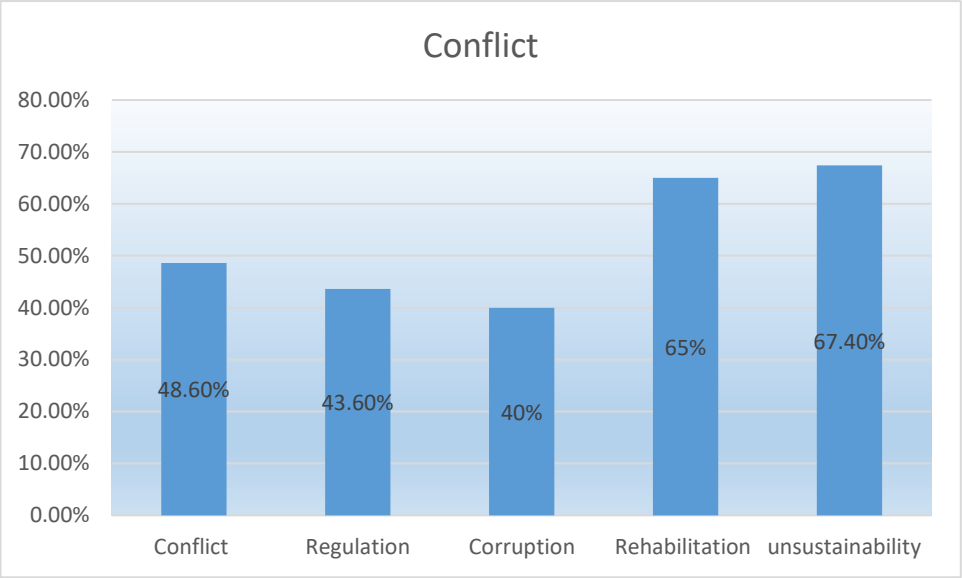

Figure 4.10 Causes of conflict in Sand Harvesting

Source: Researcher, 2022

The results indicate that the sand harvesting has led to many conflicts among stakeholders 173(48.6%). Information gathered through the FGDs indicated that conflicts manifest in various forms: boundary disagreements among the land owners, undesignated roads, competition between the local loaders, scoopers and outsiders, distribution/sharing of proceeds and due to resistance by locals on rules and regulations imposed by the County Government. Land owners and harvesters feel they are exploited by the brokers, middlemen and transporters and this always leads to leads to conflicts among them. The results agree with the findings of He, Wang & Yan (2021) who posit that sand harvesting is one of the sources of conflict among the community members. According to Muthomi *et.al* (2015) the sources conflicts include conflicts between the local leaders and sand harvesters, tension, misunderstanding among harvesters, lack of job opportunities, insecurity, sand harvesting without license, destruction of farms, cheap sale of sand, failure to pay land owners, refusal by land owners to sell sand and disagreement between different youth groups.

Additionally, the findings indicate that lack of clear regulations of sand harvesting results into conflict 155(43.6%). A key informant revealed that the lack of sand policies and regulations from the County permits the extraction of the resource without control measures and facilitates potential environmental hazards which fuel the conflict in the community.

The study also established that corruption reduces revenue collection from sand harvesting and leads to conflict 142(40%). An interview with the County revenue officer revealed that they collect Ksh 3000 per truck as shown in plate 4 .4 below. He further indicated that some drivers sometimes try to escape the payment by using undesignated routes or by going to the sites at night and some even fight the revenue collection officers.

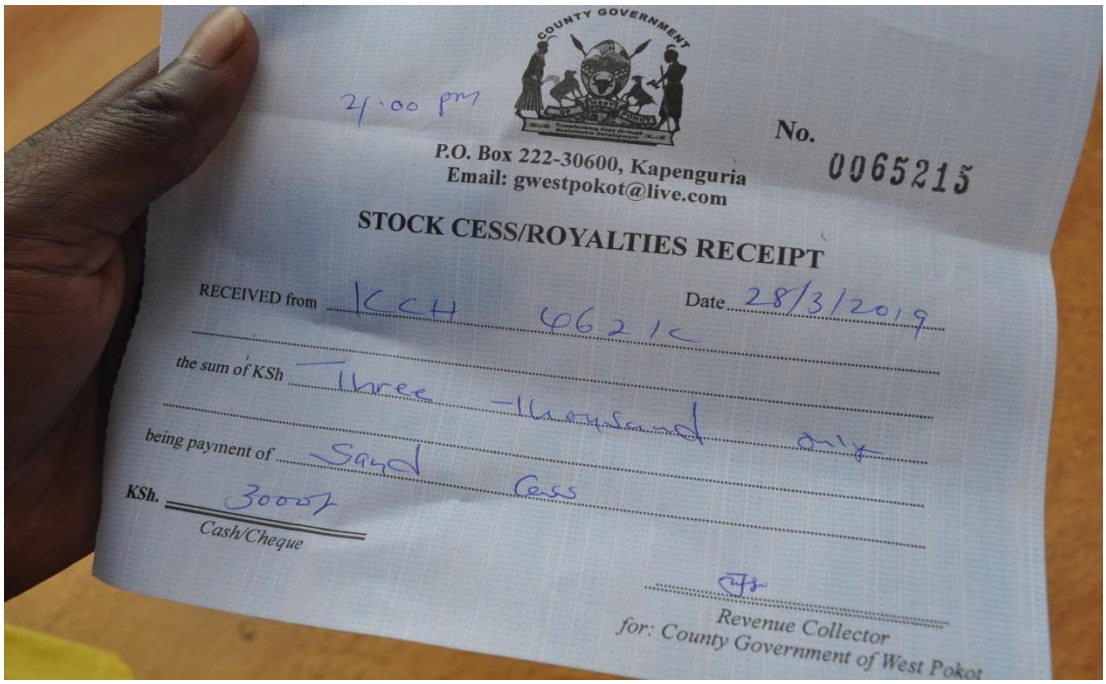

Plate 4.4: Receipt showing the amount of sand cess collected per truck

Source: Field Survey, 2022

Despite the fact the County Government collects revenue from the trucks the roads are not well maintained in fact at times the community members are forced to repair the roads on their own especially the routes to access the rivers. Through the FGD the community members noted that some of the money collected is not receipted.

Lack of rehabilitation of sand harvesting sites fuels conflicts among the stakeholders 231(65%). It was observed during the data collection that there are unrehabilitated sites in the study area as shown in plate 4.5 and 4.6. A key informant interview in Serewo revealed that during the rainy seasons the uncovered pits are filled with water and become dangerous to both people and livestock.

Plate 4.5: Unrehabilitated site in Serewo

Source: Field Survey, 2022

Plate 4.6: Unrehabilitated site in Mtembur

Source: Field Survey, 2022

The results also indicate that sand harvesting in the study area is unsustainable and leads to conflict due to the depletion of the resources 240(67.45). This implies that conflict may arise when sand harvesters move to another site. According to United Nations Environment Programme (UNEP) (2014), while sand has the ability to replenish itself, the extraction rates in most sites are far greater than their renewal increasing the possibilities of complete depletion.

4.4.6 Social Impact of Sand Harvesting and Livelihood Security

4.4.6.1 Diagnostics Tests

4.4.6.1.1 Factor loading, Construct Reliability and Validity

Hair *et al*. (2014) recommends the assessment of the reflective measures using both convergence and discriminant validity. As indicated in table below the measurement models presented the factor loadings, average variance extracted (AVE) and composite reliability (CR) and Cronbach's alpha were used to assess internal consistency reliability and convergence validity (Hair *et al.,* 2016). As shown, most of the loadings for the reflective items exceeded the recommended value of 0.5 (0.708)2. However, six

indicator items such as Memb 50(Non-member), MembBY3 (welfare support) and MembBY5 (Collective bargaining of sand price), Socil3 (promiscuity, prostitution and early marriages) and Conflict 4(Lack of rehabilitation) and 5(unsustainable sand harvesting) were removed because it did not meet the minimum factor loading condition.

To test the reliability of the constructs, the study used Cronbach alpha, composite reliability (CR & HMTM ratio). Since the values were greater than .8, the data was considered be reliable for further analysis. All the CRs values were higher than the recommended value of 0.700(KA & Faray, 2005) α exceeded 0.700 threshold. Convergent validity was accepted because average variance extracted AVE was over 0.500. The study further established whether there was a problem of collinearity analysis through variance of inflation factor (VIF). Based on the results, all the constructs did not have a problem of multicollinearity since the values were less < 5.

Table 4.13: Reliability and Convergent Validity Assessment Results of social Impact

Construct	Items-	Outer loadings	Cronbach's Alpha	**rho_A**	**(CR)**	**AVE)**	**VIF**
Membership	Memb1	0.606	0.813	0.727	0.709	0584	1.240
	Memb2	0.783					1.456
	Memb3	0.759					1.565
	Memb4	0.599					1.751
Membership Benefits	MembBY1	0.600	0.859	0.705	0.745	0.549	1.321
	MembBY2	0.706					1.010
	MembBY4	0.823					1.322
Social ills	Socil1	0.522	0.837	0.854	0.829	0.501	2.063
	Socil2	0.736					1.848
	Socil4	0.549					1.779
	Socil5	0.791					2.122
	Socil6	0.875					2.073
Conflict	Conflict1	0.797	0.968	0.807	0.783	0.552	1.945
	Conflict2	0.839					2.265
	Conflict3	0.563					1.349

Source: Researcher, 2022

4.4.6.1.2 Discriminant Variability

In the study the discriminant validity was also tested following the discriminant validity criterion of Fornell-Larcker. It was examined by comparing the correlations between constructs and the square root of the AVE for that construct. As shown in Table 4.20 the square root of the AVE is higher than the correlation with other constructs indicating adequate discriminant validity (Hair et. al., 2014). Thus the reflective measurement model demonstrated adequate internal consistency reliability, convergent validity and discriminant validity.

Table 4.14: Discriminant Variability (Fornell- Larcker Criterion)

	LIVELIHOODS	**SOC1**	**SOC2**	**SOC3**
LIVELIHOODS	0.591			
SOC1	-0.319	0.743		
SOC2	0.573	-0.092	0.620	
SOC3	-0.244	0.569	-0.050	0.708

Source: Researcher, 2022

4.4.6.1.3 Heterotrait-Monotrait Ratio (HTMT)

Table 4.15: Heterotrait-Monotrait Ratio (HTMT)

Heterotrait-Monotrait Ratio (HTMT)				
	LIVELIHOODS	**SOC1**	**SOC2**	**SOC3**
LIVELIHOODS				
SOC1	**0.367**			
SOC2	**0.650**	**0.173**		
SOC3	**0.272**	**0.556**	**0.189**	

Source: Researcher, 2022

The Heterotrain-Monotrait ration was tested and the values were < .7 for all constructs and therefore the model passed all diagnostic tests for PLS-SEM analysis. Henseler *et*

al. (2015) and Kline, 2011), argue that the heterotrait-monotrait (HTMT) ratio of correlations should not have value exceeding .85.

4.4.6.1.4 Model Fit

Table 4.16: Model fit (Goodness-of-Fit)

	Saturated Model	Estimated Model
SRMR	0.074	0.074
d_ULS	0.657	0.657
d_G	0.245	0.245
Chi-Square	440.740	440.740
NFI	0.763	0.763

Source: Researcher, 2022

In the study, to assess the overall quality of the adjustment model, Goodness-of-Fit (GoF) indicator was calculated, which is given by the geometric mean of the average R^2 and average AVE (Ringle, Wende & Will, 2005). The calculated value was 0.763, which indicated that the model was well adjusted, since values above 0.36 are considered good for areas such as social and behavioural sciences (Hair et. al., 2013).

4.4.6.2 Structural Model of Social Implications and Livelihood Security

The first hypothesis sought to establish the relationship between the social impacts of sand harvesting on livelihood in the area under study.

As shown in Figure 4.11 the R^2 value for the model was .525 implying that 52.5 % of the variance in livelihood is explained by conflict, membership and social ills factors. Cohen (1988) says that a R^2 value greater than 0.26 indicates that the model is substantial.

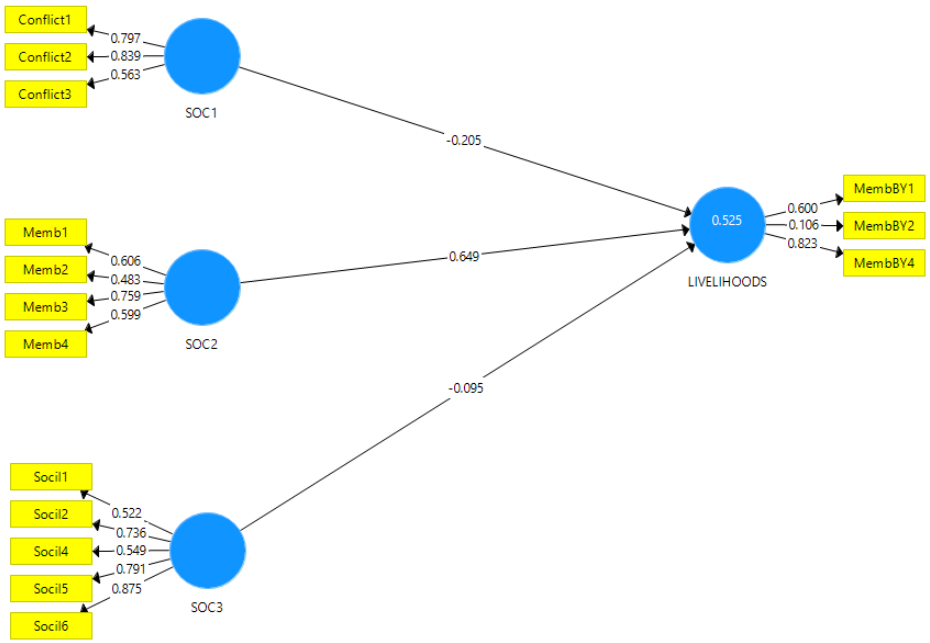

Figure 4.11: Structural Model Social Impact and Livelihood Security

Source: Researcher 2022

Table: 4.17 Relationship among Social Variables- Path Coefficients

Path Coefficient	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
SOC1 -> LIVELIHOODS	-0.205	-0.188	0.079	2.601	**0.009**
SOC2 -> LIVELIHOODS	0.649	0.657	0.059	11.043	**0.000**
SOC3 -> LIVELIHOODS	-0.095	-0.089	0.070	1.355	**0.176**

Source: Researcher, 2022

From the table, the results of the path coefficients show the following observations; Soc l factors associated with conflict had a negative and a significant effect on livelihoods, β=-0.205, p <.05. Similarly, Soc 2(membership factors) had a positive and a significant effect on livelihoods, β=0.649, p <.05. Soc 3 (social ill factors) had a negative and had no significant effect on livelihoods, β=-0.095, p >.05. It can therefore be observed that conflicts associated factors and social group belongingness had an impact on

livelihoods, however factors related to social ills did not have any impact on livelihoods.

H_{01}: There is no significant relationship between Social impacts of sand harvesting on livelihoods

From the findings, we reject the null hypothesis that there is no significant relationship between Social impacts of sand harvesting on livelihoods, and accept the alternative.

4.4.7 Solutions to the Social Implications

The following are workable solutions on social implications challenges summarized by the researcher using the questionnaire respondent's suggestions

1. The age limit to the active participation in sand harvesting activities should be above 18 years.
2. Sand buyers should pay a negotiated and agreed wage to landowners, sand loaders and harvesters.
3. The various stakeholders to organize themselves into recognized groups with clear operational structures for their self-regulation.
4. Sand buyers are encouraged to support local community projects in consultation with the local community.
5. Improvement of social amenities in the harvesting sites.
6. The need for sensitization and awareness creation on impact of drug abuse among the youths
7. The development of mentorship programs on importance of education, moral behaviours and family relations.
8. Addressing the root causes of conflict in the various harvesting sites.

9. Community vigilance and reporting of all cases of early marriages and any underage children engaged in sand harvesting activities to the local administration.
10. Provision of protective gears and better tools.

4.5 Economic Implications and Livelihood Security

The second objective of the study was to evaluate the economic implications of sand harvesting on livelihood security. Economically, sand harvesting is a source of livelihood through the provision of incomes and employment opportunities. This section describes findings that relate to economic implications of sand harvesting activities in the following categories: Economic financial support, economic activities, economic infrastructure and economic investment.

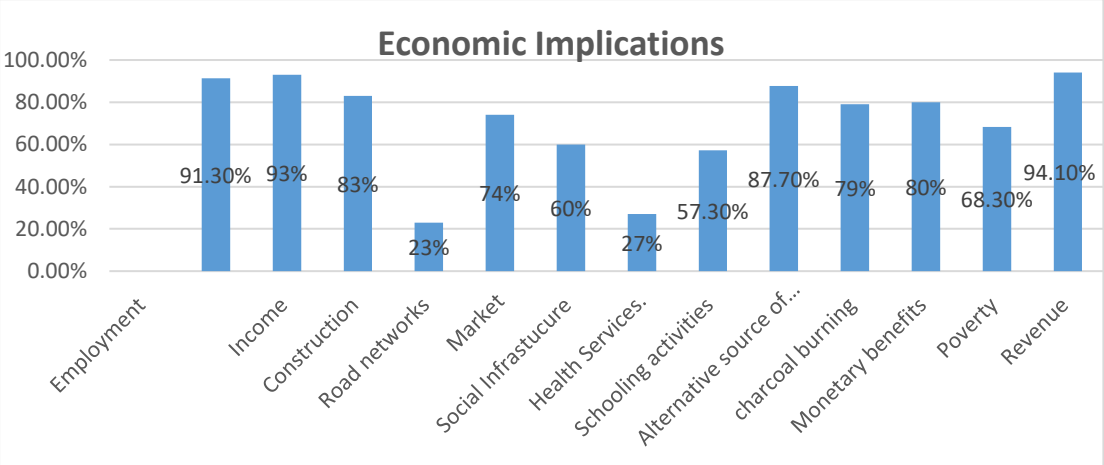

Figure: 4.12 Economic Implications of Sand Harvesting

Source: Researcher 2022

4.5.1 Economic Financial Support in Sand Harvesting

The results show that as much as sand harvesting contributes a beneficial share to the economy the monetary benefits to the local economy is minimal 283(80%). The FGD confirmed that although the community is endowed with sand resources the monetary

value from the sales is very low. This could be attributed to the low price of ksh 4000 paid per lorry of sand at the site yet the same fetches between ksh 30,000 to ksh 40,000 in Kitale, Eldoret town and beyond.

On the same note, the results show that high levels of poverty persist despite engagement in sand harvesting activities 243(68.3%). This clearly indicates that the community has not been able to break the cycle of poverty as much as they are endowed with the sand resource. One participant stated that:

> *"those buying our sand are making huge profits in town like Kitale and Eldoret…… while us who are harvesting and loading the sand into lorries are going hungry…we cannot afford to eat two meals in a day,…..we can pay fees for our children….we have many problems……".14th June, 2020.*

Lucia and Sala (2018) pointed out that increased poverty can occur, if the local population loses traditional means of livelihood, and when governments fail in reinvesting revenues from mining.

The findings further indicate that sand harvesting is a source of revenue to the County Government 335(94.1%). For example, a key informant in Mtembur explained that the County collects Ksh 3000 Cess fee per lorry and there is an average minimum of 40 lorries per day per site translating to Ksh 120,000 per day from one harvesting site. CCSI, SDSN, UNDP and WEF (2016) opine that sand mining can contribute to sustainable development, particularly to its economic dimension. It can fetch fiscal revenues, drive economic growth, create jobs and contribute to infrastructure development. Further they observed that mining is relevant for all Sustainable Development Goals and has particularly strong impacts on livelihoods.

4.5.2 Economic Activities in Sand Harvesting

The results show that there is cheap sand for construction 295(82.6%). This implies that the community has the opportunity to use the available resources to construct their own houses, social amenities and rental houses. From observation, most of the harvested sand is not utilised for construction within the community and this can be attributed to high level of poverty and high prices of the other construction material like stones/ bricks and iron sheets.

Additionally, sand harvesting has created a market for other goods and services 264(74.1%). Other businesses have come up to provide services to the sand harvesters for example food kiosks, truck washing points and shops. According to A study by Palma, Dias and Freitas (2021) sand and stone mining leads to increased sales of goods and services such as selling of water, foodstuffs.

The results also reveal that sand harvesting is an alternative source of livelihood 312(87.7%) this implies that the income from sand has enabled some to engage in alternative sources of livelihood like animal and crop farming as indicated in earlier findings on economic activities.

Based on research findings, sand harvesting engagement has led to reduced charcoal burning business 281(79%). Many residents who would otherwise be engaged entirely on charcoal burning have shifted to sand harvesting thus minimizing the destruction of forests. Though from observation, charcoal selling is still an alternative source of livelihood for some of the residents.

4.5.3 Economic Infrastructure and Sand Harvesting

The findings show that sand harvesting activities has improved road networks at 82(23%). It was observed in Serewo as shown in plate 4.7 that roads leading to the harvesting sites have been adversely affected by soil erosion.

Plate 4.7: The State of the Roads in Serewo Area

Source: Field Survey, 2022

The road to Mtembur sand harvesting site was not in good shape though it was as observed during data collection that the road was under maintenance by the County Government of West Pokot.

Plate 4.8: State of the road in Mtembur

Source: Field Survey, 2022

In addition, the road in Kanyarakwat was in a worse state as shown in Plate 9.

Plate 4.9: State of the Road in Kanyarkwat

Source: Field Survey, 2022

A key informant reiterated that there was poor road maintenance in the sand harvesting sites by the concerned authorities yet the County Government collects revenue from sand harvesters. The findings contradict with those Lucia and Sala (2018) who opine that the presence of a mine in the territory can contribute to local development, when mining companies engage in providing and improving local infrastructures (e.g. road network, power and water supply), which in turn allow local populations to access health and education services.

Furthermore, the study found out that sand harvesting is a source of funding to community projects like schools and dispensaries 199(60%). For example, from the focus group discussions in Mtembur, it was ascertained that the private fee collected by the community-based organizations was used to fund community projects like construction of class rooms in Mtembur mixed day school.

Plate 4.10: A class room funded by Mtembur CBO

Source: Field Survey, 2022

The findings indicates that a small percentage of 96(27%) agreed that sand harvesting has led to access to better health services. From key informant interviews it was noted that not much has been to improve the health services infrastructure in the region. The income from sand harvesting has enabled some of residents to pay for better health services at an individual level.

> *" .....the money from the sand business is good.....we have been able to improve the schools……at least we can now access bursaries…….health services are still not adequate.....the money from the sand harvesting should be well managed by the County Government ...."* **FGD Mtembur** *14th June, 2020.*

Sand harvesting activities have enhanced schooling activities. An FGD at Kanyarkwat revealed that income from sand harvesting has enabled community members to buy uniforms, stationery and pay schools fees for their school going children. Koehnken, & Acreman (2020) argues that the income from sand harvesting is used to meet the basic needs of the family including food, paying tuition for children and even for entertainment.

4.5.4 Economic Investment and Sand Harvesting

The results show that sand harvesting is a source of employment 325(91.3%). Sand harvesting provides job opportunities to those who are involved like the sand loaders, harvesters and drivers and the many who are engaged indirectly related to sand harvesting. The key informant interview revealed that many youths are engaged in sand harvesting in the study area due to free entry and exit in the mining activity.

The findings concur with those of Lucia and Sala (2018) who found out that sand harvesting has a positive impact on rural livelihoods since it is an activity that employs many due to the minimal barriers to entry, low technology, capital and limited specialized skill requirements. According to Ahlbrandt & Thomas (2021) through sand

harvesting a large number of the youths are employed and other casual labourers who sell food stuffs to the harvesters. They further opined that sand harvesting contributes significantly to economic development through the creation of employment opportunities, creation of local supply of raw materials for industry, generation of export revenues and alleviation of poverty.

The results also indicate that sand harvesting is a source of constant income to land owners, loaders, harvesters, transporters and those who are indirectly involved 331(93%). The FGD revealed that each truck has 4 harvesters who are paid Ksh 400, 8 loaders who are paid Ksh 1600, the land owners are paid Ksh 1000, the community are paid Ksh 1000 and the County Government Cess collection is Ksh 3000 this indicates that sand harvesting enables those who are involved to earn income. It was also observed as shown that the sand is scooped and heaped ready for transportation as shown in Plate 4.11 and 4.12.

Plate 4.11: Sand Scooping in Mtembur

Source: Field Survey, 2022

The harvesters and loaders have a clearly stipulated way of dividing money amongst themselves. Rais *et al., (*2019) indicates that the economic impact of sand mining is more constant income. In addition, Ingram *et al.,* (2011) found out that artisanal and small-scale mining generates income because minerals provide higher income than other traditional activities within rural mining communities in the Sangha Tri National landscape in central Africa.

Plate 4.12 Heaped Sand Ready for Sale and Transportation at Serewo

Source: Field Survey, 2022

4.5.5 The Relationship between Economic Implications and Livelihood Security

4.5.5.1 Diagnostics Tests

4.5.5.1.1 Factor loading, Construct Reliability and Validity of Economic Impact

As shown in table 4.23 the factor loadings for this construct was analyzed and indicators is whose factor loading was less than 0.7 like ECOINFRA 5 and ECOINV 4 were removed. The table below shows the factor loading values of the remaining indicators which are greater than seven.

The study also used Cronchbach alpha to test the reliability of the constructs, composite reliability (CR & HMTM ratio).Since the values were greater than .8, the data was considered to be reliable for further analysis. All the CRs values were higher than the recommended value of 0.700(KA & Faray, 2005) α exceeded 0.700 threshold. Convergent validity was accepted because average variance extracted AVE was over 0.500. Based on the results, all the constructs did not have a problem of multicollinearity since the VIF values were less < 5.

4.5.5.1.2 Discriminant Variability

It was established that the square root of the AVE is higher than the correlation with other constructs indicating adequate discriminant validity. Thus the reflective measurement model demonstrated adequate internal consistency reliability, convergent validity and discriminant validity.

Table 4.18: Reliability and Convergent Validity Assessment Results of Economic Impact

Construct	Items-	Outer loadings	Cronbach's Alpha	**rho_A**	**(CR)**	**AVE)**	**VIF**
Economic Financial Support	ECONFIN1	**0.711**	**0.855**	**0.470**	**0.816**	**0.565**	2.465
	ECONFIN2	0.852					2.452
	ECONFIN3	0.886					1.145
	ECONFIN4	0.826					1.004
Economic Activities	ECONACT1		**0.865**	**0.558**	**0.740**	**0.633**	
	ECONACT2	0.748					1.162
	ECONACT3	0.731					1.145
	ECONACT4	0.867					1.036
Economic Infrastructure	ECONIFR1		**0.996**	**0.833**	**0.773**	**0.524**	1.280
	ECONIFR2	0.701					2.577
	ECONIFR3	0.718					1.659
	ECONIFR4	0.758					2.200
							1.572
Economic Investment	ECONINV1	0.756	**0.399**	**0.559**	**0.276**	**0.591**	4.174
	ECONINV2	0.819					4.187
	ECONINV3	0.843					1.041
	ECONINV5	0.759					1.054

Source: Researcher, 2022

4.5.5.1.3 Heterotrain-Monotrait Ration

The Heterotrain-Monotrait ration was tested and the values were < .7 for all constructs and therefore the model passed all diagnostic tests for PLS-SEM analysis.

4.5.5.1.4 Model Fit

The calculated value was 0.763, which indicated that the model was well adjusted, since values above 0.36 are considered good for areas such as social and behavioural sciences (Hair et. al., 2013).

4.5.6 Structural Model Economic Implication and Livelihood Security

The study sought to establish relationship between economic implications of sand harvesting on livelihood security.

As shown in Figure 4.13 the R^2 value for the model was .404 implying that 40.4 % of the variance in livelihood security is explained by economic factors.

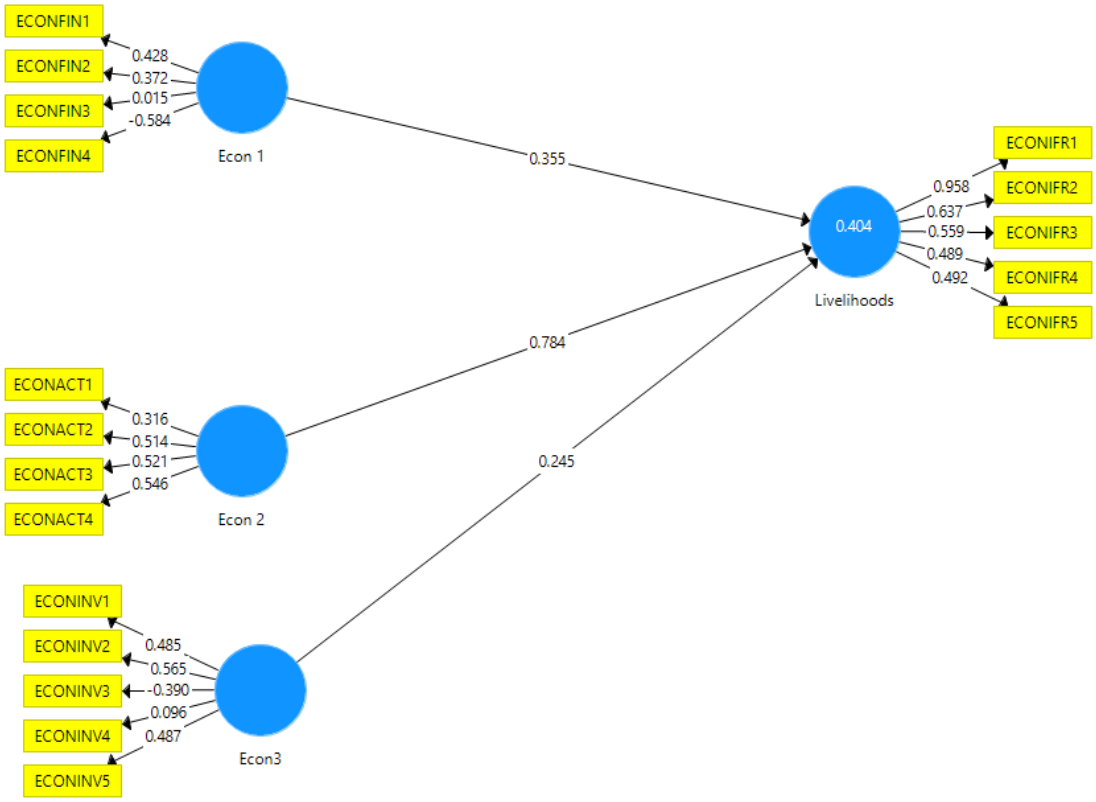

Figure 4.13: Structural Model of Economic Implication and Livelihood Security

Source: Researcher 2022

Table 4.19: Relationship between Economic Factors and Livelihood Security

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Econ 1 -> Livelihood	0.173	0.172	0.059	2.906	**0.004**
Econ 2 -> Livelihood	0.249	0.255	0.056	4.420	**0.000**
Econ 3 -> Livelihood	0.237	0.246	0.049	4.886	**0.000**

Source: Researcher, 2022

As it can be seen from the table, all the factors were statistically significant (p= 0.004, 0.000, 0.000 respectively at p<0.05). Econ1 included factors such as investment programs, Econ 2 included factors related to economic activities and Econ 3 dealt with factors related to economic infrastructure. It can therefore be observed that sand harvesting activity has a positive impact on investment programs, economic infrastructure and is a stimulant for economic activities in the study area.

Ho2: There is no significant relationship between economic implications of sand harvesting on livelihood security. From the findings, we reject the null hypothesis that there is no significant relationship between economic implications of sand harvesting on livelihood security and accept the alternative.

4.5.7 Solutions to Economic Implications and Livelihood Security

The following are workable solutions on economic implications challenges summarized by the researcher using the questionnaire respondent's suggestions

1. Creating forums where stakeholders are taught financial management, innovation and diversification of livelihood resources.
2. Enhance efforts to maximize utilization of the sand resources while taking care of the environment.

3. The relevant authorities to come up with projects to improve and maintain the physical infrastructure.
4. Setting up of proper structures to ensure that revenue collected is received and well managed and used in community infrastructure upgrading by the County Government.
5. The County Government to set up markets infrastructure to increase the sale of goods and services.
6. There is need for the provision of policies and regulations to increase and standardize sand prices in the sand harvesting sites.
7. The community-based organizations to be entrepreneurial and invest in the sand harvesting in order to retain the proceeds and maximize the benefits for example by buying their trucks and accessing external markets themselves.

Generally, from the above findings it can be deduced that economic impacts of sand harvesting on livelihood can be both positive and negative. Sand harvesting often gives stimulus to the local economy and increases population income and business opportunities. However, income inequality, an unfair distribution of the benefits coming from resource extractions and corruption due to the bad management of mineral wealth, can trigger social tensions.

4.6 Environmental Implications and Livelihood Security

The third objective of the study was to evaluate the environmental implications of sand harvesting on livelihood security. The section describes findings that relate to environmental implications of sand harvesting on livelihood security.

Table 4.20: Environmental Implications

	Environmental Factors	Frequency	Percentage (%)
1.	Lands for farming reduced because of sand harvesting activities.	145	40.7
2.	Storage of sand causes destruction of vegetation cover	214	60
3.	Sand harvesting destroys underground aquatic ecosystem	242	67
4.	Sand scooping reduces surface water quality and quantity.	251	61
5.	Sand harvesting leads to destruction of the forest cover	206	48
6.	Sand harvesting is associated with increased dust pollution	207	57
7.	Sand harvesting leads to river bed degradation	311	87.4
8.	Sand harvesting increases erosional valley	308	86.5
10	Many pits are left uncovered and becomes dangerous to both people and livestock.	318	89.4
11	Accumulation of water in open burrow pits creates an environment for mosquitos breeding which spread malaria.	306	86
12.	There is contamination of water and scarcity of water due to sand harvesting	289	81.1
13.	Removal of river sand reduces siltation of rivers which increase the rate flowing water.	261	73.3
14.	Widening and deepening of rivers affect river flow downstream.	280	78.7

Source: Researcher, 2022

4.6.1 Environmental Degradation and Sand Harvesting

From the results, sand harvesting activities destroy the underground aquatic ecosystem 242(67%). According to Lawal (2011) and Ambak and Zakaria (2010), stream sand mining results in the destruction of aquatic ecosystems and the scooping of sand from the ground destroys the vegetation cover and the soils which serve as the habitat for wildlife. This situation destabilises the ecosystem of living organisms thereby threatening their lives. In addition, sand mining operations also result in deforestation, habitat destruction and biodiversity erosion in ecosystems (Saviour, 2012).

Furthermore, the findings show that sand scooping reduces surface water quality and quantity 251(61%). According to a key informant the sand dams are destroyed during the dry seasons and this affects the water catchment ability and retention enhancing water shortage in the region as well as the water quality. Sand mining diminishes water clarity and quality due to high turbidity levels, reduction of dissolved oxygen and high temperatures in such water bodies (Reid, 2006; Kondolf, 1994).

The practice of sand harvesting leads to river bed degradation 311(87.4%) resulting from the deepening and widening of the river beds as more sand is scooped to meet the rising demand. Enhanced soil harvesting causes soil erosion, disturbance of groundwater and changes the river course as evidenced in Plate 4.13

Plate 4.13 Photo of Degraded River Bed in Mtembur

Source: Field Survey, 2022

According Bagchi (2010) environmental land and surface degradation is a serious impact of sand harvesting on Indian rivers since it damages the river banks and general ecosystems due to access ramps to the riverbed. Likewise, the research findings reveal that sand harvesting increases erosional valleys 308(86.6%). This has negative effects on other livelihood activities and renders the land redundant.

Plate 4.14: Photo of Erosional Valleys at Serewo

Source: Field Survey, 2022

Results also indicate that there is contamination of water and scarcity of water due to sand harvesting 289(81.1%). Pereira (2012) argues that certain magnitudes of the sand extraction may result also in the lowering of the water table and subsequently water security issues. The findings further indicate that removal of river sand reduces siltation of rivers which increase the rate of flowing water 261(73.3%).

Plate 4.15: Bare Ground with High Water Run-Off Potential at Serewo

Source: Field Survey, 2022

The study results also show that sand harvesting results into the widening and deepening of rivers. This affects the flow of the river downstream 280(78.7%), destroys the river bank, the river course and the vegetation around it, thus enhancing the soil erosion and flooding possibilities being hazardous to the communities around.

Plate: 4.16 Photo of Widened River Banks

Source: Field Survey, 2022

Extraction of sand is more likely to have ramifications around the environments of their occurrence. Extraction of sand from rivers, streams, flood plains, and channels conflict with the functionality of riverine ecosystems and some of the disturbances are from the mining methods and machines used (Kori and Mthanda).

4.6.2 Physical Environment and Sand Harvesting

The findings indicate that land for farming has reduced due to sand harvesting activities 145(40.7%). The farming in West Pokot is mainly done along the river beds due to fact that the area is semi-arid, the increased harvesting activities and the consequent erosion of the soil reduces the arable land.

Likewise, 214(60%) agreed that storage of sand causes destruction of vegetation cover. It was however observed during the field study that it is not a common practice to store sand in specific places for long because many transporters collect the sand from the rivers directly especially in Mtembur and Serewo.

Plate 4.17: Loading of the sand in the Truck at Mtembur

Source: Field Survey, 2022

FGD in Kanyarkwat revealed that sand is stored along the roadside away from the mining sites during the rainy season due to the bad state of the access road to the mining sites. The results agree with the findings of Musa (2020) who found out that the activities of sand mining lead to the destruction of vegetation, agricultural and non-agricultural lands.

Sand harvesting leads to destruction of the forest cover 206(48%). It was observed during the data collection period as shown in plate 4.18 that forest cover has been destroyed. The mining sites are always changing and in the process of creating new mining sites and new access roads more vegetation is cleared thus affecting the forest cover.

Plate 4.18 Destruction of the Vegetation Cover by Sand Harvesting at Serewo

Source: Field Survey, 2022

Sand harvesting leads to destruction of the forest cover 206(48%). It was observed during the data collection period as shown in plate 4.19 that forest cover has been destroyed. The mining sites are always changing and in the process of creating new mining sites and new access roads more vegetation is cleared thus affecting the forest cover.

In addition, sand harvesting is associated with increased dust pollution (207(57%).The dust pollution is enhanced by the eroded forest cover which would have acted as wind breakers and the dust from the trucks ferrying the sand.

4.6.3 Environmental Outcome and Sand Harvesting

Furthermore, the results show many pits are left uncovered and become dangerous to both people and livestock 318(89.4%). The focus group discussions indicated that sand harvesting pits divert the river course and renders the area risky for other livelihood activities due the fear of drowning and impassability of the roads. The trucks ferrying the sand frequently get stuck during the rainy season and in the process of unstucking them more pits after left behind. One responded reiterated that:

> " *…these lorries get stuck everyday ….. the young men are paid to scoop the sand around the tyres ….more holes are left everywhere ….the terrain and mining sites are continually damaged and the Government is just looking…….*" FGD Kanyarkwat*16th June, 2020.*

On the same note accumulation of water in open burrow pits creates an environment for mosquitoes breeding which spread malaria 306(86%). The results are consistent with Jonah *et al.,* (2015); Narh, (2016), and Baba, (2017) findings that abandoned pits act as breeding grounds for water-induced diseases and death-traps.

4.6.4 Environmental Impact and Livelihood Security

4.6.4.1 Diagnostics Tests

4.6.4.1.1 Factor loading, Construct Reliability and Validity Environmental Impact

The factor loadings for environmental impact construct was analyzed and indicators is whose factor loading was less than 0.7 like EED 4 and 5, EPE 1 and 3, ECE 1 and 5 and ECO were removed. The table below shows the factor loading values of the remaining indicators which are greater than seven. Since the Cronchbach alpha values were greater than .8, the data was considered be reliable for further analysis. All the CRs values were higher than the recommended value of 0.700. Convergent validity was accepted because average variance extracted AVE was over 0.500. Based on the results,

all the constructs did not have a problem of multicollinearity since the VIF values were less < 5.

Table 4.21: Reliability and Convergent Validity Assessment Results of Environmental Impact

Construct	Items-	Outer loadings	Cronbach's Alpha	**rho_A**	**(CR)**	**AVE)**	**VIF**
Environmental Degradation	EED1	0.76	**0.86**	**0.87**	**0.85**	**0.66**	3.59
	EED2	0.92					1.69
	EED3	0.83					4.44
Physical Environment	EPE2	0.79	**0.87**	**0.77**	**0.76**	**0.55**	1.51
	EPE4	0.72					1.62
	EPE5	0.86					1.44
	EPE6	0.70					1.56
Environmental Conservation and control groups	ECE2	0.77	**0.94**	**0.67**	**0.85**	**0.59**	1.31
	ECE3	0.87					1.17
	ECE4	0.70					1.38
Environmental Outcome	ECO1	0.76	**0.80**	**0.61**	**0.74**	**0.51**	1.36
	ECO2	0.75					1.38
	ECO3	0.73					1.02

Source: Researcher, 2022

4.6.4 1.2 Discriminant Variability

As shown in Table 4, the square root of the AVE is higher than the correlation with other constructs indicating adequate discriminant validity. Thus, the reflective measurement model demonstrated adequate internal consistency reliability, convergent validity and discriminant validity

Table 4.22 Discriminant Variability

	ENVR1	ENVR2	ENVR3	LIVELIHOOD
ENVR1	0.81			
ENVR2	0.64	0.67		
ENVR3	0.64	1.28	0.62	
LIVELIHOOD	0.61	0.82	0.74	0.56

Source: Researcher, 2022

4.6.4.1.3 Heterotrait-Monotrait Ratio (HTMT)

The Heterotrain-Monotrait ration was tested and the values were < .7 for all constructs and therefore the model passed all diagnostic tests for PLS-SEM analysis.

4.6.4.1.4 Model Fit

The calculated value was 0.763, which indicated that the model was well adjusted, since values above 0.36 are considered good for areas such as social and behavioural sciences

4.6.5 Structural Model on Environmental factors and Livelihood Security

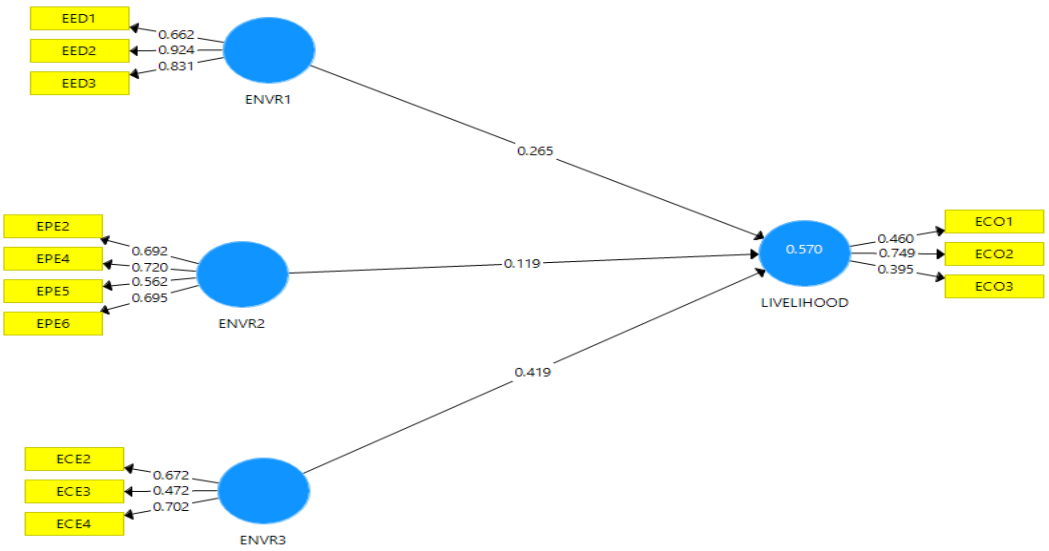

Figure 4.14 Structural Model on Environmental factors and Livelihood Security

Source: Researcher 2022

As shown in Figure 4.14The R^2 value for the model was .570 implying that 57 % of the variance in livelihood is explained by environmental factors.

4.6.5.1 Relationship between Environmental impact of sand harvesting and Livelihood Security

Table 4.23 Original Model on Environmental factors and Livelihood Security

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
ENVR1 -> LIVELIHOODS	0.272	0.271	0.100	2.723	0.007
ENVR2 -> LIVELIHOODS	0.131	0.135	0.077	1.691	0.091
ENVR3 -> LIVELIHOODS	0.396	0.398	0.069	5.734	0.000

Source: *Researcher 2022*

The table above shows the original model of the relationship between environmental factors and its impacts of sand harvesting on livelihoods. From the table, it was observed that the first and the third variables were statistically significant for the relationship on livelihood. However there was no statistically significant relationship for the second variable on livelihood.

$H_0$3: There is no significant relationship between environmental impacts of sand harvesting on livelihoods.

From the findings, we reject the null hypothesis that there is no significant relationship between Environmental impacts of sand harvesting on livelihoods and accept the alternative.

4.6.6 Solutions on Environmental Implications and Livelihood Security

The following are workable solutions on environmental implications challenges summarized by the researcher using the questionnaire respondent's suggestions

Need for enhanced involvement of all stakeholders in the discussion of safe/sustainable harvesting practices;

1. Awareness creation about the adverse environmental effects of sand harvesting and how they can be addressed.
2. Demarcation of suitable sites for harvesting activities;
3. Sand dam or gabions to be constructed by the County Government in designated sand harvesting sites along the river banks.
4. Sand harvesting or scooping to be restricted to the river beds with no harvesting allowed on riverbanks to avoid widening of rivers.
5. County government are encouraged to invest in environmental conservation activities.
6. Training on sustainable harvesting techniques to mitigate the negative environmental effects that mining generates.
7. Incentives to be given to environment conservers.
8. Rehabilitation of sand harvesting sites

4.7 The Role of Government Institutions and Authorities in Sand Harvesting Regulations

Table 4.24: Government and Institutional Support

Variable	Mean	Std. Deviation	Skewness	Kurtosis
The county government institutions and authorities like NEMA are carrying out awareness creation and sensitization to ensure sustainable extraction of the resources.	1.1713	0.66406	4.554	21.143
The county government institutions and authorities regulate sand harvesting activities.	1.4438	0.95220	2.554	6.035
Lack or laxity in implementation and enforcement of the laws by the enforcing authority (county government) affects the sand harvesting activities.	4.3090	1.02368	-1.646	2.015
There is community participation through creation of sub county and ward sand management committees.	1.4916	0.93594	2.170	4.136
The county government and authorities are undertaking several measures to stop environmental degradation resulting from sand harvesting activities.	1.4157	0.78807	2.555	7.259
The county government is directly involved in streamlining sand prices.	1.4017	0.78643	2.617	7.529
The county government institutions create direct link to final consumers of sand through marketing.	1.4663	0.92933	2.460	5.775

Source: Researcher, 2022

This section provides the study findings for the role of government institutions and authorities in sand harvesting activities descriptive statistics. The findings indicate that the county government institutions and authorities like NEMA are not carrying out awareness creation and sensitization to ensure sustainable extraction of the sand resources. This is attested by the results (Mean=1.17, SD=0.66, Skewness=4.55, Kurtosis=21.14). This implies that the community has not been sensitized and are

therefore not fully aware of measures to take in order to ensure sustainable extraction of the sand resource. Similarly, there are not regulations of sand harvesting activities as shown by the results (Mean=1.44, SD=0.95, Skewness=2.55, Kurtosis=6.04). The lack of sand regulations activities indicates a gap that allows extraction of the resource without control measures. Further, the results indicate that lack or laxity in implementation and enforcement of the laws by the enforcing authority affects the sand harvesting activities. (Mean=4.31, SD, 1.02, Skewness=-1.65, Kurtosis=2.02). This implies that lack of guidelines and procedures on sand harvesting activities leads to lack of mitigation on the potential environmental destruction. In similar vein (Trop 2017; UNEP 2014; Uscinowicz *et al*. 2014) asserts that the main area of concern has been how to regulate and provide guidelines and procedures to mitigate the potential environmental damage from sand harvesting activities. According to Green (2012) in south Africa the regulatory framework is not doing well in terms of serving what has identified as the three most important objectives, including conserving the resource; permitting an ordered and sustainable exploitation of the resource; and mitigating the environmental impacts associated with sand mining.

In addition, the findings indicate that there is no community participation due to lack of sub county and ward sand management committees (Mean=1.49, SD=0.94, Skewness=2.17, Kurtosis=4.14). The implication is that, lack of participation means lack of active role of the community who are supposed to be in the frontline in the management of the resource. Similarly, the results indicate that the county government and authorities are not undertaking several measures to stop environmental degradation resulting from sand harvesting activities (Mean=1.42, SD=0.788, Skewness=2.56, Kurtosis=7.26). This implies that the continuous environmental degradation will

eventually affect the livelihoods of the community negatively because it is not being addressed.

The results also show that there is no streamlining of sand prices by the county government (Mean=1.40, SD=0.79, Skewness= 2.62, Kurtosis=7.53). This affects the income sand harvesters, loaders and land owners receive and it also means that more sand is being harvested from the community but they do not get the real value of the resource. The finding also indicates that there is no direct link to final consumers of sand through marketing (Mean=1.47, SD= 0.93, Skewness=2.46, Kurtosis=5.78). This indicates that there is exploitation by the middlemen who have direct links than the land owners or sand harvesters.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of the Findings

The findings were summarized as follows:

5.1.1 Background Information of the Households

The study established that the majority of the household heads were not directly involved in sand harvesting. Those who were directly involved include the land owners, sand harvesters, loaders and those who were indirectly involved include transporters, the County Government, brokers, business activities around the sand harvesting sites, and sand harvesting community organizations. The study was inclusive and that the views of both genders were incorporated in the study to establish the socio-economic and environmental effects of sand harvesting. Cross-tabulation results indicated that there were more male and females who were directly involved in sand harvesting in Serewa compared to Mtembur and Kanyarakwat. In Serewa men are directly involved in sand harvesting because they mainly harvest and load the sand into the trucks and Serewa had more trucks coming to collect sand as compared to Mtembur and Kanyarakwat this could be attributed to a better road network, price and quality of the sand.

The 26-35 and 36-45 age groups had a high frequency implying a youthful segment of the population engages in sand harvesting activities, the majority of the household heads belong to the productive age category. Majority of the household's heads had attained basic education or had never attended school; many youths have no formal education resulting to limited employment opportunities in the formal sector making sand harvesting the only available alternative which does not need any formal skills

with limited entry and exit restrictions. The determining factor is the application of the physical strength of the harvester. Most of the household consist of 5 to 9 household members indicating high dependency; ideally the large sized households are an incentive for the household heads to invest more working hours in sand harvesting in order to earn enough to sustain household demands. . Most households engage in crop farming and animal husbandry implying that households diversify their sources of livelihoods. The findings indicate that majority earn below Kshs 5,000 per month from sand harvesting. The second categories earn between Ksh 5,000 to 20,000, the third category Ksh 20,000 to 35,000 and those who earn above Kshs 50,000 are landowners. From the FGD the general feeling was that the income earned was very low and yet they use a lot of their time and energy to harvest and load the sand. In addition, there is a lot of exploitation from the middlemen (brokers) who handle the cash on behalf of the site owners and other labourers.

5.1.2 Social Implications of Sand Harvesting on Livelihoods

The first objective of the study determined the social implications of sand harvesting on livelihood security. Social ties in sand harvesting are essential in opening up livelihood opportunities. The majority belong to self-help groups and community-based organizations such as Mesako CBO. It was further established that the main reasons why some have not joined the social groups include lack of membership fee, social class and lack of identity cards. The main membership benefits enjoyed in the social groups include welfare support and farm inputs access however collective bargaining power for sand prices was ranked the least. The Binary logistic regression is given by -4.223-0.025 Gender-0.813: Stakeholders Involvelemnt-1.97; Cooperative group-0.665; self-help group-0.601; welfare group-0.156; school fees access+1.668 farm input access-0.291; Welfare Support+0.449; Credit Access-0.446; bargaining sand Price.

Stakeholders' involvement, membership to a cooperative group, self-help group and benefits from input access are significant predictors of non-membership to sand harvesting groups. The other indicators such as; benefits from school fees access, welfare support, credit access, sand prices bargaining and gender did not significantly determine the output in the equation. Sand harvesting activities have contributed to school dropout (30.6%), school absenteeism (67.7%), drug abuse (58.4%), upsurge of criminal activities (33.7%), promiscuity, prostitution and early marriages (48.6%), alcoholism (67.4%), domestic violence (50.5%), family breakdown (41.3%). Lack of rehabilitation of sand harvesting sites fuels conflicts among the stakeholders (65%). Based on the structural model, the R^2 value for the model was .525 implying that 52.5 % of the variance in livelihood is explained by the social factors (conflict, membership and social ills).

5.1.3 The Economic Implications of Sand Harvesting on Livelihoods

The second objective of the study assessed the economic implications of sand harvesting on livelihood security. Economically, sand harvesting is a source of livelihood through the provision of incomes and employment opportunities. Sand harvesting is a source of employment 325(91.3%) and provides job opportunities to the sand loaders, harvesters and drivers and the many who are engaged indirectly related to sand harvesting. The harvesters and loaders have a clearly stipulated way of dividing money amongst themselves. The County is endowed with cheap sand for construction 295(82.6%). This implies that the community has the opportunity to use the available resources to construct their own houses, social amenities and rental houses. On the contrary, most of the harvested sand is not utilised for construction within the community and this can be attributed to high level of poverty and high prices of the other construction material like stones/ bricks and iron sheets.

There is poor road maintenance in the sand harvesting sites by the concerned authorities yet the County Government collects revenue from sand harvesters. A small percentage of 96(27%) pointed sand harvesting has led to access to better health services. The R^2 value for the structural model was .404 implying that 40.4 % of the variance in livelihood security is explained by economic factors. Generally, it can be deduced that economic impacts of sand harvesting on livelihood are both positive and negative. Sand harvesting often gives stimulus to the local economy, increases population income and business opportunities. However, income inequality, an unfair distribution of the benefits coming from resource extractions and corruption due to the bad management of mineral wealth, can trigger social tensions

5.1.4 Environmental Implications of Sand Harvesting on Livelihoods

The third objective of the study evaluated the environmental implications of sand harvesting on livelihood security. Sand harvesting activities have reduced the size of farming land 145(40.7%); storage of sand causes destruction of vegetation cover; destroy the underground aquatic ecosystem 242(67%; sand scooping reduces surface water quality and quantity 251(61%); destruction of the forest cover 206(48%); increased dust pollution (207(57%); river bed degradation 311(87.4%); and increases erosional valleys 308(86.6%) which have negative effects on other livelihood activities and renders the land redundant.

Due to excessive sand harvesting, many pits are left uncovered and become dangerous to both people and livestock 318(89.4%);accumulation of water in open burrow pits creates an environment for mosquitoes breeding 306(86%); contamination of water and scarcity of water due to sand harvesting 289(81.1%); removal of river sand reduces siltation of rivers which increase the rate of flowing water 261(73.3%); the widening

and deepening of rivers that affects the flow of the river downstream 280(78.7%), destroys the river bank, the river course and the vegetation around it, thus enhancing the soil erosion and flooding possibilities being hazardous to the communities around. Based on the structural model, the R^2 value for the model was .570 implying that 57 % of the variance in livelihood is explained by environmental factors

5.2 Conclusions of the Study

The study adopted a multidimensional approach to examine the social, economic and environmental implications of sand harvesting on livelihood security in West Pokot's Mtembur, Serewo and Kanyarkwat sand mines. The study concluded that indeed sand harvesting had magnificent compound effects on livelihoods for the affected housheolds. In the social sphere, sand harvesting has resulted into the formation of community-based organizations but this is on a minimal scale with insignificant livelihood effects. The weak collective action has weakened the ability of the sand harvesting households to overcome the grip of the middlemen/brokers/cartels that take advantage of the community's vulnerability. The vulnerability and consequent exploitation have blocked the locals from maximizing the returns from the sand harvesting venture. More social ills than benefits have accrued to the community around the sand mines in West Pokot.

Economically, sand harvesting is a source of income and employment opportunities to loaders, harvesters, drivers and other indirect beneficiaries in Mtembur, Serewo and Kanyarkwat. The sand is cheap; ideally this should result into its affordability to the locals and the general low cost of production. On the centrally, the benefits accruing to the sand mine owners and harvesters are extremely low. Most profits end up with the middlemen/brokers/ cartels who exploit the owners by paying low prices for the sand

and the locals rely upon them for the means of transportation and markets. The poor road network and generally inaccessible sand mines is an additional cost of transporting the resource and weakens the bargaining power for high sand prices. The lack of the means of transport and information on the sand destination is a major barrier to the opportunity of the sand mining communities to maximise benefits and consequently secure their livelihoods.

Sand harvesting is accompanied by disastrous environmental effects. Sand harvesting is indeed a blessing in disguised due to the gradient in West Pokot that favours its natural formation. However, the human activities involved in sand harvesting impact negatively on livelihoods around the mining sites who are also the least beneficiaries of the sand business. The rate at which sand is harvested contributes to the depletion of the resource and the rapid spread of the environmental effects as the harvesters migrate from one site to the other in pursuit of more quantities of sand. As they move, more damage is left behind with the locals bearing the greatest cost of the environmental damage. These raise questions on the cost-benefits and sustainability of the sand ventures. Consequently, the study recommends the measures to be put in place to surmount the hazardous socio-economic and environmental effects and enhance the multiplier effects of sand harvesting on livelihood security.

5.3 Recommendations

Based on the findings and conclusions derived so far, the following are the recommendations;

a) County governments should prioritize supporting sand harvesters to form and strengthen community-based organizations and mining cooperatives to enhance

their collective power for bargaining for better prices, competitive mining and access to remunerative external markets.

b) Sand harvesting is a blessing in disguise. There is need by all stakeholders, to make it a real source of livelihood in the study area.

c) The County and National Governments through Water and Resource Management Authority and NEMA, should enforce the existing legal frameworks and regulations to promote sustainable sand harvesting activities in the study area.

d) The County Government should invest in the support infrastructure to reduce the cost of doing sand business.

e) Community members should be sensitized through institutional support to diversify their sources of livelihoods.

f) Community sensitization on the social, economic and environmental costs and benefits of sand harvesting in order for them to make informed choices.

g) There is to inject value addition in sand harvesting for maximum economic returns.

5.4 Recommendation for Further Study

The study's main objective was to determine implications of sand harvesting on livelihood security in West Pokot, Kenya. Based on the findings, the study was limited to sand harvesting social, economic and environmental implications on people's livelihood. Thus, more research should be carried out to determine other elements/factors that could affect people's livelihood other than the ones mentioned e.g. cattle rustling, agriculture, entrepreneurship and manufacturing. This would enable the researchers and concerned parties to manage the activities through developing relevant policies, acts, institutions and other regulations that will enable partakers in the

activities conduct their business smoothly. Furthermore, conducting a replication study in other counties in the country such as Mombasa County is also needed to supplement findings in this study.

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APPENDICES

Appendix I: Questionnaire for the Households Heads of Selected Sand Harvesting Sites

Moi University
School of Arts and Social Sciences
Department of Anthropology, psychology and sociology
Moi University P.O. Box 3900 -30100
Eldoret.

Dear Sir/Madam,

The Respondent

Re: Research Study.

I am a post graduate student pursing PHD degree in Development Studies conducting academic research on "Social-economic and Environmental Implications of Sand Harvesting on Livelihoods among the Residents of West Pokot, Kenya".

The findings will be useful to the stakeholders, County Governments, Ministry of Environment, National Environment Management Authority (NEMA) and development actors interested in getting a better understanding on the sand harvesting process and its implication on people's livelihoods. You are therefore requested to answer all the questions according to the instructions given to each, your answers will be treated as confidential. Please do not indicate your name. Thank you in advance for your co-operation and God bless you.

Yours faithfully,

Milka Psiwa

0722 688778

QUESTIONNAIRE FOR THE HOUSEHOLDS HEADS OF SELECTED SAND HARVESTING SITES.

Please answer these questions to the best of your knowledge. Please put a tick [ ] where appropriate. Do not include your name anywhere in the questionnaire.

A	**BACKGROUND DETAILS**	
1.	Please tick your area of resident	1.Serewa [ ] 2.Mtembur [ ] 3.Kanyarkwat [ ]
2.	Gender	1. Male [ ] 2. Female [ ]
3.	Age	1. Less than 18 [ ] 2. 19-25 [ ] 3. 26- 35 [ ] 4. 36-45 [ ] 5. 46- 60 [ ] 6. Above 60 [ ]
3.	Highest level of formal education	1.Never Attended [ ] 2.Primary [ ] 3.Secondary [ ] 4.College [ ]
4.	Marital Status	1.Married [ ] 2.Single [ ] 3.Widowed [ ] 4.Separated [ ]
5.	Number of people in the household	1.1-4 [ ] 2. 5 - 9 [ ] 3. 10-12 [ ] 4. Above 13 [ ]
6.	Apart from sand harvesting what other major economic activities are you engaged in. (Kindly tick all that apply).	1.Crop farming [ ] 2. Cattle keeping [ ] 3. Goat Farming [ ] 4. Bee Keeping [ ] 5.Poultry Keeping [ ] 6. Tree seedling [ ] 7. Others (Specify)…….
7.	Range of Income per month from sand harvesting	1. Below 5000 [ ] 2. 5,001-20,000 [ ] 3. 20, 001-35,000 [ ] 4. 35,001-50,000 [ ] 5. Above 50,001 [ ] 6. Not sure [ ]

B	**SOCIAL IMPLICATIONS OF SAND HARVESTING**

Please indicate your extent of agreement on the organization that you belong

	Social Group	YES	**NO**
8.	Do you belong to any social group		
9.	I belong to the community sand harvesting group		
10.	Am a member of a cooperative society		
11	I belong to a Self –help group		
12.	Am a member of a Welfare group		

The following are reasons of not joining a social group

	Reasons	**YES**	**NO**
13.	Lack of National Identity Card(ID)		
14.	Ethnic reasons		
15.	Social Class		
16.	Lack of income		

The following are membership benefits derived from social group

	Membership Benefits	**YES**	**NO**
17.	School fees access		
18.	Farm input access(seeds)		
19.	Welfare support		
20.	Credit Access		

Please indicate your level of agreement on the following effects of sand harvesting on schooling

	Effects	**Strongly Agree (5)**	**Somewhat Agree(4)**	**Neutral(3)**	**Somewhat Disagree (2)**	**Strongly Disagree (1)**
21.	High school drop-out					

22.	Increase absenteeism among the school going children					
23.	Lack of concentration by students in class due to noise made by lorries					

Please indicate your extent of agreement on social ills associated with sand harvesting

Social ills		**Strongly Agree (5)**	**Somewhat Agree(4)**	**Neutral(3)**	**Somewhat Disagree (2)**	**Strongly Disagree(1)**
24.	Sand harvesting contributes to drug abuse among the youth					
25.	Upsurge of criminal activities with the influx of youths foraging the neighborhood to eke a living					
26.	It has led to increase in promiscuity, prostitution and early marriages					
27.	It has led to increased incidences of alcoholism					
28.	It is associated with increased domestic violence					
29.	Associated with family breakdown					

To what extent do you agree to the following on conflict associated with sand harvesting

	Conflict	**Strongly Agree (5)**	**Somewhat Agree(4)**	**Neutral(3)**	**Somewhat Disagree (2)**	**Strongly Disagree(1)**
30.	Sand harvesting has led to many conflicts among stakeholders					
31.	Lack of clear regulations of Sand harvesting leads to conflicts					
32.	Corruption reduces revenue collection from sand harvesting and leads to conflicts					

33.	Lack of rehabilitation of sand harvesting sites fuels conflicts among the stakeholders.					
34.	Sand harvesting in the study area is unsustainable and it leads to conflict due to overexploitation of the resource					

35. **Suggest possible workable solutions to the above social implications**

SECTION C: ECONOMICS IMPLICATIONS OF SAND HARVESTING ON LIVELIHOODS

Using the following scale, please tick the one that best describes your opinion: **Strongly Agree (5), Somewhat Agree (4), Neutral (3), Somewhat Disagree (2) and Strongly Disagree (1)**

	Statement to be Rated	SA	A	UN	D	SD
36	Sand harvesting is a source of employment					
37.	Sand harvesting is a source of constant income to land owners, loaders, harvesters and transporters.					
38.	Cheap sand for construction sand is available for the community					
39.	Sand harvesting has improved road networks in the study area					
40.	Sand harvesting has created market for other goods and services					
41.	Sand harvesting is a source of funding to community projects like schools and dispensaries.					
42.	Sand harvesting has led to better access to health services due to increased income.					
43.	Sand harvesting activities has enhanced schooling activities					
44.	Sand harvesters as provided alternative source of livelihood like bee keeping alongside food crop production					
45.	Sand harvesting engagement has led to reduced charcoal burning business.					
46.	Although Sand harvesting is beneficial share of monetary benefits to the local economy is minimal					
47.	High level of poverty persists despite sand harvesting activities					

48.	Sand harvesting has led to better access to health services due to accessibility of dispensaries.					
49.	Sand harvesting is a source of revenue to the county government					
50.	Sand harvesting has led to the improved standards of living					
51.	Sand harvesting activities has enabled households to afford three meals per day					
52.	High and lucrative profit from sand harvesting has led to betterment of people's livelihoods					
53.	Funds generated from sand harvesting is adequate to support your all household's needs.					

54. Suggest possible workable solutions to the above economic implications

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SECTION D: ENVIRONMENTAL IMPLICATIONS OF SAND HARVESTING ON LIVELIHOODS

Using the following scale, please tick the one that best describes your opinion: **Strongly Agree (5), Somewhat Agree (4), Neutral (3), Somewhat Disagree (2) and Strongly Disagree (1)**

		SA	A	UN	D	SD
55.	Lands for farming reduced because of sand harvesting activities.					
56.	Storage of sand causes destruction of vegetation cover					
57.	Sand harvesting destroys underground aquatic ecosystem					
58.	Sand scooping reduces surface water quality and quantity.					
59.	Sand harvesting leads to destruction of the forest cover					
60.	Sand harvesting is associated with increased dust pollution					
61.	Sand harvesting leads to river bed degradation					
62.	Sand harvesting increases erosional valley					
63.	Environmental groups exist that deal with tree planting and control of erosion.					
64.	There is repairs and maintenance of damaged road infrastructure					
65.	There are environmental rehabilitation programs in sand harvesting areas.					
66.	There exist no strict measures for controlling the rate of sand harvesting to protect the environment					

67.	Many pits are left uncovered and during the raining seasons they are filled with water and become dangerous to both people and livestock.					
68.	Accumulation of water in open burrow pits creates an environment for mosquitos breeding which spread malaria.					
69.	There is contamination of water and scarcity of water due to sand harvesting					
70.	Removal of river sand reduces siltation of rivers which increase the rate flowing water.					
71.	Widening and deepening of rivers affect river flow downstream.					
72.	Training on sand harvesting sustainability leads to environmental conservation.					
73.	There is overexploitation of sand resources					
74.	In my opinion there is no sustainable use of sand resource if the environment effects of sand harvesting are not minimized.					
75.	Community participation leads to environmental protection after sand harvesting.					

76. Suggest possible workable solutions to the above environmental implications

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SECTION D: REGULATIONS AND POLICY FRAME WORK FOR SAND HARVESTING

Using the following scale, please tick the one that best describes your opinion: **Strongly Agree (5), Somewhat Agree (4), Neutral (3), Somewhat Disagree (2) and Strongly Disagree (1)**

		SA	A	UN	D	SD
77.	The county government institutions and authorities like NEMA are carrying out awareness creation and sensitization to ensure sustainable extraction of the resources.					
78.	The county government institutions and authorities regulates sand harvesting activities.					
79.	Lack or laxity in implementation and enforcement of the laws by the enforcing authority (county government) affects the sand harvesting activities.					
80.	There is community participation through creation of sub county and ward sand management committees.					
81.	The county government and authorities are undertaking several measures to reduce environmental effects resulting from sand harvesting activities.					

82.	The county government is directly involved in streamlining sand prices.					
83.	The county government institutions creates direct link to final consumers of sand through marketing.					

Appendix II: Key Informant Interview Schedule

1. What is the common sand harvesting technology employed in the study area?
2. How sand harvesting is regulated?
3. What are the social implications of sand harvesting?
4. What are the economic implications of sand harvesting?
5. What are the environmental implications of sand harvesting?

Appendix III: Focused Group Discussions

1. What is the common sand harvesting technology employed in the study area?
2. How sand harvesting is regulated?
3. What are the social implications of sand harvesting?
4. What are the economic implications of sand harvesting?
5. What are the environmental implications of sand harvesting?

Appendix IV: Coding of the Variables

Social Group belongingness	
Memb1	I belong to the community sand harvesting group
Memb2	Am a member of a cooperative society
Memb3	I belong to a Self –help group
Memb4	Am a member of a Welfare group
Memb50	Am not member of any Group
Reasons for not joining any group	
RsnM1	Lack of National Identity Card(ID)
RsbM2	Ethnic reasons
RsnM3	Social Class
RsnM4	Lack of incom
Membership Benefits	
MembBY1	School fees access
MembBY2	Farm input access(seeds)
MembBY3	Welfare support
MembBY4	Credit Access
MembBY5	Collective Bargaining of sand
Effects of sand harvesting on schooling	
Sch1	High school drop-out
Sch2	Increase absenteeism among the school going children
Sch3	Lack of concentration by students in class due to noise made by lorries
Social ills associated with sand harvesting	
Socil1	Sand harvesting contributes to drug abuse among the youth
Socil2	Upsurge of criminal activities with the influx of youths foraging the neighborhood to eke a living
Socil3	It leads to increase in promiscuity, prostitution and early marriages
Socil4	It leads to increased incidences of alcoholism
Socil5	It is associated with increased domestic violence
Socil6	Associated with family breakdown
Conflicts associated with sand harvesting	
Conflict1	Sand harvesting has led to many conflicts among stakeholders
Conflict2	Lack of clear regulations of Sand harvesting leads to conflicts
Conflict3	Corruption reduces revenue collection from sand harvesting and leads to conflicts
Conflict4	Lack of rehabilitation of sand harvesting sites fuels conflicts among the stakeholders.
Conflict5	Sand harvesting in the study area is unsustainable and it leads to conflict due to overexploitation of the resource
Economic Financial Support	
ECONFIN1	High level of poverty persists despite sand harvesting activities
ECONFIN2	Funds generated from sand harvesting is adequate to support your all household's needs.
ECONFIN3	Although Sand harvesting is beneficial share of monetary benefits to the local economy is minimal
ECONFIN4	Sand harvesting is a source of revenue to the county government

Economic Activities	
ECONACT1	Sand harvesting engagement has led to reduced charcoal burning business.
ECONACT2	Sand harvesters as provided alternative source of livelihood like bee keeping alongside food crop production
ECONACT3	Cheap sand for construction is available for the community
ECONACT4	Sand harvesting has created market for other goods and services
Economic Infrastructure	
ECONIFR1	Sand harvesting has improved road networks in the study area
ECONIFR2	Sand harvesting has led to better access to health services due to increased income.
ECONIFR3	Sand harvesting is a source of funding to community projects like schools and dispensaries.
ECONIFR4	Sand harvesting has led to better access to health services due to accessibility of dispensaries.
ECONIFR5	Sand harvesting activities has enhanced schooling activities
Economic Investment	
ECONINV1	Sand harvesting is a source of employment
ECONINV2	Sand harvesting is a source of constant income to land owners, loaders, harvesters and transporters.
ECONINV3	High and lucrative profit from sand harvesting has led to investment
ECONINV4	Sand harvesting has led to improved standards of living
ECONINV5	There is availability of food in the household
Government and Institutional Support	
Polic1	The county government institutions and authorities like NEMA are carrying out awareness creation and sensitization to ensure sustainable extraction of the resources.
Polic2	The county government institutions and authorities regulates sand harvesting activities.
Polic3	Lack or laxity in implementation and enforcement of the laws by the enforcing authority (county government) affects the sand harvesting activities.
Polic4	There is community participation through creation of sub county and ward sand management committees.
Polic5	The county government and authorities are undertaking several measures to reduce environmental effects resulting from sand harvesting activities.
Polic6	The county government is directly involved in streamlining sand prices.
Polic7	The county government institutions creates direct link to final consumers of sand through marketing.
Environmental Degradation	
EED1	Sand scooping reduces surface water quality and quantity
EED2	Sand harvesting increases erosional valley
EED3	Sand harvesting leads to river bed degradation
EED4	There is contamination of water and scarcity of water due to sand harvesting
EED5	Sand harvesting destroys underground aquatic ecosystem

Physical Environment	
EPE1	Lands for farming reduced because of sand harvesting activities.
EPE2	Storage of sand causes destruction of vegetation cover
EPE3	Sand harvesting is associated with increased dust pollution
EPE4	Widening and deepening of rivers affect river flow downstream.
EPE5	Removal of river sand reduces siltation of rivers which increase the rate flowing water.
EPE6	Sand harvesting leads to destruction of the forest cover
Environmental Outcome	
ECO1	Accumulation of water in open burrow pits creates an environment for mosquitos breeding which spread malaria
ECO2	There is sustainable exploitation of sand resources
ECO3	In my opinion there is maximum utilization of sand resource and the environment effects of sand harvesting are minimized.
ECO4	Many pits are left uncovered and during the raining seasons they are filled with water and becomes dangerous to both people and livestock.
Environmental Conservation and control groups	
ECE1	There is environmental rehabilitation programs in sand harvesting areas.
ECE2	Environmental groups exist that deal with tree planting and control of erosion
ECE3	Training on sand harvesting sustainability leads to environmental conservation.
ECE4	There is repairs and maintenance of damaged road infrastructure.
ECE5	There exist no strict measures for controlling the rate of sand harvesting to protect the environment
ECE6	Community participation leads to environmental protection after sand harvesting.

Appendix V: NACOSTI Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

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Date of Issue: 12/August/2020

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This is to Certify that Ms.. Milka Chelagat Psiwa of Moi University, has been licensed to conduct research in Westpokot on the topic: Social Economic and Environmental Implications of Sand Harvesting on Livelihoods among the residents of West Pokot County for the period ending : 12/August/2021.

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National Commission for Science, Technology and Innovation
off Waiyaki Way, Upper Kabete,
P. O. Box 30623, 00100 Nairobi, KENYA
Land line: 020 4007000, 020 2241349, 020 3310571, 020 8001077
Mobile: 0713 788 787 / 0735 404 245
E-mail: dg@nacosti.go.ke / registry@nacosti.go.ke
Website: www.nacosti.go.ke