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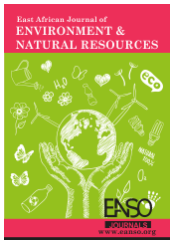

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Original Article

Socio-economic and Environmental Impacts of Sand Mining in Mbiuni Ward, Mwala Constituency, Machakos County, Kenya

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ABSTRACT

Sand mining is an important economic activity and has been undertaken across the world over centuries. However, indiscriminate sand mining activities have detrimental socio-economic and environmental effects. The objective of the current study was to determine the socio-economic and environmental effects of sand mining in Mbiuni Ward, Mwala Constituency, Machakos County, Kenya. Stratified random sampling enabled to arrive at a sample size made up of sand miners, sand loaders, drivers, land owners, truck owners, and others. The study involved collection of data through observation and oral interviews were used to administer the questionnaires. The study found that sand mining has socio-economic impacts such as drug and substance abuse, increase in school drop-out rate, violence, and improved livelihoods. Environmental impacts include land degradation, widening of river channel, water pollution, deforestation, and pollution. In conclusion, sand mining has social-economic and environmental impacts in Mbiuni Ward. Mining activities should be regulated by the relevant agencies in order to mitigate the negative environmental and socio-economic effects.

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INTRODUCTION

Sand is a naturally occurring material made up of finely divided rock and mineral particles. Apart from water, sand is the most utilized natural resource in the world (Filho et al., 2021). It occurs naturally in oceans, lakes, and rivers. Some of its uses include construction, water filtration, glass manufacture, hydraulic fracturing among others. Sand is unevenly distributed in the world and many countries depend on importation from other countries (Filho et al., 2021). It is an increasingly valuable resource and is vital for the continued growth of economies around the globe (Filho et al., 2021). Many countries are extracting sand at unhealthy levels that exceed the replenishment rates (Torres et al., 2021). The global demand for sand stands at 40-50 billion tons per year and could increase to 60 billion tons by the year 2030 (Bendixen et al., 2019). Increase in human population, rapid urbanization, and infrastructural development has led to increase in demand for sand over the last three decades (Bendixen et al., 2019). The huge demand for sand has resulted in increased sand mining, affecting human livelihoods, and causing negative environmental consequences (Sreebha & Padmalal, 2011; Johnbull & Brown, 2017; Torres et al., 2021).

Overexploitation of sand leads to negative effects on the environment. For example, sand mining leads to widening of river beds, reduction of river water quality, river bed lowering, erosion of river banks, reduced water quality, loss of habitats, and biodiversity (Ako et al., 2014; Muiruri et al., 2020; Rentier & Cammeraat, 2022). Sand mining also has socio-economic effects. For example, increased erosion together with the degradation of riparian vegetation can cause destruction of buildings, roads, and other infrastructure (Tesi et al., 2018). Lowering of groundwater table by sand harvesting activities has negative effects on agricultural activities since it makes it difficult for irrigation structures to reach the water. Sand mining can cause shortage of potable water due to pollution of river water and lowering of ground water table (Lekomo et al., 2021). It can also have negative effects on fisheries productivity (Hwang et al., 2014; Koehnken et al., 2020). The pits that are created during sand mining activities can act as reservoirs for water and serve as breeding grounds for insect pests such as mosquitoes (Ako et al., 2014). This can affect the health of the local people and their productivity. Despite these negative effects, sand harvesting is an important source of employment and revenue (Filho et al., 2021).

Sand mining in many areas of Kenya is conducted in an intensive and unregulated manner. This has negative consequences for the sustainability of the environment and human livelihoods. For example, Machakos County has vast amounts of sand resources that are greatly contributing to the economic development of the country and local livelihoods. Sand is a building material and is therefore a necessity for the many construction projects in the Country. The high demand for sand has led to increased pressure for the supply of sand. However, unsustainable mining practices have been taking place despite the harmful impacts on the environment. The objective of this study is to assess the environmental and socio-economic effects of sand mining in Mbiuni ward, Mwala constituency, Machakos County, Kenya.

METHODOLOGY

Study Area

The research was carried out in Machakos County, which is composed of six constituencies; Kathiani, Kangundo, Machakos Town, Masinga, Yatta and Mwala. The study area selected for the study on the effects of sand mining is Mbiuni ward in Mwala constituency, Machakos County. Mbiuni is at an elevation of 1215 meters and longitude of $37^0$25' E and latitude of $1^0$15' S.

Socio-economic Activities

The main economic activities in Mbiuni ward are sand mining, quarrying, and agriculture. Of the three economic activities, sand mining is the main source of livelihood for most people living in the

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area. Sand mining is also a source of revenue for the county council that collects levy fees from trucks that ferry sand. Sand mining is mainly concentrated along the River Thwake catchment areas. Sand mining offers job opportunities to sand scoopers and the women that cook food for the casual laborers. However, sand mining has led to environmental problems such as water scarcity. The crops grown in the area include cassava, kales, potatoes, cowpeas, chick peas, and mangoes.

Climatic Conditions

Climatic conditions are highly variable with rainfall ranging between 500-1300 mm. Short rains are experienced in the months of October - December with more rainfall experienced between the months of March and May. Change in climatic conditions is however leading to modification of the rainfall patterns. October and March are the warmest months while July is the coldest month. Average temperatures range between 17-24 ^{0}C throughout the year (Mwaura, 2013).

Research Design

Descriptive research design was used where a case study was conducted on the effects of sand harvesting in Mwala constituency, Machakos County, Kenya. Stratified sampling technique was used to issue questionnaires to the local community members and people involved in sand mining jobs. Descriptive research design was used because it is relatively quick and cheaper and the results can be inferred to a large population. Its application allowed for collection of both qualitative and quantitative data.

Data Collection

Data collection was done through observation and interviews. Observation of the impacts of sand mining was used to obtain information on the effects of sand mining on the physical environment. Photographs were also taken to demonstrate the impacts of sand mining. The local people and people involved in mining activities were interviewed by asking questions about the impacts of sand mining.

Target Population

Target population refers to the entire population from which a study collects data (Asiamah et al., 2017). The study assessed the opinions of the residents of Mbiuni ward about the effects of sand mining. The population of Mbiuni ward is 33,373 people as per the 2009 national census.

Sample Size

A sample is a set of representative observations drawn from a population. For a sample size to be representative of the entire population, it needs to be sufficient and unbiased. The formula that was used was adopted from Yamane (1967).

$$n = \frac{N}{1+N(e)^2} \quad (1)$$

In the above formula (1): n = sample size, N = population size, and e = margin of error, e = 0.1.

Hence,

$$n = \frac{33373}{1+33373(0.1)^2} = 99.70$$

sample size is 100 people

Reliability of the Research Method

Reliability refers to the measure of the degree to which a research tool yields consistent results after repeated trials (Kothari, 2004). Questionnaires were pre-tested to determine their reliability as tools for data collection. Corrections were made later on after the pre-testing and questions modified accordingly to enable the achievement of reliable information.

Data Analysis

The questionnaires were sorted into those that were completely filled and those that were partly filled. Out of 100 questionnaires, 80 questionnaires met the researchers' expectations in terms of the information provided by the respondents. Quantitative data was entered into Microsoft excel to enable presentation of information. The quantitative data were expressed by the use of figures and tables. Information was also qualitatively presented in form of pictures.

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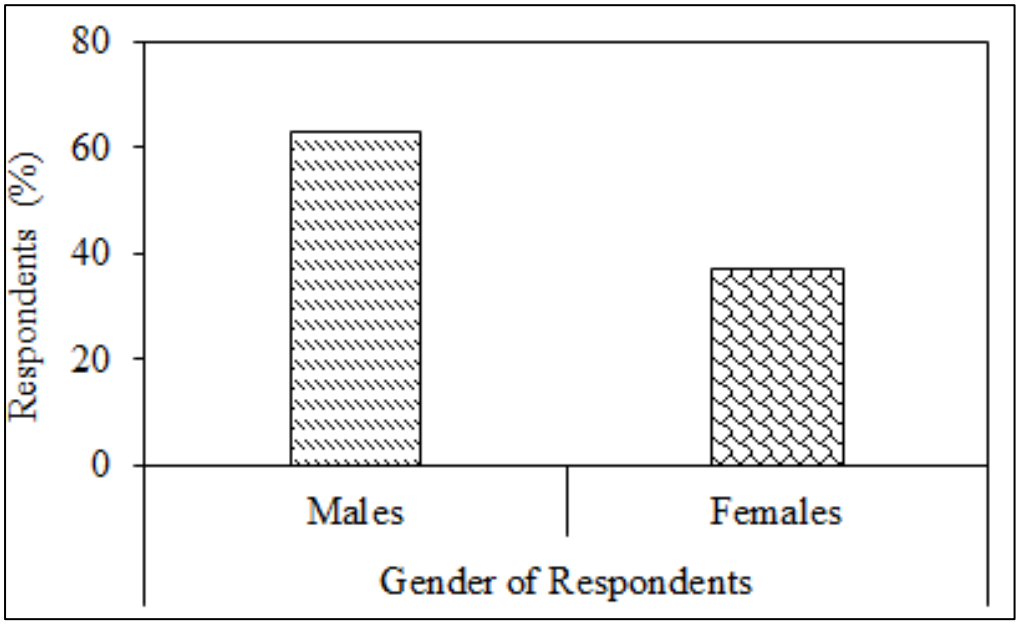
RESULTS

Personal Information

Gender

The respondents were mainly men (63%) while the proportion of women (37%) interviewed was relatively lower (Figure 1).

Figure 1: Gender of the respondents



Household Size

Most of the households had more than 7 family members (65%) whereas fewer households (15%) had 1-3 family members (*Table 1*).

Table 1: House hold size of respondents

Household size	Frequency	Percentage (%)
1-3	12	15
4-6	16	20
7>	52	65
Total	80	100

Age and Level of Education

Most of the interviewed respondents were between 21 and 35 years (56%) whereas fewer (19%) were below 20 years of age (*Table 2*). Most of the respondents had attained secondary school (30%) and primary school (25%) levels of education whereas fewer respondents (17.5%) had no education (*Figure 2*).

Table 3: Age of respondents

Age	Frequency	Percentage (%)
0-20	15	18.8
21-35	45	56.3
36>	20	25
Total	80	100

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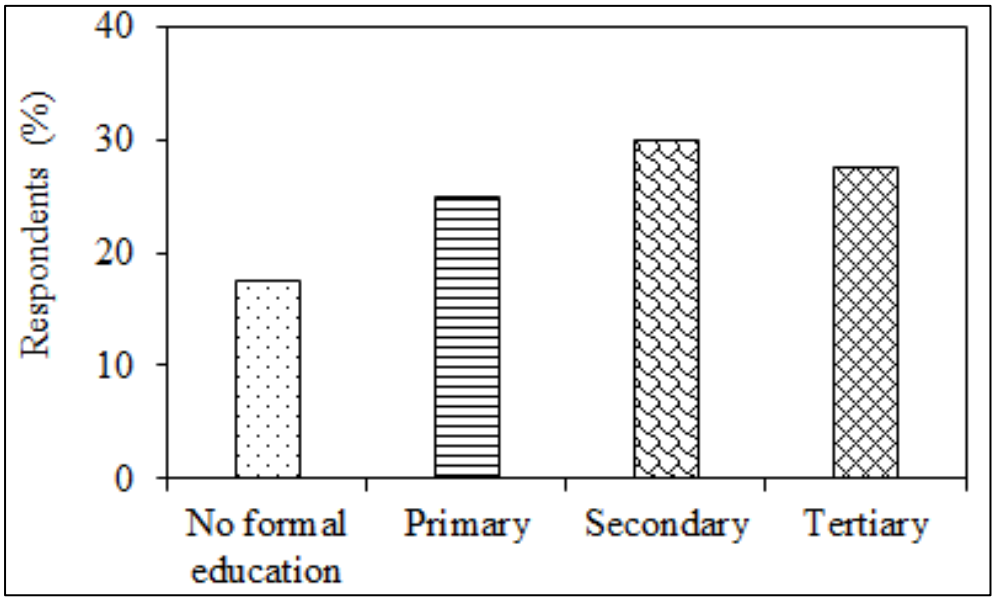
Figure 2: Level of education of the respondents



Occupation and Income

Most of the people who were interviewed were sand miners (26.3%) and sand loaders (22.5 %) whereas fewer respondents were drivers (6.3%) and land owners (10%) (*Figure 3*). With regard to income, most of the respondents (65%) had a monthly income which was less than 10,000 Kenya shillings whereas fewer respondents (15%) earned more than 15,000 Kenya shillings (Figure 4).

Figure 3: Occupation of the respondents

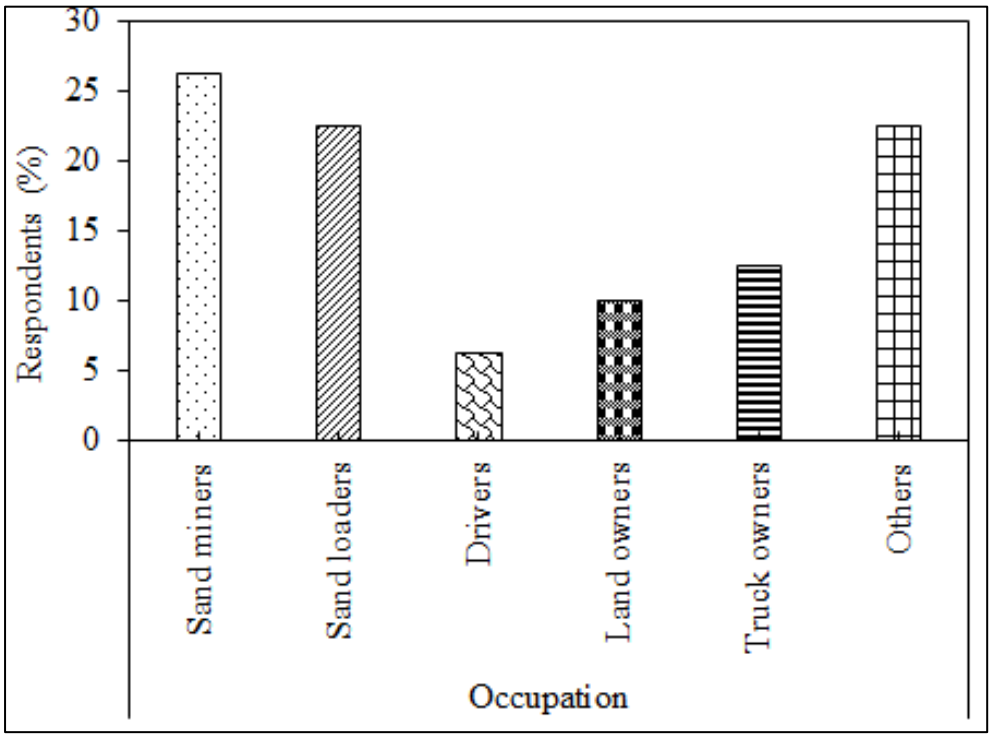


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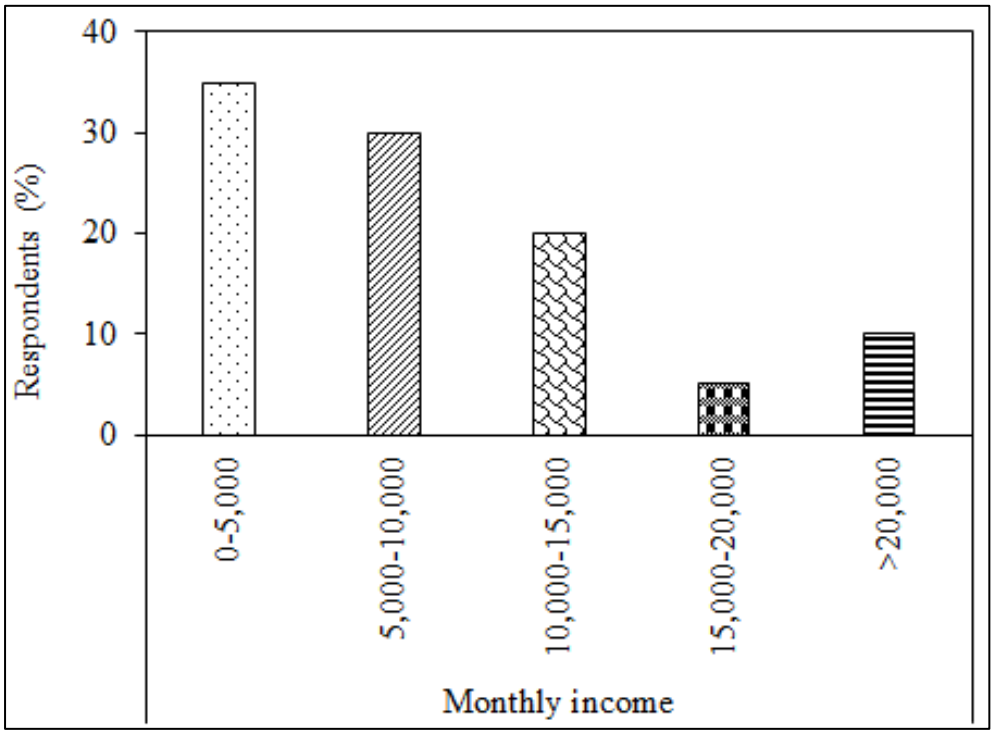
Figure 4: Monthly income (Kenya shillings) of the respondents.



Socio-economic Impacts of Sand Mining

Most of the respondents (90.4%) indicated that sand mining had led to social issues whereas fewer respondents (9.6%) did not associate sand mining with social issues. Sand mining was mainly associated with social issues such as drug and substance abuse, school dropout, and criminal activities (Figure 5).

Sand mining has a lot of negative consequences on the landscape and most (87.8%) of the respondents indicated that sand harvesting had affected the value of land in the area. On the other hand, fewer respondents (12.2%) indicated that sand mining did not have an impact on the value of land in the area.

Generally, the respondents did not attribute the growth of businesses in the area to sand mining. The percentage of respondents that associated growth of businesses to sand mining was 11.3% whereas 88.7% of the respondents did not associate growth of businesses with sand mining. The main reasons that were given for growth of businesses in the area are increase in the number of small businesses (e.g., cafes, shops), selling of land, and hiring of trucks for transporting sand. Most of the respondents (56.6%) indicated that sand mining had led to improved livelihoods whereas 43.4% indicated that sand mining had not led to improvement of livelihoods.

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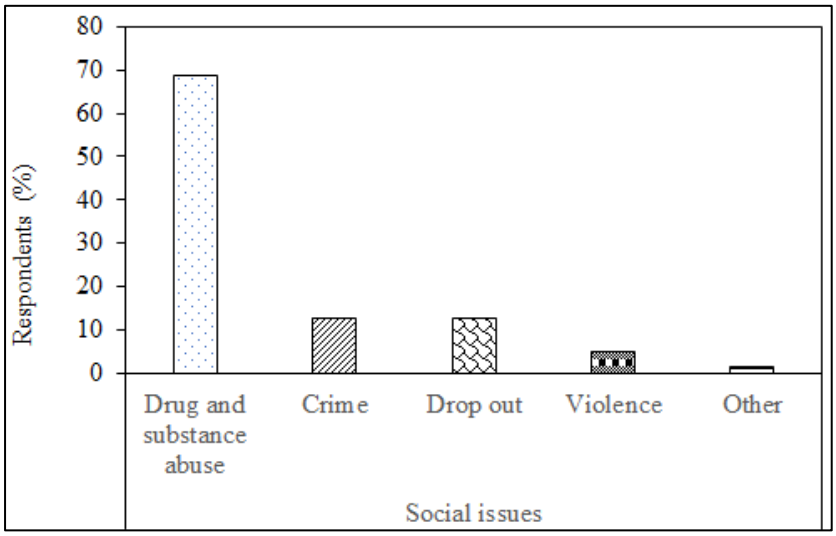
Figure 5: Social issues associated with sand mining in Mbiuni ward, Mwala constituency.

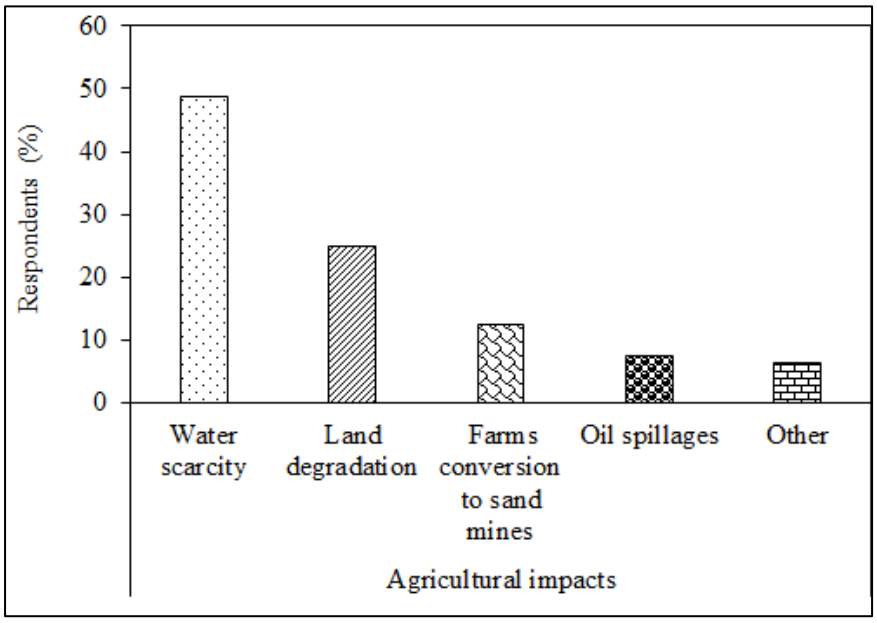


Most of the local community members conduct agricultural activities near rivers due to lack of piped water. Most of the respondents (87.5%) indicated that sand mining had an impact on agricultural activities whereas fewer respondents (12.5%) indicated that sand mining had no effect on agricultural activities. Most respondents indicated that sand mining affected agricultural activities through water scarcity (48.75%), land degradation (25%), and conversion of farmlands to sand mines 12.5% (Figure 6).

Sand being a shared resource is likely to cause conflicts among stakeholders. Most of the respondents (93.4%) associated sand mining with increased conflicts among the stakeholders. The most form of conflicts reported include family disagreements, illegal mining, and conflicts regarding resources and benefits sharing.

Most of the land where sand mining takes place is mainly controlled by the community members and permission is required before mining takes place. Additionally, mining is largely not controlled by the government or any association or organization.

Figure 6: Sand mining factors affecting agricultural activities in the Mbiuni ward, Mwala constituency



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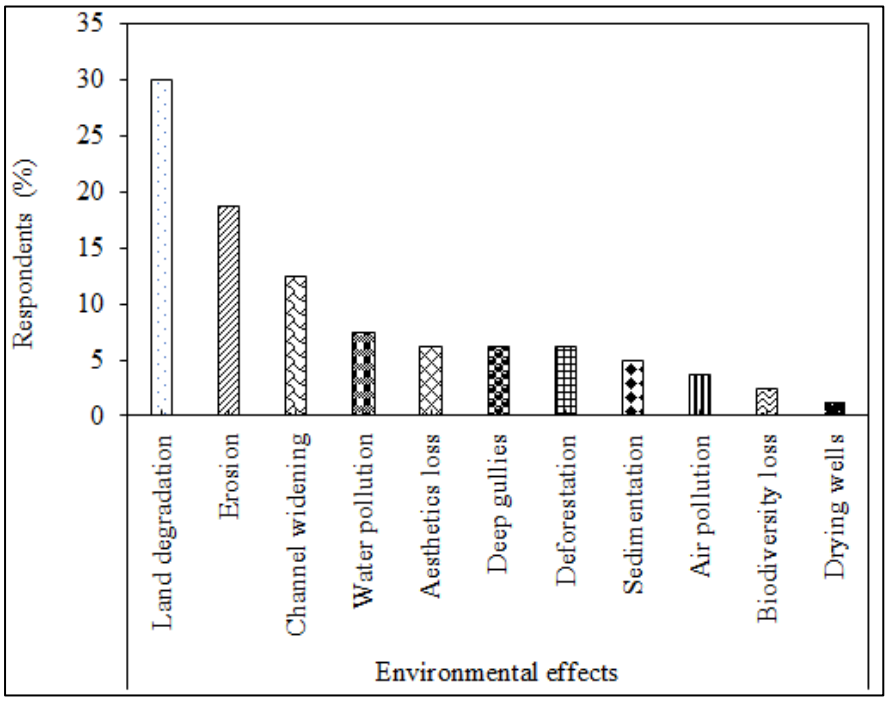
Environmental Impacts of Sand Mining

Sand mining has various impacts on the environment and one of the impacts is land degradation (Plate 1). Most of the respondents (30%) indicated that sand mining had led to land degradation. Other impacts that were mentioned by the respondents include soil erosion (18.75%), channel widening (12.5%), water pollution (7.5%), loss of landscape aesthetics value (6.25%), deep gullies (6.25%), and deforestation (6.25%). Fewer respondents indicated that sand mining caused air pollution (3.75%), loss of biodiversity (2.50%), and drying of wells (1.25%) (*Figure 7*).

Plate 1: Photograph showing impact of sand mining on land and vegetation

Figure 7: Environmental impacts associated with sand mining in Mbiuni ward, Mwala constituency.



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DISCUSSION

The gender of the respondents is mainly men and this can probably be attributed to the fact that sand mining activities are typically undertaken by men (Bosco & Sumani, 2019). The age of most respondents was below 35 years. This implies that sand mining activities are typically undertaken by the youthful adults and similar findings have been reported by other studies (e.g., Bosco & Sumani, 2019; Dawson, 2021). Mining activities in Mbiuni ward are undertaken using rudimentary tools like shovels and pick axes just like in other regions of Africa, such as Cameroon (Tientcheu et al., 2021).

The household size of most respondents constituted of more than 7 persons. Engagement in sand mining activities can probably be attributed to the need for quick money to cater for the needs of the relatively large families. For example, Arwa (2013) assessed the existing governance structures in sand mining in Masinga, Kenya, and found that sand harvesting is primarily carried out by men and that women are mainly involved in businesses such as selling of food to the miners. The study also found that the promise of quick money is attracting more male adults to the sand pits than the females.

Most of the respondents had either reached primary school (25%) or secondary school (30%) levels whereas fewer respondents had no formal education (17.5%). Additionally, most of the respondents were sand miners and loaders (48.8%) whereas relatively fewer respondents (6.3%) were drivers. This finding can be attributed to the fact that sand mining activities (e.g., loading) does not require any special skills. Additionally, it is possible that sand mining may be the main source of livelihood and it may be difficult for the miners to find other jobs without higher education. Sand mining activities can affect pupils learning in primary and secondary schools and most of the interviewed respondents were school dropouts. Other studies have also associated sand mining with poor academic performance and increase in school dropout rate (Owusu & Dwomoh, 2012; Adu-Gyamfi, 2014; Nthambi & Orodho, 2015; Ghanney, 2020).

Most of the respondents had a monthly income which was less than 10,000 Kenya shillings. The respondents were largely sand loaders and miners who have a low income because they did not work on a regular basis and were hired depending on the amount of work at a given site.

Most of the respondents indicated that sand mining had led to social issues such as drug and substance abuse, criminal activities, school dropout, and violence (i.e., conflicts). Drugs and substance abuse is one of the social issues because most youths believe that drugs can enhance their ability to work in the sand mining sites. A lack of financial education on savings and investments could also be a reason for increased drugs use in the sand mining sector. Increase in disposable income among youths has been associated with social issues such as drug and substance abuse and prostitution in sand mining areas by other studies (Nthambi & Orodho, 2015; Musyoka & Nalugala, 2022). Other social problems associated with sand mining include insecurity and deaths caused by conflicts (Gitonga, 2017; Gathogo, 2020; Musyoka & Nalugala, 2022). Despite the negative social effects, sand mining is an important economic activity which provides jobs for the local communities and contributes to national development. Sand mining may also lead to the establishment of new businesses in an area and lead to improved livelihoods. However, it may have negative effects such as reduced value of land due to environmental factors associated with sand mining, such as land degradation, erosion, and pollution of soil and water (Idris-Nda et al., 2018). Sand mining can also affect agricultural production in an area by causing water scarcity, through reduction in surface, and ground water levels (Rentier & Commeraat, 2022). Conversion of farm lands into sand mining sites, trampling by heavy vehicles, soil erosion, and pollution can also have adverse effects on agricultural production.

Sand mining activities have effects on the physical, chemical, and biological environment. With regard to the physical environment, effects include riverbed widening and lowering. Impacts on the chemical environment include reduced water quantity and pollution of air, soil, and water. Biological effects include reduced density and diversity of organisms due to detrimental impacts on the natural habitat (Nthambi & Orodho, 2015;

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Gathogo & Amimo, 2017; Rentier & Cammeraat, 2022).

CONCLUSIONS AND RECOMMENDATIONS

In conclusion, sand mining activities in Mbiuni ward have socio-economic and environmental effects. It is recommended that sand mining activities should be formally registered with the government to curb illegal mining activities which increase environmental degradation and results in various negative social-economic effects,

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