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## Abstract

**Purpose:** Sand harvesting is one of the major livelihoods in Kenya Arid and Semi-Arid Lands (ASALs) and more so in Mbooni Constituency in Makueni County. Despite the gained employment and the income opportunities, the practice has caused a serious concern among people because of its negative effect on livelihood and the environment. The extent of sand harvesting and its effect to local livelihood and environmental degradation in the Mbooni Constituency were examined in this paper.

**Methodology:** The research was informed by the Sustainable Livelihoods Framework, Human Capital Theory and the Environmental Kuznets Curve theories, among others. Its survey design was descriptive and contained 354 participants who were sand harvesters, truck drivers, sand owners and community members. Stratified random sampling was employed, and information was collected using structured questionnaires. Data analysis was performed using SPSS, employing both descriptive and inferential statistics, as well as multiple regression analysis.

**Findings:** The results showed that unregulated and intensive sand mining has led to a decline in land productivity, the destruction of riverbeds and water resources, and a reduction in agricultural potential, necessitating the application of alternative management strategies.

**Unique Contribution to Theory, Practice and Policy:** To mitigate the negative effects of sand harvesting and promote sustainability, it is recommended to enforce stricter regulations controlling the amount and rate of sand extraction.

**Keywords:** *Sand Harvesting, Livelihood, Environmental Degradation*

**JEL Codes:** *Q01, Q15, O13, Q53*

## INTRODUCTION

The second most widely utilized natural resource in the world, after water, is sand, which is composed of tiny particles of rocks and minerals (Filho et al., 2021). This is versatile and therefore cannot be ignored in various sectors, such as hydraulic fracturing, glass production, water purification, and, most importantly, construction. Nevertheless, the distribution of sand worldwide is uneven, forcing many countries to rely on imports (Filho et al., 2021). The list of factors that drive demand in this area includes rapid population growth, urbanization, and the development of infrastructure, which encourages massive extraction. This can have devastating environmental effect with drastic effects on human livelihoods (Sreebha and Padmalal, 2011; Johnbull and Brown, 2017; Torres et al., 2021).

Sand mining is a critical global industry with significant environmental consequences. Overexploitation of sand resources, driven by rapid urbanization, population growth, and infrastructure development, is a widespread issue. In regions like Poyang Lake, South East Asia, and the United States, unsustainable extraction practices have led to severe ecological impacts such as erosion, subsidence, and the destruction of river ecosystems. In particular, uncontrolled offshore mining in the Mekong River has caused saltwater intrusion and reduced agricultural output, while the demand for silica sand in the United States has led to a "sand rush" in states like Texas, Illinois, and Wisconsin. Despite its importance, weak regulations and unsustainable extraction continue to threaten ecosystems and local communities, with severe repercussions for biodiversity and the environment (Sreebha & Padmalal, 2011; Johnbull & Brown, 2017; Da & Le Billon, 2022).

Sand mining is still common in Africa, and in some cases, it is a viable option for livelihood in situations where other economic options are scarce. One of the most prominent extraction locations is South Africa and Sierra Leone (Magid & Jimu, 2023). Although sand mining generates revenue, it is associated with significant ecological imbalances, including the loss and degradation of the riverine ecosystem (Johnbull & Brown, 2017). These effects have been compounded by poor regulation in West Africa. The Volta River basin in Ghana has been severely affected by uncontrolled sand harvesting (Akoto et al., 2021).

In Kenya, particularly in Makueni County, which falls under the Arid and Semi-Arid Lands (ASALs), sand harvesting has become a significant livelihood activity due to the absence of alternative economic opportunities. This region, heavily dependent on rain-fed agriculture, faces vulnerabilities to drought and irregular rainfall, which has forced many to turn to sand harvesting as a means of income. However, the practice is largely unregulated due to weak enforcement of the Mining Act of 2016 and the Environmental Management and Coordination Act (Amendment, 2015). Though guidelines were recommended by the National Environment Management Authority (NEMA) in 2019, they remain advisory and lack the legal force to curb the environmental impact of sand mining. Moreover, corruption and insecurity exacerbate the problem, with illegal sand harvesters using gangs and bribing enforcement agencies to carry out their activities without consequence (Gitonga, 2017; Bhatawdekar et al., 2021; Fabius, 2013). These issues are compounded by the availability of seasonal rivers rich in sand deposits, creating a cycle of over-exploitation that is rapidly degrading the environment and threatening local livelihoods.

Mbooni Constituency in Makueni County represents a striking example of the convergence of livelihood needs and ecological risks. As a region heavily reliant on sand harvesting due to limited alternative income sources, Mbooni faces the dual challenge of sustaining its population

while preserving the environment. The ongoing over-exploitation of sand, driven by the need for construction and limited regulation, is rapidly depleting local water sources and altering river courses, further compounding the region's vulnerability to drought and environmental degradation. This study, therefore, seeks to evaluate the extent to which sand harvesting in Mbooni is contributing to both livelihood enhancement and environmental degradation, highlighting the urgent need for sustainable management practices.

## Statement of the Problem

Sand harvesting has emerged as a major form of livelihood activity in the Mbooni Constituency, Makueni County with most of the households in the region depending on sand harvesting as a major revenue generating activity. Despite this, providing employment and short-term monetary benefits, there have been serious environmental and social issues which have been brought forth by the senior practice. The riverbeds, land productivity, water-holding capacity, and agricultural activities in the region have also been affected negatively by the extraction process because it has been uncontrolled (Muiruri & Amimo, 2017; Kivuva, 2017; Kithikii, 2023).

Despite the economic advantages, local harvesters face low wages and struggle to meet the basic needs of food, education, and healthcare. Sand harvesting has entrenched poverty, hunger, and poor health in the community, as the work is physically demanding, and workers are often exposed to health and safety hazards. Moreover, with limited income from sand mining, many families remain trapped in a cycle of economic vulnerability (Wambua, 2015; Mbuvi et al., 2020). This has deepened the socio-economic challenges faced by the local population, limiting their opportunities for better livelihood alternatives. Research by Muiruri and Amimo (2017) and Kivuva (2017) highlights how communities in Makueni are particularly vulnerable due to their dependence on sand harvesting, but these studies do not fully address the compounded effects of this practice on both the social and environmental fronts in the Mbooni area.

Furthermore, the lack of strong regulations and poor enforcement mechanisms has allowed predatory practices, benefiting intermediaries and traders rather than the local communities. This has led to significant environmental destruction, as sand is harvested at unsustainable rates, further degrading the region's natural resources (NEMA, 2019). While studies such as Kithikii (2023) have discussed the regulatory gaps in Makueni County, the specific impact of these issues in Mbooni Constituency remains under-explored. Few studies have holistically addressed how both environmental degradation and socio-economic vulnerability interact in Mbooni, making this an important research gap. Existing literature, such as the works of Kithikii (2023) and Kivuva (2017), lacks a comprehensive focus on the compounded effects of sand harvesting, which this study aims to address. By filling this knowledge gap, the research will provide insights to inform policies and strategies that balance economic needs with long-term conservation of the ecosystem.

## Justification of the Study

Harvesting of sand in Mbooni Constituency, Makueni County has resulted in some economic gains in the short term at the cost of a serious environmental damage and disturbance of the local livelihoods. This is due to the fact that its magnitude and effects should be known in order to put in place sustainable strategies to satisfy economic demands and conserve the environment.

## Scope of the Study

The study was carried out in Makueni County in one of the six constituencies of the eastern region of Kenya, in the Mbooni Constituency. The size of the area that Mbooni covers is 949.2 km2, and as per the Kenya Population and Housing Census of 2019, it contains 200,350 people. The study addressed settlements that live along three rivers, Ngoni, Wamua, and Waani, which are the major sand deposits in the constituency.

The participants targeted included citizens directly or indirectly engaged in the sand harvesting industry through involvement of sand miners, sand property owners, truck drivers and those affected by the activity directly. The sampling was based on simple random sampling and sampling size was 354 respondents. Data was collected in structured questionnaires and analyzed using descriptive statistics as well as inferential statistics.

This research was aimed at determining the extent of sand harvesting and its effect on livelihood and environmental degradation in Mbooni Constituency. It is the analysis of key variable, the extent of sand harvesting with a dependent orientation based on livelihood outcomes and the sustainability of the environment.

## LITERATURE REVIEW

In this section, the literature on sand harvesting and its effect on livelihood and environmental degradation in the Mbooni Constituency, Makueni County, Kenya is summarized. The review is organized into three major areas: the theoretical framework on which the study is built, global, regional, and local empiricism and the conceptual framework that ties the major variable under study.

### Theoretical Framework

### Sustainable Livelihoods Framework

The SLF which began in the 1990s with the Institute of Development Studies and is premised on the work of Chambers and Conway (1992) provides a holistic view of how households maintain their own livelihoods in resource-based environments that are constrained. It identifies five categories of capital (human, social, natural, physical and financial), which dictate the livelihood strategies under specific circumstances of vulnerability (Scoones, 2009). Livelihoods and poverty have been seen as a multidimensional dimension, in that it is not only about income but the accessibility and use of assets (Serrat, 2017).

The SLF is specifically relevant to sand harvesting in Mbooni Constituency, because extraction activities directly impact natural capital (land productivity and river ecosystems), financial capital (sand sales through extraction) and human capital (labor, health and skills of the workers). Sand harvesting has caused environmental degradation, declining agricultural output, and food insecurity despite the short-term economic benefit to the economy.

Central to the vulnerability context in Mbooni, however, is the role of power dynamics, corruption, and weak institutional enforcement. The power exerted by intermediaries and traders, who control sand extraction and sales, exacerbates the vulnerability of local communities. Corruption within local authorities and enforcement agencies often leads to the disregard of environmental regulations, allowing illegal sand mining to flourish. The lack of effective enforcement and the absence of accountability within governance structures create an environment where the benefits of sand harvesting are concentrated in the hands of a few, while the broader community bears the ecological and social costs. Despite criticism that the SLF tends to overlook politics, governance, and resource distribution (de Haan, 2012), it remains

widely applied in rural livelihood and natural resource studies (Natarajan et al., 2022). This framework, when applied to Mbooni, offers critical insight into how institutional failures, power imbalances, and corruption intersect with livelihood strategies to shape the outcomes of sand harvesting, thus highlighting the need for policies that balance economic objectives with effective resource management and institutional accountability.

The SLF of this study represents a paradigm of analyzing the impact of sand harvesting on the different grades of capital in Mbooni and hence offers a perspective into the approaches and policy options that have the potential to better balance economic objectives and the management of resources in a sustainable manner.

## Environmental Kuznets Curve Theory

The Grossman and Krueger (1991) proposed Environmental Kuznets Curve (EKC) is a U-shaped curve that states that there is a negative relationship between the economic development and the environmental quality. Ecological degradation is at an elevated level in the early development phases as the intensity of economic activities increases. Still, it does not continue to increase after a particular income threshold, as a greater understanding of environmental issues, increased regulations, and the use of technology have the potential to restore ecological value (Stern, 2004). This paradigm highlights the possibility of harmonizing economic growth with environmental sustainability (Dasgupta et al., 2002).

In small-scale economies, the economic growth from sand harvesting is unsustainable. The extraction process causes significant environmental damage, such as riverbed degradation and soil erosion, without triggering the environmental recovery predicted by the EKC. Moreover, the lack of stringent regulations and weak enforcement prevent the adoption of environmental protections or technological improvements that could reverse ecological damage. The income from sand harvesting does not lead to improved social infrastructure or environmental recovery, and communities remain trapped in a cycle of poverty and degradation (Muiruri & Amimo, 2017; Kivuva, 2017).

Further, corruption and institutional failures hinder effective governance, leaving local populations vulnerable to ongoing ecological risks. Unlike in wealthier economies, Mbooni lacks the resources or institutional capacity to implement policies that align with the EKC model's prediction of improved environmental quality with rising income. Therefore, the EKC theory may not adequately address the complexities of sand harvesting in Mbooni, where economic growth and environmental sustainability are unlikely to align without substantial changes in governance and resource management.

## Human Capital Theory

Human Capital Theory is a theory of people developed by Schultz (1961) and Becker (1964), which views individuals as assets whose knowledge, skills, health, and other capabilities can be improved through investment, yielding economic and social returns (Tan, 2014). The major investments are in education, training, healthcare, and acquisition of skills that can maximize productivity and income, and eventually, lead to the development of the country (Marginson, 2019).

Nevertheless, even with its influential position, the theory is frequently criticized because of the high level of population concentration on economic outcomes, and the absence of concern about social, cultural, and equity factors (Marginson, 2019). It has been also criticized to shift the expenditure of health and education on individuals rather than categorizing it as a social

good (Tan, 2014). Its limitations notwithstanding, it is a worthy framework to learn about the impact of livelihood activities on human well-being and future productivity.

The Human Capital Theory offers a lens in which impact to the livelihood and economic aspirations of the workers can be evaluated as a result of sand harvesting in Mbooni Constituency. The activity would bring about short-term revenue generation however, it subjects labourers to an unhealthy physically demanding working environment that can interfere with their health and their education, skill development and productivity in the long run. The theory emphasizes the short-term monetary gains of sand harvesting and long-term erosion of human capital to reach the goal of resilient and sustainable livelihoods.

## Empirical Review

### Extent of Sand Harvesting

Increased demand on sand has recently reached global heights with the growth of population and development of construction sectors. According to Peduzzi and Bendz (2022), the consumption of sand today goes beyond 50 billion tons a year, becoming the second most exploited natural resource after water. Likewise, it has been reported that similar trends occur in Africa, where Umar et al. (2020) observed that extraction in five countries had increased by 5.7% a year in 2019-2023. In Asia, Diwakar and Singh (2024) found that sand harvesting of riverine sources in northern India grew by 4.2 million tons per year, and Nguyen and Tran (2023) found that increased use was experienced in the Mekong Delta of Vietnam, where extraction became year-round rather than seasonal. However, most of these studies focus on the short-term economic benefits of sand mining without delving deeply into the long-term environmental impacts, which could be better understood through longitudinal studies that track the sustained effects of sand extraction on ecosystems over time. This presents a clear gap in the literature, particularly in regions like Mbooni Constituency, where sand mining is having irreversible ecological consequences.

Torres-Bejarano et al. (2019) found in Latin America that sand mining in Colombia tripled during periods of construction booms, and the highest rates were above 200 tons/site/day. Similarly, Diaz-Gallegos et al. (2021) noted that the growth of Mexican Gulf mining increased by 28 percent per year, and most of the sites later failed to maintain regulatory control. Similar results were observed in Brazil, where Oliveira and Santos (2020) observed a 34 percent rise in the number of sand mining locations, with the majority of them acting illegally. These studies highlight the growing scale of extraction, but there is a need for more comparative regional studies to understand the interplay between regulatory frameworks, governance, and environmental degradation. Comparing regions facing similar sand extraction challenges, such as those in Mbooni and Brazil, could yield insights into effective regulatory approaches and community-led resource management models.

The African case studies also highlight the magnitude of extraction. Akpan et al. (2021) numbered 423 active sites in southern Nigeria which a 41% rise on earlier estimates and Badaru and Mohammed (2021) noted a transition in Lagos to full-time daily operations, not only on the weekend. Mwangi and Kiprono (2022) reported an increase in the number of sand harvesting sites in Machakos and Kitui where 78 sites were recorded, whereas 63 were in ecologically sensitive riparian areas. Equally, Omondi and Wachira (2022), discovered that cooperatives on the Tana River extended the number of working days to less than two weeks to about one month. Ntajal and Abukari (2024) identified 186 active sites in Ghana, 72 percent of which were within 500 meters of ecologically important zones. These studies focus on the

environmental risks but lack exploration into the socio-economic vulnerability of local populations, such as poverty, low wages, and exposure to work hazards

These results reflect the growing extent of sand harvesting in scale, frequency, and intensity in different regions. While providing economic benefits, the trend is increasingly associated with unregulated operations, ecological risks, and growing pressures on riverine and coastal ecosystems.

## Conceptual Framework

This study's conceptual framework illustrates the relationship between the level of sand harvesting (independent variable) and its effect on livelihoods and environmental degradation (dependent variable) in Mbooni Constituency, Makueni County. The extent of sand harvesting is analyzed by the amount of sand harvested, the number of existing harvesting sites, and the rate at which harvesting is done. These are intended to affect the livelihood outcomes of household income, household food security, and the accessibility of basic needs, while also affecting the environment through land degradation and low agricultural output rates. The framework assumes that, although sand harvesting has a temporary positive economic effect, its long-term effects can hurt the sustainability of livelihoods and ecological stability in the area.
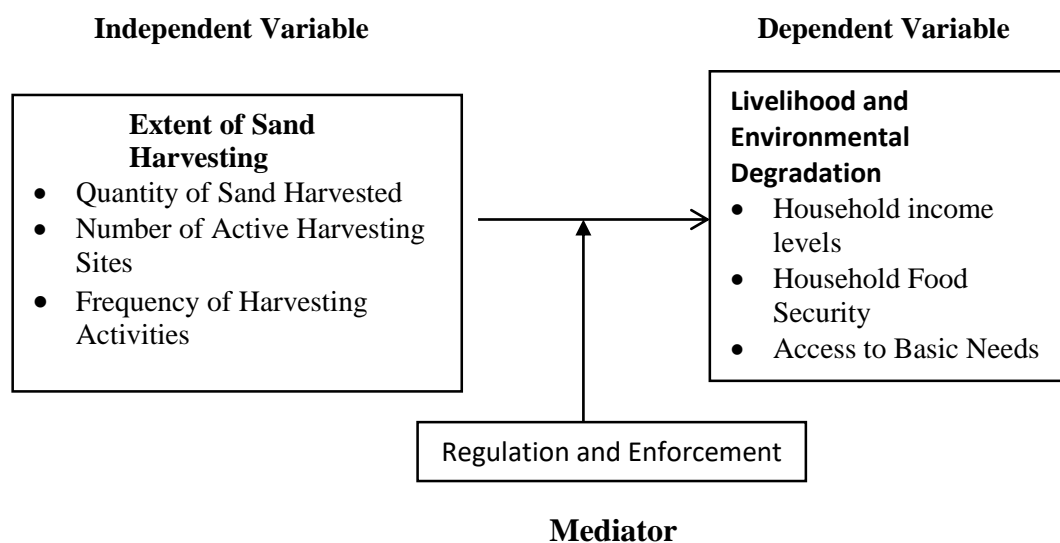
**Independent Variable**                                  **Dependent Variable**

| **Extent of Sand Harvesting** | **Livelihood and Environmental Degradation** |
|---|---|
| • Quantity of Sand Harvested<br>• Number of Active Harvesting Sites<br>• Frequency of Harvesting Activities | • Household income levels<br>• Household Food Security<br>• Access to Basic Needs |

Regulation and Enforcement

**Mediator**

*Figure 1: Conceptual Framework*

## METHODOLOGY

The methodology used in this study was descriptive as it sought to find out the extent of sand harvesting on livelihood and the environment degradation in Mbooni Constituency, Makueni County. This section outlines the research design, population of study, sampling frame, sample size, instruments, data collection methods, pilot test and the methods of data processing and analysis employed to come up with the results.

## Research Design

According to Kothari (2020), a research design is the general outline within which the procedure of the study is carried out, and also specifies how the data will be collected, measured and analyzed. The research design that was used in this study was a descriptive research design, which examined the effect of sand harvesting on livelihood and environmental degradation in

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Mbooni Constituency of Makueni County. The descriptive design was the most appropriate since it enabled the study to provide a comprehensive description of the phenomenon being researched and no bias was involved (Abutabenjeh and Jaradat, 2018). It served to collect objective data on a huge, heterogeneous, and representative sample, therefore, gaining an understanding of the existing situation in sand harvesting and its possible impacts on the community. Moreover, the design enabled the familiarity with the relationship between the independent variable; extent of sand harvesting, and the dependent variable; livelihood and environmental degradation. The approach allowed to gather valid and detailed data concerning the perception, attitudes, and experiences of stakeholders in Mbooni Constituency (Rahi, 2022).

## Target Population

A population is defined as the entire number of people/ things that possess similar attributes on which a sample can be selected (Orodho & Kombo, 2022). According to Mugenda and Mugenda (2003), the target population refers to any case or group of cases that possesses a given attribute of interest. Kombo and Tromp (2019) put more stress on its nature as the aggregate that the measures are based on. In this study, the study population entailed the people directly or indirectly engaged in sand harvesting activities in Mbooni Constituency. These comprised sand miners, sand owners, truck drivers and inhabitants who live around rivers with extensive effects of sand mining, such as the Ngoni, Wamua and Waani rivers. Since this population is heterogeneous, the study selected participants to represent all stakeholder groups (Etikan & Bala, 2023). The target population is shown in Table 1.

**Table 1: Target Population**

| Category and Area | Population |
|---|---|
| **Sand miners/harvesters** | |
| Ngoni | 150 |
| Wamua | 120 |
| Waani | 100 |
| **Sand owners** | |
| Ngoni | 23 |
| Wamua | 15 |
| Waani | 12 |
| **Truck drivers** | |
| Ngoni | 80 |
| Wamua | 60 |
| Waani | 50 |
| **Community members** | |
| Ngoni | 1,000 |
| Wamua | 800 |
| Waani | 700 |
| **Total** | 3,110 |

## Sampling Technique and Sample Size

Sampling is the process of selecting a representative subset of a population for study (Kumar, 2018). To ensure inclusivity, the study employed stratified random sampling, a method effective for heterogeneous populations that ensures proportional representation of distinct

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subgroups (Taherdoost, 2020). The population was stratified into four groups: sand miners, sand owners, truck drivers, and community members.

As follows n$=\frac{N}{1+N(e)2}$

Where n= Sample size

N = Total population size (3,110)

e = Margin of error (assumed at 5% or 0.05)

n = 3,110 / (1 + 3,110(0.05) ^2)

n ≈ 354

Therefore, the total sample size for the study was 354 respondents.

**Table 2: Sample Size**

| Category and Area | Sample Size |
|---|---|
| **Sand miners/harvesters** | |
| Ngoni | 17 |
| Wamua | 13 |
| Waani | 11 |
| **Sand owners** | |
| Ngoni | 6 |
| Wamua | 4 |
| Waani | 3 |
| **Truck drivers** | |
| Ngoni | 10 |
| Wamua | 9 |
| Waani | 6 |
| **Community members** | |
| Ngoni | 110 |
| Wamua | 88 |
| Waani | 77 |
| **Total** | 354 |

**Data Collection Tools**

Data collection instruments are tools used to obtain relevant information from respondents (Kombo & Tromp, 2022). This study utilized structured questionnaires containing both closed- and open-ended questions. Questionnaires were selected due to their suitability for collecting data from a large population within a relatively short time (Kabir, 2022). Closed-ended questions facilitated the collection of quantifiable data, while open-ended questions enabled respondents to elaborate on their perceptions, experiences, and insights, thereby enriching the study with qualitative perspectives (Mahon & Joyce, 2023). The questionnaire was designed in such a way that it answers the study goals and there was a section related to the extent of sand harvesting.

**Data Processing and Analysis**

Data analysis is the process of structuring, arranging, and analyzing raw data to determine the patterns and come up with meaningful results (Anderson and Thompson, 2023). The major data that was gathered using questionnaires was initially verified to be complete, consistent

and understandable before being coded to be analyzed. The calculation and analysis of the data were performed with the help of the Statistical Package of Social Sciences (SPSS), which is commonly known by its capability to process a wide variety of data and implement various statistical methods (Martinez and Chen, 2024).

To summarize the data, the study was conducted using descriptive statistics like frequencies, percentages and means. The relationship between independent variable, that is, the degree of sand harvesting, and the dependent variable, which consists of both livelihood and environmental degradation, was examined using inferential statistics, specifically, multiple regression analysis. The regression model was:

$$Y = \beta_0 + \beta_1 X_1 + e$$

Where:

$\beta_0$=Intercept coefficient

$\beta_1$ = Regression coefficient of the one independent variable

$X_1$ = Extent of Sand Harvesting

e = error term

To test statistical significance, Analysis of Variance (ANOVA) was applied, which is effective in comparing mean differences across multiple groups simultaneously (Thompson & Garcia, 2023).

## RESULTS

### Demographic Characteristics

The results of the household characteristics give valuable background information about the dynamics of sand harvesting in Mbooni Constituency. The nearly equal representation of respondents across the three rivers (Wamua, Waani, and Ngoni) ensures that the views obtained accurately reflect the geographical distribution of the activity, thereby enhancing the validity of the research. The fact that the number of male respondents who took part in the survey is the majority (71.75%) shows that sand harvesting is a gendered activity, where men are at the forefront as the physically involved participants. At the same time, women are merely observers of the economic and environmental consequences of the activity.

The age distribution reveals that the activity is primarily found within the 26–45 years age group (50.56%), which is the most economically active age group, indicating that sand harvesting serves as a source of livelihood for young and middle-aged adults seeking income-generating opportunities. This age distribution reveals both the potential economic gains and the risks in the long run, as continued exposure to risky working environments would threaten productivity and health in the future, aligning with the human capital theory. The existence of occupational data also demonstrates the pattern of the sand harvesting value chain. The majority (36.72%) consists of sand miners/harvesters, followed by community members (29.66%), truck drivers (19.21%), and sand owners (14.41%). This distribution indicates that the industry continues to create employment opportunities not only directly but also indirectly, thereby becoming an integral part of the local economy.

Nevertheless, the high concentration of low-skilled and mostly labour-intensive work validates the susceptibility of labourers relying on physically demanding work to make a living. The frequency of sand harvesting demonstrates its importance as an ongoing source of livelihood,

rather than a special activity. As 84.18 per cent of the respondents were involved in harvesting at least three days a week, and 25.99 per cent daily, the exercise is becoming a common economic practice due to the continuity in demand for the construction sector. While this regularity ensures steady income, it also intensifies the risks of environmental degradation due to the continuous and unsustainable extraction of sand.

Overall, these findings demonstrate that sand harvesting in Mbooni Constituency is a critical economic activity dominated by men in their productive years, with strong participation across multiple roles in the value chain. At the same time, the dependence on frequent harvesting underscores the urgency of developing policies that protect livelihoods while mitigating the negative environmental effect that threaten long-term sustainability.

**Table 3: Demographic characteristics**

|  |  | Frequency | Percentage (%) |
|---|---|---|---|
| River | Ngoni | 109 | 30.79 |
|  | Waani | 118 | 33.33 |
|  | Wamua | 127 | 35.88 |
| Gender | Male | 254 | 71.75 |
|  | Female | 100 | 28.25 |
| Age | 18-25 years | 61 | 17.23 |
|  | 26-35 years | 105 | 29.66 |
|  | 36-45 years | 74 | 20.90 |
|  | 46-55 years | 60 | 16.95 |
|  | 56 years and above | 54 | 15.25 |
| Primary Occupation | Community member | 105 | 29.66 |
|  | Sand miner/harvester | 130 | 36.72 |
|  | Sand owner | 51 | 14.41 |
|  | Truck driver | 68 | 19.21 |
| Frequency of sand harvesting in your area | 1-2 days | 56 | 15.82 |
|  | 3-4 days | 109 | 30.79 |
|  | 5-6 days | 97 | 27.40 |
|  | Daily | 92 | 25.99 |

**Descriptive Analysis on Key Variables**

**Extent of Sand Harvesting on Livelihood and Environmental Degradation**

The findings presented in Table 4.2 reveal that sand harvesting in the study area is generally perceived as both extensive and frequent. A majority of respondents (67.23%) rated the intensity of sand harvesting in their locality as either high or very high, with a corresponding mean score of 3.85 (SD = 1.15). Likewise, 69.49% perceived the quantity of sand harvested daily to fall within the upper categories, reflected by a mean score of 3.89. Additionally, 59.32% and 65.53% of respondents, respectively, rated the number of active harvesting sites and the disruption of standard land-use patterns as high or very high. These results reflect strong community awareness of the spatial expansion and ecological disruption associated with sand extraction activities. The findings corroborate those of Bachmann et al. (2024), who argue that sand harvesting in sub-Saharan Africa is becoming increasingly intensive, with visible effects

on land degradation and resource-based conflicts. Similarly, the observed land-use disruptions are consistent with the environmental concerns raised by Lemeleny and Namalwa (2024), who found that excessive sand harvesting often alters watershed functions and diminishes agricultural productivity in affected regions.

Conversely, other indicators present a more restrained view of the extent of sand harvesting. Only 30.79% of respondents agreed that harvesting occurs consistently throughout the year, yielding a lower mean score of 2.93, which may reflect seasonal fluctuations in demand, particularly tied to construction cycles. Perceptions of increased community participation were also low, with 65.82% reporting "low" or "very low" increases in participation over time (mean = 2.30). This could be attributed to limited mechanization and rudimentary harvesting tools, which constrain individual extraction capacity, as also noted in Bachmann et al. (2024). The majority of respondents indicated that monthly volumes harvested are below 500 tons, while only a small fraction cited figures exceeding 1,000 tons. Notably, 62.43% reported that sand harvesting has declined over the past five years, suggesting a potential shift in local livelihood strategies or improved regulation. This was further supported by qualitative data from key informants, who noted that some former harvesters have diversified into other income-generating activities such as small-scale trade, farming, and non-farm employment. The average mean score across all indicators was 3.09, indicating a moderate but uneven perception of sand harvesting in the area. While specific dimensions, such as harvesting intensity and daily quantities, suggest increased activity, others including continuity, participation, and total volume reflect signs of stagnation or decline.

**Table 4: Extent of Sand Harvesting on Livelihood and Environmental Degradation**

| | | Frequency | Percentage (%) | Mean | Standard Deviation |
|---|---|---|---|---|---|
| How would you rate the intensity of sand harvesting activities in your area? | Very low | 17 | 4.80 | | |
| | Low | 32 | 9.04 | | |
| | moderately | 67 | 18.93 | 3.85 | 1.15 |
| | High | 110 | 31.07 | | |
| | Very high | 128 | 36.16 | | |
| The quantity of sand harvested daily has significantly increased | Very Low | 15 | 4.24 | | |
| | Low | 20 | 5.65 | 3.89 | 1.07 |
| | Moderate | 73 | 20.62 | | |
| | High | 126 | 35.59 | | |
| | very high | 120 | 33.90 | | |
| The number of active sand harvesting sites in this area has grown. | Very Low | 23 | 6.50 | | |
| | Low | 52 | 14.69 | | |
| | Moderate | 69 | 19.49 | 3.64 | 1.25 |
| | High | 94 | 26.55 | | |
| | very high | 116 | 32.77 | | |
| The frequency of sand harvesting activities has disrupted normal land use patterns | Very Low | 18 | 5.08 | | |
| | Low | 38 | 10.73 | | |
| | Moderate | 66 | 18.64 | 3.76 | 1.15 |
| | High | 122 | 34.46 | | |
| | very high | 110 | 31.07 | | |
| Sand harvesting activities occur regularly throughout the year without seasonal breaks. | Very Low | 40 | 11.30 | | |
| | Low | 80 | 22.60 | | |
| | Moderate | 125 | 35.31 | 2.93 | 1.10 |
| | High | 82 | 23.16 | | |
| | very high | 27 | 7.63 | | |
| More people in the community have become involved in sand harvesting over time | Very Low | 123 | 34.75 | | |
| | Low | 110 | 31.07 | | |
| | Moderate | 50 | 14.12 | 2.30 | 1.31 |
| | High | 34 | 9.60 | | |
| | very high | 37 | 10.45 | | |
| In your estimation, what is the approximate volume of sand harvested from your area per month? | less than 100 tons | 121 | 34.18 | | |
| | 100-500 tons | 120 | 33.90 | | |
| | 501-1000 tons | 81 | 22.88 | 2.09 | 1.01 |
| | more than 1000 tons | 25 | 7.06 | | |
| | don't know | 7 | 1.98 | | |
| Over the past 5 years, how has sand harvesting activity in your area changed? | significant decrease | 130 | 36.72 | 2.23 | 1.21 |
| | moderate decrease | 91 | 25.71 | | |
| | no change | 78 | 22.03 | | |
| | moderate increase | 33 | 9.32 | | |
| | significant increase | 22 | 6.21 | | |
| **Average** | | | | **3.09** | **1.16** |

## Regression Analysis

The regression results in Table 5 show that the extent of sand harvesting has a statistically significant adverse effect on livelihoods and environmental conditions in Mbooni Constituency, with an unstandardized coefficient (B = –0.010) and a p-value of 0.015. This implies that increased intensity of sand extraction contributes to declining land productivity, reduced household welfare, and accelerated environmental degradation. These findings are consistent with those of Mohammed and Choge (2022), who observed in Garissa County that unregulated sand mining eroded riverbanks, diminished agricultural potential, and weakened

household resilience. The alignment between the two studies highlights a broader pattern in Kenyan counties, where sand harvesting, if not adequately regulated, undermines both livelihoods and environmental sustainability.

**Table 5: Regression Results**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Tolerance | VIF |
| | (Constant) | 2.789 | 0.307 | | 9.084 | 0 | | |
| | Extent of Sand Harvesting | -0.01 | 0.063 | -0.008 | -2.158 | 0.015 | 0.998 | 1.002 |
| **a. Dependent Variable:** Livelihood and environmental degradation | | | | | | | | |

## Summary

This paper examined the extent of sand harvesting and its effects on Livelihood and Environmental Degradation in Mbooni Constituency, Makueni County. The information obtained from 354 respondents gave an in-depth picture of the prevalence and deep-rootedness of sand harvesting in the area. The results demonstrated that the harvesting process is very intensive, and most respondents indicated that its volume and frequency were high or very high. The activity has disrupted land use patterns, increased the number of active sites, and put pressure on local resources. Although harvesting sand earns a living for many families, it has also led to rapid environmental degradation, forming a cycle whereby the livelihoods of the same people are threatened by the same activity that provides their income.

## Extent of Sand Harvesting on Livelihood and Environmental Degradation

The findings revealed that sand harvesting is not only widespread but also occurs in substantial quantities. Approximately two-thirds conducted extensive daily extraction and extensively disturbed the land use. There were seasonal trends, and during specific periods of the year, harvesting reached its peak. Although sand harvesting offers fast cash to families who have few other options, over time, the activity has become increasingly relied upon, and communities have become further dependent on it, despite its harmful effects.

Reliance on sand harvesting as a source of income has compromised the livelihoods of households. Although it provides short-term financial relief, the activity decreases long-term resilience by undermining agricultural productivity, the foundation of most households. A decrease in crop production, loss of grazing grounds, and compromised food security was observed. This dependence on sand harvesting, thus, introduces vulnerability, since communities will have fewer natural resources and fewer opportunities to earn a sustainable income. The environmental cost of sand harvesting was enormous. The respondents cited erosion of soils, loss of vegetation and loss of riverbanks as some of the best examples of degradation. Topsoil erosion has resulted in very low productivity of the land and the erosion and sedimentation have led to even more degradation of the ecosystem. The most adverse effects were observed in the areas that were left unattended after harvesting such as areas that were left barren and areas that failed to retain water. These are the consequences of an unsustainable course where the degradation of the environment literally endangers the survival of the community in the long term.

## CONCLUSION AND RECOMMENDATIONS

### Conclusion

The paper concludes that sand harvesting in Mbooni Constituency is an intensive and industrial level activity, and its effects extend widely to livelihood and environmental effects. Most people rely on it as an important source of livelihood but its disastrous consequences on soil fertility, plant cover and water systems ruin the livelihoods of many, both in the short and long term. The findings validate that the negative impact of sand harvesting surpasses its immediate positive impact, as the communities are exposed to poverty and environmental deterioration.

### Recommendations

It is suggested to implement more the strict rules that will control the amount of sand extraction and its rate so that it could be harvested in a sustainable way.

- Rehabilitation of Degraded Areas: In the case of areas destroyed by harvesting, rehabilitation programs need to be given priority which consists of reforestation, soil conservation and terracing methods.

- Promote Alternative Livelihoods: Support income diversification by using climate-smart agriculture, agro-processing and small-scale businesses to reduce dependence on sand harvesting.

- Community Sensitization: Educate the community on the threats associated with over harvesting in the long run and involve the community in resource management and monitoring.

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