

**Research Article**

## **Perceptions on the environmental impacts of illegal river sand mining in the Limpopo Province, South Africa**

**Maropene Tebello Dinah Rapholo<sup>1\*</sup>, Isaac Tebogo Rampedi<sup>1</sup>, Fhatuwani Sengani<sup>2</sup>**

<sup>1</sup> Department of Geography, Environmental Management and Energy Studies, Auckland Park Kingsway Campus, University of Johannesburg, Auckland Park, Johannesburg 2006, South Africa

<sup>2</sup> Department of Geology and Mining, Physical and Mineral Sciences, University of Limpopo, Private Bag X1106, Sovenga 0727, South Africa

\*corresponding author: maropener@uj.ac.za

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### **Abstract**

Illegal river sand mining in regions like the Limpopo Province poses severe threats to ecosystems and communities. Nevertheless, the community's perspectives concerning these effects have not been determined. Thus, the aim of the investigation was to assess community perceptions regarding the environmental consequences linked to river sand mining in the Limpopo Province, South Africa. The study employed mixed methods to acquire the primary data. The quantitative data were acquired using questionnaires; meanwhile, the qualitative data were collected through semi-structured interviews from various respondents. The demographic profile of the respondents indicated a predominantly male population, with a majority lacking formal qualifications. Additionally, the prevalence of very high unemployment rates in the area seemed to influence participation in the activity. Consequently, some perceived it as an economic opportunity to generate income for their sustenance. It has been found that as developments increase, the demand for river sand increases as well, leading to a high extraction rate of sand. Lastly, the extraction of the resources was found to be un-regulated or controlled; therefore, it is concluded that unregulated extraction of these resources resulted in a high extraction rate and environmental crises such as un-rehabilitated pits, water pollution, land pollution, among others. It is therefore recommended that collaborative efforts among relevant authorities to enforce stringent regulations and penalties. Equally vital are public awareness campaigns, which can play a pivotal role in educating communities about the environmental repercussions of illegal sand mining.

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### **Introduction**

Across the globe, the environmental impacts of illegal sand mining activities are being recognized as causes of accelerated sedimentation entrainment and widespread environmental degradation in the affected catchments (Ako et al., 2014; Zeng et al., 2018; Owusu and Waylen, 2019). Consequently, the majority of countries impose limitations on sand mining activities,

including both central and local governments (Duan et al., 2019). For instance, in China, governmental authorities at several tiers have established legislation and regulations to forbid the unauthorized extraction of sand. Nevertheless, despite the existence of restrictions and legislation, illicit sand mining remains widespread in areas including the Yangtze River Basin, the Yellow River Basin, the Pearl River Basin, and the Huaihe River Basin (Lai et al., 2014; Zhao et

al., 2015; Meng et al., 2018; Zeng et al., 2018). The rise in sand extraction is partly fueled by the money gained from these operations (Meng et al., 2018). In addition, illicit sand mining is a clandestine, temporary, and fragmented operation, making it challenging to promptly discover and address (Meng et al., 2018).

Due to the increasing need for soil aggregates in construction materials and infrastructure, the practice of mining river sand has developed (Meng et al., 2018). According to Goddard (2007), it is crucial to establish a reference state and sand budget before making decisions on mining locations, quantities, and frequencies. Furthermore, it is necessary to uphold river channels in a state that meets the minimal physical and biological requirements, sometimes referred to as the reference state (Goddard, 2007).

Although there is an increasing awareness of the ecological consequences of engaging in illicit sand mining, there are still those who view it as a means of generating revenue for their livelihood. Since sand mining has economic benefits, some of the rural communities and their traditional leaders give away certain lands within their jurisdiction to illegal miners (Madyise, 2013). Furthermore, Madyise (2013) indicates that in the rural areas of Botswana, villagers build their own dwelling structures at a low cost because of the availability and accessibility of sand. Such exploitation of sand also brings along other benefits, such as creating employment opportunities, especially for those who have heavy vehicles to load and transport the sand where it is needed (Madyise, 2013).

To the contrary, sand mining was perceived by communities to have undesirable impacts such as noise and dust pollution, truck traffic problems, and the visually blighted landscapes in the East Gonja District (EGD) of Ghana and the Gunnarsholt area of Iceland Musah and Barkarson (2009). Unfortunately, it is the local communities that tend to bear the negative impacts of mining—be it social, economic, or environmental (Davis and Tilton, 2005).

In a recent study based in Zanzibar Unguja Island, North 'B' Unguja District at Kazole, Michungwa Miwili, and Donge (Ali, 2020), it was found that the activities of sand extraction constituted a major threat and challenges to the socio-economic activities of inhabitants. Furthermore, respondents perceived sand mining to have brought a reduction of farmlands, loss of biodiversity, land degradation, and poor relationships between residents and sand miners. It is, therefore important to understand the magnitude and significance of these environmental problems and how they undermine long-term sustainability in the affected lands.

Based on the literary data provided before, it is evident that unlawful sand mining has detrimental environmental consequences in several parts of the world. Illegal sand mining has a significant impact on several areas of South Africa, with a particular focus

on the Limpopo province. This issue has been documented by Basson and Rust in 2017, as well as by Mnguni and Mnguni in 2018. The unauthorized mining of sand from riverbeds, carried out in disregard of environmental norms, has substantial consequences for the surrounding ecology, communities, and regional development (Gondo et al., 2019). The grain size and texture of this material are well-suited for blending with cement and other substances, therefore guaranteeing the structural stability of buildings. Consequently, there is a constant and significant demand for river sand, which leads to both legitimate and criminal mining. The extent of illicit sand mining in South Africa is difficult to measure accurately due to its secretive character. However, it is well recognized as a widespread issue throughout the country (Basson and Rust, 2017; Mnguni and Mnguni, 2018). The Limpopo Province, located in the northern region of South Africa, is characterised by numerous rivers and water bodies, which have led to a significant concentration of sand mining industries in the area. The need of controlling sand mining to protect the natural resources of the province is emphasised by its abundant biodiversity, agricultural regions, and delicate ecosystems.

Gaining insight into the knowledge and perspectives of people living near rivers affected by illicit river sand mining is essential for promoting certain United Nations Sustainable Development Goals (SDGs). Illegal sand mining has a direct impact on many Sustainable Development Goals (SDGs), such as the provision of clean water and sanitation (SDG 6), efforts to combat climate change (SDG 13), the preservation of marine life (SDG 14), and the conservation of terrestrial ecosystems (SDG 15).

Perceptions differ among groups due to characteristics such as socio-economic level, education, and culture (Pampel, 2014). Understanding and acknowledging this wide range of differences is crucial for creating efficient and appropriate policies and programmes for the management of natural resources. By raising consciousness, providing knowledge, and encouraging cooperation, suitable measures can empower people and cultivate responsible management of the environment in the impacted areas, therefore harmonising with the United Nations Sustainable Development Goals (SDGs). The unlawful river sand mining in the Limpopo Province is associated with several perspectives and involves numerous environmental, social, and economic aspects (Malebana, 2021). Concerns encompass environmental deterioration (Kgaphola et al., 2023), a significant peril to river ecosystems, as well as illicit sand mining, which leads to erosion, biodiversity loss, and degradation of water quality.

Nevertheless, conducting a comprehensive investigation is essential not only for enhancing the comprehension of the diverse consequences of illicit river sand mining but also for actively contributing to raising awareness, empowering communities, shaping

policies, and advocating for sustainable practices that are vital for the welfare of both the environment and the individuals who rely on it.

This study examines the perspectives and opinions of several stakeholders, such as local people, government agencies, and sand miners, on the issue of illicit river sand mining in the Limpopo Province. In addition, the research evaluates the level of comprehension individuals have regarding the impacts of illicit sand extraction on nearby rivers and ecosystems. Through a thorough analysis of the perceptions and consequences of illicit river sand mining in the Limpopo Province, the acquired information will provide useful insights and recommendations for effectively tackling this urgent problem and encouraging responsible management of resources.

## Materials and Methods

The research geographical area is situated in the Limpopo Province of South Africa (Figure 1), spanning a total area of 125,754 km<sup>2</sup> and accommodating a population of around 5.8 million individuals (Rapholo et al., 2023). The province is partitioned into five districts: Capricorn, Mopani, Sekhukhune, Vhembe, and Waterberg (Rapholo et al., 2023). The province has a variety of landforms, encompassing mountains, forests, savannahs, and wetlands. It is abundant in valuable natural resources, including minerals, animals, and water (Rapholo et al., 2023). Nevertheless, the province encounters several environmental obstacles, including drought, soil erosion, deforestation, pollution, and illicit river sand extraction (Rapholo et al., 2023).

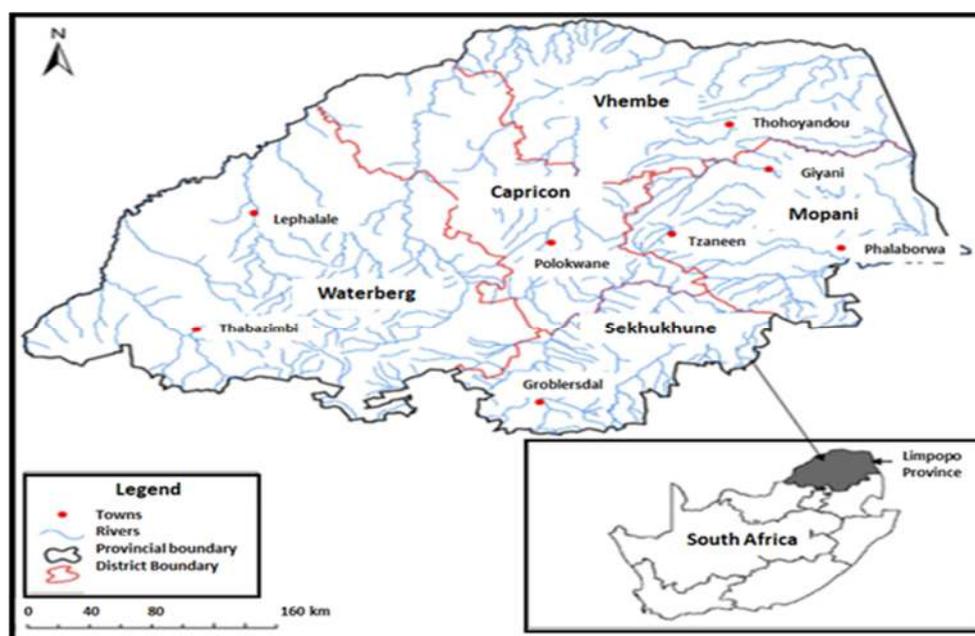


Figure 1. Map showing the geographical location of Limpopo Province in South Africa. The bottom insert shows the location of Limpopo Province in South Africa.

The research was carried out in communities located next to rivers that are prone to unlawful mining of river sand in the Limpopo Province. The selection of certain places was based on their firsthand exposure to the environmental consequences of sand mining, ensuring a targeted and pertinent dataset for research. The study focused on seven rivers in the province where illegal river sand mining occurs: Mvudi River, Dwars River in Matoks, Turfloop River, Nzhelele River, Olifants River, Molototsi River, and Lephalele River. Such rivers are located in different districts and have different physical and socio-economic characteristics.

### Data collection

The study applied mixed methods to acquire the primary data based on the complexity of the research problem. Such a methodology has been documented (Doring et al., 2017; Kgaphola et al., 2023) to be the

most appropriate method in complex studies. The quantitative data were acquired using questionnaires; meanwhile the qualitative data were collected through semi-structured interviews from various respondents. In terms of quantitative data, a total of 93 respondents answered the structured questionnaires, the respondents were comprised of 15 individuals from villages surrounding Dwars River, 11 from Turfloop River, 13 from Nzhelele River, 16 from Olifants River, 13 from Molototsi River, and 15 from Lephalele River, respectively. The sampling consisted of seven catchments with more 10 villages surrounding them. Four postgraduate assistants who were trained in data collection collected the primary data. The data needed for the study was collected during the April-September 2023 period. In terms of qualitative data collection, semi-structured interviews were conducted with a few members of the communities. In total, 32 respondents

volunteered, and these respondents were across all villages surrounding the catchments, with a minimum of 3 and a maximum of 5 respondents per catchment. The purpose of the interviews was to collect more information regarding community awareness on river sand mining activities as well as their environmental impacts. However, since some of the environmental impacts can be physically and visually observed, photographs were taken to support the collected data.

### **Instrument**

The study featured questionnaires that included both structured and open-ended questions, which were categorized into three groups. The initial component of the study collected demographic information from participants, including their age, gender, marital status, greatest level of education, and work sector. The second section of the study was to evaluate the level of community knowledge regarding river sand mining operations. This was done by providing respondents with a checklist to fill out. Finally, the final segment explored the respondents' understanding of the environmental consequences linked to river sand mining, as well as their opinions on this activity. Kinnerbrew et al. (2021) proposed the use of this framework to analyse environmental challenges. They stressed the significance of combining qualitative and quantitative approaches and data to understand the complex dynamics involved in environmental management and sustainability.

### **Data analysis**

By applying Cohen et al.'s (2007) methodology, content analysis was utilized to get precise conclusions from the data collected. The quantitative data obtained from the demographic section and the responses to particular questions were examined using frequency counts and percentages. Data analysis involved the use of tables, bar graphs, and images. Microsoft Excel software and the Statistical Package for Social Science

(SPSS) were utilized to calculate sums, means, and frequency distributions. Qualitative data from open-ended questions were subjected to thematic analysis, allowing for the identification of recurring themes and nuanced perspectives expressed by the respondents.

### **Results**

Table 1 shows that male respondents were in the majority (73.12%) while female respondents were nearly 27% (i.e. 26.88%). Majority of respondents were found to be between the ages of 41 to 50 (31.18%) years, followed by those in the 51-60 years' category (25.81%), and a few respondents were between the age of 20 and 30 (7%) years. More than 33% of the respondents were without a Grade 12 certificate. By contrast, few people (more than 6%) were found to have no qualifications. Though the number of respondents with Grade 12 and diplomas was much higher than those without such educational levels, 7% of respondents had post-graduate qualifications. Figure 2 provides the employment characteristics of the respondents. The highest number of respondents were unemployed (12.9%). Sectors such as health and religious leaders were represented by one person each. In supporting this data, some of the respondents made the following statements:

“The common employment within this area is mostly being a farmer, small-scale miner or just being unemployed. Though some people in this community may be educated, unemployment levels remain very high”

Source: Respondent 17

“I think we are dominantly working in the farms and as sand miners, although few are teachers and civil construction workers, but construction people usually work for a short duration until the tender ends, which lead to unemployment there”

Source: Respondent 22.

Table 1. Socio-demographic characteristics of respondents.

		<b>Frequency</b>	<b>Percentage</b>
Gender	Male	68	73.12
	Female	25	26.88
Age	20-30	7	7.53
	31-40	15	15.05
	41-50	30	31.18
	51-60	22	25.81
	>60	19	20.43
Highest Educational Qualifications	None	6	6.45
	Below Grade 12	31	33.33
	Grade 12	20	21.51
	Diploma	24	25.81
	Undergraduate degree	5	5.38
	Postgraduate degree	7	7.53

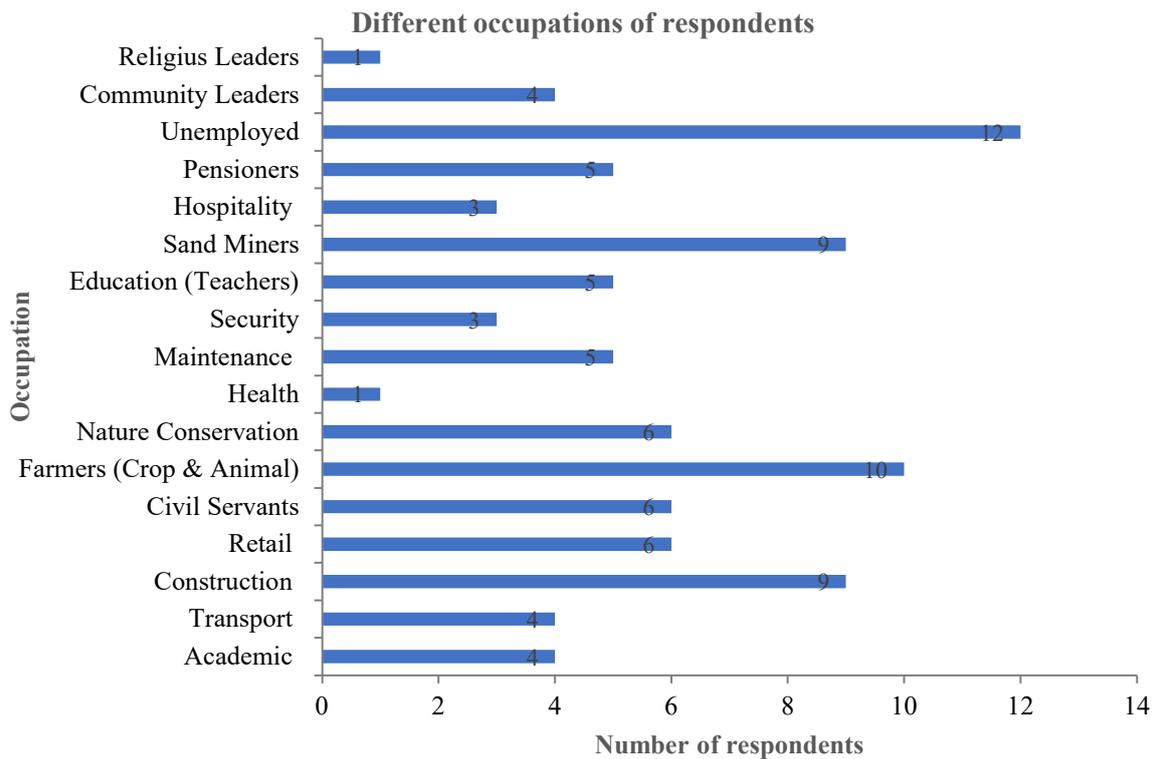


Figure 2. Respondents' employment sector distribution.

**Awareness and perceptions of river sand mining**

*Functions of river sand in the study area*

Figure 3 outlines the distribution of different functions that river sand serves within the study area. The unanimous agreement among all respondents (100%) on using river sand for building houses underscores its fundamental importance in construction activities within the community. Nearly half of the respondents (44.09%) used river sand for landscaping purposes, including home gardens, school grounds, and recreational areas. A significant majority of

respondents (93.55%) utilized river sand in government and private projects.

As depicted in Figure 4, the unanimous response from all respondents is well supported as most of this river sand is preferred to be used to produce bricks as well as building materials. In Figure 4, it can be seen that river sand plays an important role in various building activities. Furthermore, it can be inferred that such materials are used for large construction projects, judging from the sizes of the various structures that were being constructed and the high frequency of construction vehicles found at the time of the present research.

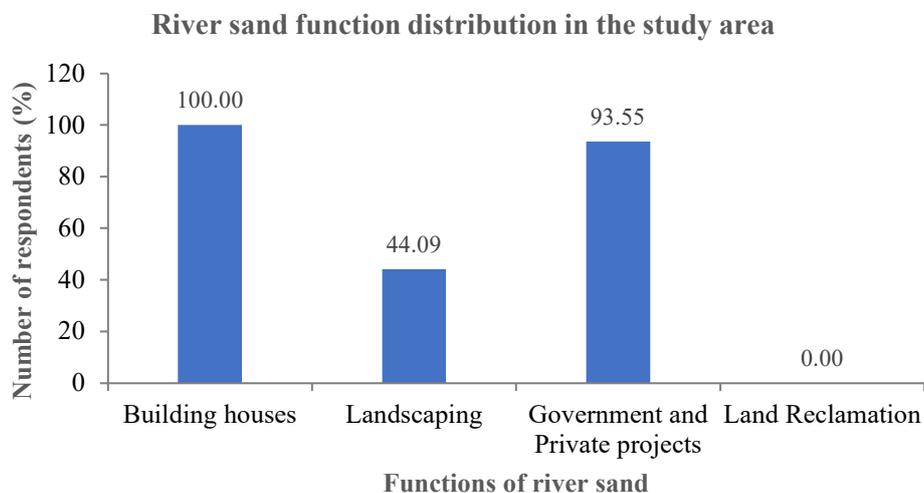


Figure 3. River sand function distribution in the study area.



Figure 4. River sand is collected using tipper trucks.

The large vehicles are typically employed for bulk transportation, thus indicating significant quantities of sand being extracted from the riverbeds. Some respondents adequately expressed the validation of the latter point in the following manner:

“I think river sand is commonly used for building houses in most parts of the villages. The sand is mined on a large scale and this is evidenced by large trucks that transport it.”

Source: Respondent 7

“Well, it is well known that river sand mining is common in our community which is specifically used for building, and one can say this activity has now gained interest due to the increasing number in the building of new houses.”

Source: Respondent 30

“Though sand is commonly used for building houses but government and private projects are also consuming most of it and most of our customers are running tenders that are in construction where sand is always needed.”

Source: Respondent 51

#### *Right of access to sand mining*

Figure 5 indicates the respondents' views and knowledge on who is responsible for granting authorization or permission to extract sand from the river. More than half of the respondents (58.06%) indicated that they do not know who grants permissions for sand mining in the study area. However, a minority of respondents (12.90%) indicated that the tribal authority or the chief is the responsible agent. However, 35.48% of respondents indicated that no one has the authority to grant permission to sand miners. A further step was undertaken to reveal respondents' views or observations on whether local traditional leaders or authorities are taking the necessary measures to prevent illegal sand mining activities in communities

surrounding the affected rivers. In light of that, the majority (54,84%) of the respondents indicated that there is no limit on sand extraction quantity. In supporting the previous statement, respondent 12 indicated the following point:

“Sand extraction can never be limited by local traditional leaders nor the municipality because they both understand that this is the source of livelihood”.

Source: Respondent 12

In supporting respondent 12, the majority (33.16%) of the respondents pointed out the following:

“The local traditional leaders and the municipality are aware that if they attempt to prevent us from mining, the only implication will be to vote against them during local elections and during community tribal council meetings. This is the reason we do not even pay any levies to extract sand”

“Local traditional leaders and political leaders do not see the need to prevent us from illegal mining”

On the other hand, 12% of respondents indicated that they do pay the local traditional leaders as expected, and due to such defiance, they are either intimidated to pay the levy or they receive fines. In supporting the statements, respondent 55 denoted the following:

“Small-scale miners are very few in our villages, therefore we pay a certain amount to the traditional leaders to control the supply in the area. We are not allowed to mine sand without that levy at all.”

#### *Knowledge of environmental impacts associated with river sand mining in the study area*

Based on Figure 6, it is clear that the common environmental impact associated with river sand mining indicated by respondents was the development of open pits that are left un-rehabilitated. Such open pits were reported by 91% of the respondents. Similarly, the collapse of river banks was mentioned by 68% of respondents. Nevertheless, less frequently mentioned impacts included the loss of farming (15%).

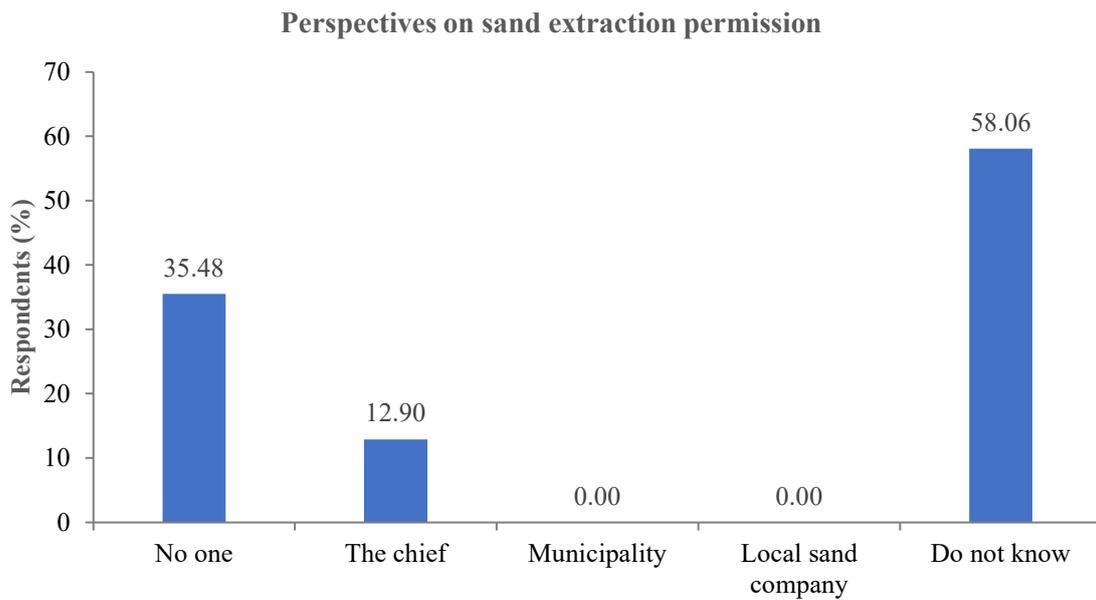


Figure 5. Respondents' perspectives on sand extraction permission.

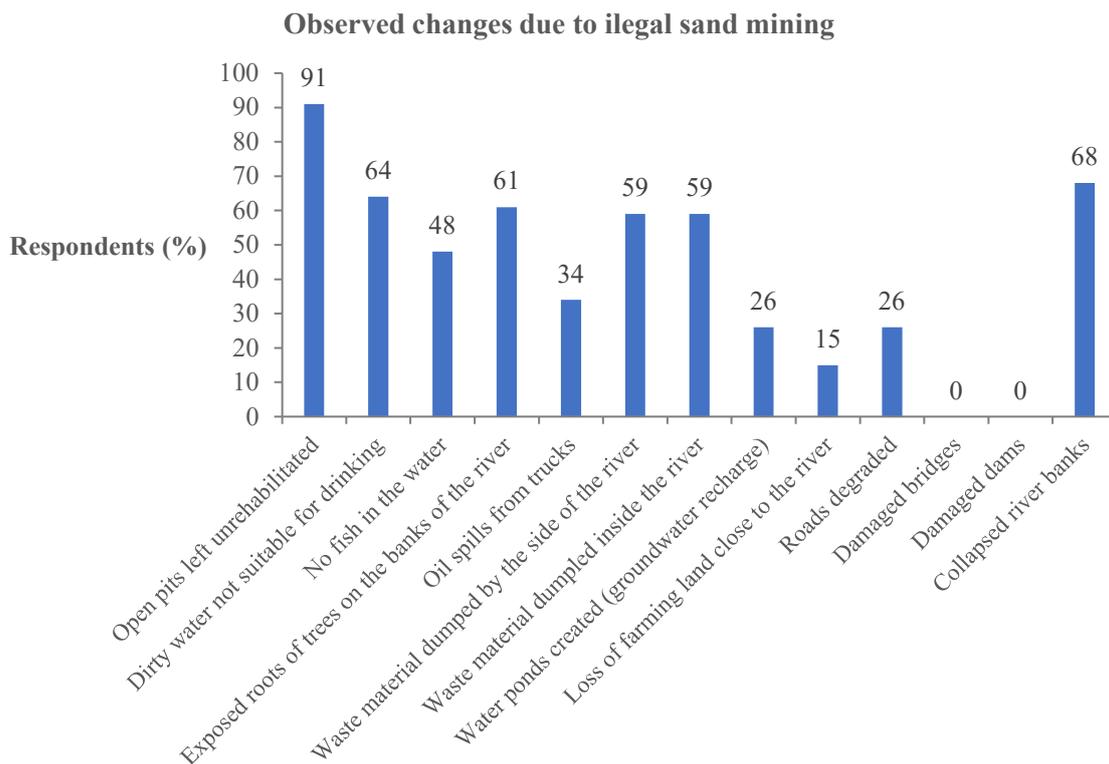


Figure 6. Observed changes by the respondents in the various communities along the affected river channels.

Figure 7 supports the respondent views on outlining un-rehabilitated pits left across the river sand mining areas. Gradually un-rehabilitated pits degenerate into deep dams, while some becomes a which eventually become illegal dumping sites (Figure 7c-d). Some of the respondents reported the following points:

“Most of our rivers have dams that were generated from this river sand mining. Although this activity was

of benefit, but now most people in the community are using those deep exactions as dumping sites, while those which are filled with dirty water are dangerous to children and animals.”

Source: Respondent 45

“I can say that we normally generate deep pits but because we do not have separate soil to fill them we ended up leaving them as they are and it is dangerous”

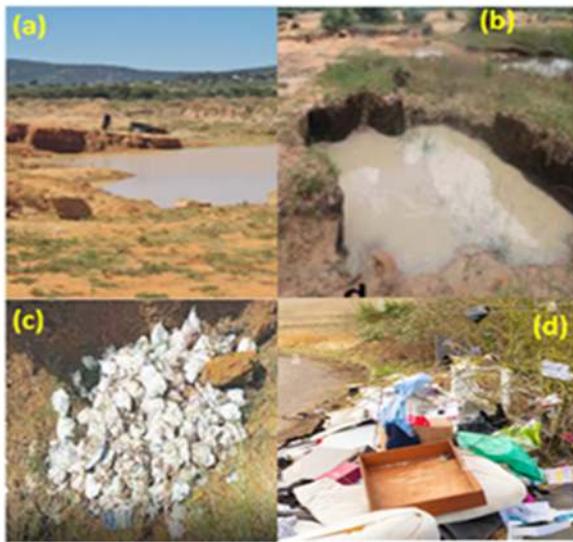


Figure 7. Un-rehabilitated open pits due to river sand mining.

The un-rehabilitated pits were mostly observed in rivers such as Nzhelele River, Turf River and Dwars River. These pits are more common in previously mined areas. Based on Figure 7c-d, domestic solid waste consisting of plastics and disposable diapers becomes a major source of river pollution. Some respondents, particularly farmers, indicated that their livestock consume some of these waste materials, thus resulting in indigestion and sometimes animal deaths. Other waste materials, such as building rubble, empty tins, and bottles, are also dumped in these areas (Figure 7d)

Figure 6 shows that 64% of respondents reported water pollution as one of the environmental impacts associated with river sand mining. For rivers such as the Mvhudi, Letaba, and Nzhelele, downstream users indicated that there is a decrease in water quality due to uncontrolled dumping of various types of waste materials (see Figure 8a) and fuel spills from the miners' trucks (see Figure 8b).



Figure 8. (a) Polluted water, (b) Oil spill from miner equipment

In supporting the previous statement and Figure 8a-b, respondents who were mostly farmers have indicated that besides the heightened turbidity at the mining sites due to sediment resuspension and sedimentation from organic particle matter, some of the high levels of turbidity is caused by oil spills or leaks from excavation equipment and transportation trucks.

It has been reported by 26% of respondents that in areas closer to rivers, almost all the vegetation is destroyed by the trucks involved in the transportation of sand (see Figure 9). Heavy trucks cause soil compaction which reduces the effectiveness of soils by restricting the rooting depth of vegetation. The respondents further indicated that the same sand collection tipper trucks drive at a high speed through the village and some have since caused road damages.



Figure 9. Compacted soil and loss of natural vegetation along some of the access roads associated with sand mining sites.

## Discussion

From the results presented in the previous section, the majority of the respondents were men. Such a gender distribution has been reported in previous studies, thus suggesting that illegal sand mining in some areas is a male dominated activity (Madyise, 2013). This is also corroborated by Ali (2020), in a study conducted in Zanzibar, where male respondents were the majority of illegal sand miners.

In terms of qualifications, most respondents were poorly educated, thus less qualified for some of the jobs in the formal economic market. Also, illegal sand mining has low entrance barriers, thereby encouraging people with entrepreneurial capacity to enter the sector depending upon the opportunities it presents to them. This is in line with the findings by Ako et al. (2014) in north-western Nigeria, Saviour (2012) in India, and Syah and Hartuti (2018) in Indonesia.

In terms of the usefulness of river sand, Gondo et al. (2019) indicated that some of the communities located around certain rivers have witnessed an increase in the number of building projects in areas where there is a high frequency of such extractions, thus similar to trends in the present study area.

River sand has many applications in the construction sector – for example, by combining it with cement and concrete to build and fortify structures or by making bricks for new constructions (2013). Still, the utilisation of heavy equipment and big trucks in the extraction of sand from rivers might result in detrimental environmental repercussions. The activity has the capacity to disrupt biological ecosystems, cause soil compaction leading to erosion, alter water flow patterns, and reduce biodiversity.

In addition, the pollution emitted by heavy-duty trucks can exacerbate the deterioration of natural ecosystems, therefore adversely affecting both the plant and animal life in the impacted areas. Moreover, extended participation in this activity might place strain on local infrastructure, such as roads and bridges, due to the possibility of these cars causing damage and deterioration to transportation networks. However, the burden frequently imposes maintenance expenses on communities at large and municipalities.

From an economic perspective, the use of heavy trucks in sand mining indicates that these operations are motivated by financial interests. The research findings indicate that unregulated illicit sand mining can result in the emergence of a clandestine sand market that operates beyond the boundaries of legal rules and fair economic standards. Within this framework, illicit extraction of sand might potentially contribute to the degradation of indigenous natural resources that are vital for sustaining the functionality and integrity of the local ecosystem. The abundance of tipper trucks and heavy-duty vehicles involved in illicit sand mining need strong rules and enforcement actions. Implementing effective laws, rigorous surveillance, and imposing sanctions for illicit sand mining operations are crucial to control these practices and alleviate their detrimental environmental effects.

To tackle these problems, a comprehensive strategy is needed that includes strict laws, raising public awareness, and fostering cooperation among government agencies, local communities, and environmental organizations. This will ensure that sand mining in the region is conducted in a sustainable and responsible manner.

The findings of the current study have revealed a significant level of ambiguity in the studied regions about the entities responsible for governing and overseeing access to sand mining locations. Consequently, regions that are susceptible to harm are being equipped with explosive devices without any possibility of being restored. Similar occurrences have been reported elsewhere, thus indicating some of the challenges involved in the regulation and management

of illegal sand mining in the affected study areas (Nel et al., 2014; Owusu and Waylen, 2019).

## Conclusion

The focus of this study was to examine the perceptions of the environmental impacts associated with illegal river sand mining in Limpopo province. The study applied mixed methods to acquire the primary data based on the complexity of the research problem. The quantitative data were acquired using questionnaires meanwhile, the qualitative data were collected through semi-structured interviews from various respondents.

The results of the study showed that most of the respondents were males and that the majority of the respondents did not have qualifications. As denoted in the study, the results on demographic correlates with various studies; however, this gives a conclusion that sand mining is an activity mostly practiced by males and it is usually practiced by people with no education or education at a lower level. Furthermore, it was also noticed that this activity expands due to the very high unemployment rate in the area; as a result, males, as the head of the family, usually practice sand mining since it generates income quickly.

In terms of usage, the study showed that this resource is mostly used for building purposes rather than any other usage. It has been found that as development increases, the demand for river sand will increase as well, leading to a high extraction rate of sand. Similarly, the extraction of resources is not regulated or controlled; therefore, it is concluded that unregulated extraction of these resources will result in serious environmental crises such as un-rehabilitated pits, water pollution, and land pollution, among others.

In light of this, it is advised that relevant authorities collaborate to implement strict rules and penalties. Equally vital are public awareness campaigns, which can play a pivotal role in educating communities about the environmental repercussions of illegal sand mining. Additionally, diversifying construction materials by exploring and promoting alternatives can reduce the dependence on river sand mining. Overall, the study emphasizes the need for tailored education, effective regulation, and active community engagement as fundamental strategies to counter the adverse impacts of illegal river sand mining and foster sustainable practices in the affected regions.

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references-Ethics Reference Number: 2022-09-02/Rapholo\_Rampedi.

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