

# Study of Sand Mining and Related Environmental Problems along the Nzhelele River in Limpopo Province of South Africa

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**Abstract** The purpose of this study was to determine the relevance of South African regulatory framework to sand mining; map locations of sand mining activities along the Nzhelele River; assess the environmental impacts; and suggest strategies for mitigating the major impacts. The research approach involved review of legislations, mapping of sand mining activities, visual observation, and river bank erosion assessment. The study showed that improper sand mining causes degradation of the Nzhelele River and its floodplains. It emerged that lack of clear-cut guidelines constrain efforts of legislation enforcement and that strategies be developed to discourage indiscriminate extraction of sand.

**Keywords** sand mining, environmental impacts, legislation and regulatory framework, mapping of sand mining sites, management strategies

## Introduction

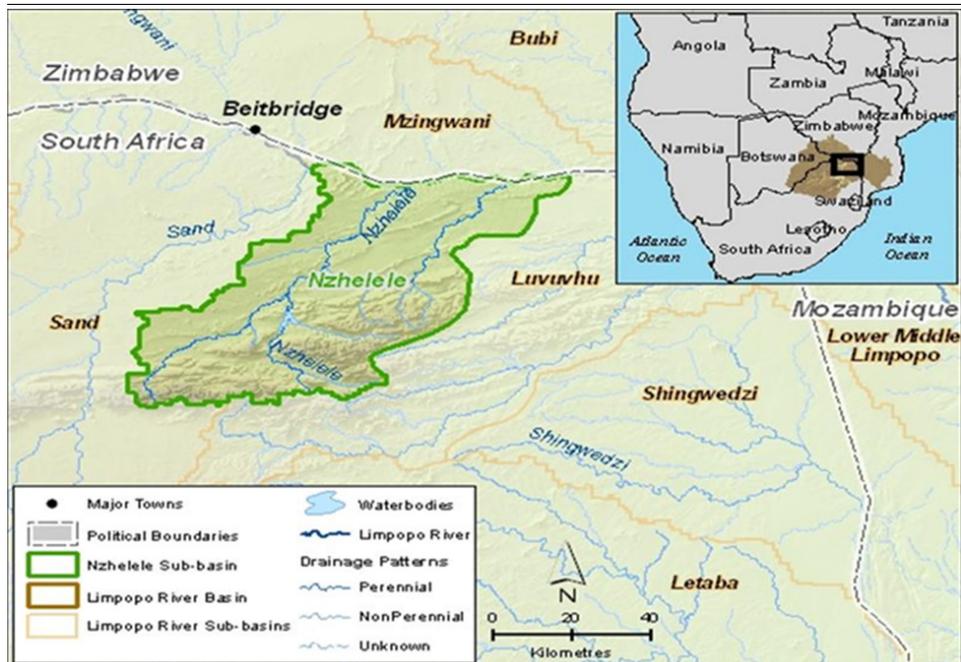
Sand mining is a common practice in many rivers and floodplains across South Africa. The demand for sand is escalating at an alarming rate as a result of ever-increasing building construction projects and other infrastructural development. This has contributed to indiscriminate sand mining and severe environmental impacts such as habitat destruction, degradation of the aesthetic beauty of the surroundings, deforestation of floodplains, and modified stream structure and functionality (Hayer & Irwin 2008 and Kondolf 1997).

There is paucity of information on the impact of sand mining in the Limpopo Province in general and the Nzhelele River valley in particular. In view of the high demand of sand, mushrooming of sand mining activities and the associated environmental degradation, it is important that a study is conducted to address the environmental impacts of sand mining along Nzhelele River. In this regard a study was conducted to examine the South African legislative environment for sand mining activities, map the locations of sand mining sites along the Nzhelele River, assess the environmental impacts of sand mining along the river, and come up with strategies for preventing, controlling and mitigating the environmental impacts of sand mining.

## Background of the Study Area

The Nzhelele River is a major watercourse in Limpopo Province of South Africa. The river's catchment area comprises 2,436 km<sup>2</sup>. This river meanders in a northeastward direction across a wide plain that contains considerable biodiversity, including numerous large mammals such as giraffes, white rhinos and blue wildebeests. Cultivation closer to the source of the river and

on the floodplains is very dominant and livestock farming is also practiced in the area. Residential and commercial construction activities are in full swing in the study area and these have led to higher demand for sand. Fig. 1.1 shows the locality map of the study area.



**Figure 1** Location of the Study Area

## Research Methods

The methodology and techniques used in collecting data to accomplish the objectives of the study were document analysis of legislation and regulations relevant to sand mining; mapping of sand mining activities along Nzhelele River; interviews with local residents, government and non-governmental officials and sand mine operators to capture the information on sand extraction; visual observation; and river bank erosion assessment.

The analysis of the legal and regulatory framework focused on registration, extraction, health and safety, and environmental protection. It also covered issues such as the extent to which the existing regulations meet best practices and standards of corporate conduct and the extent to which self-regulatory mechanisms are accommodated under the framework. In addition, small-scale sand miners were interviewed on the application of related laws in their mining activities and their understanding of the different laws.

Detailed field surveys were carried out in the study area in order to map the locations of sand mining activities. Observations were conducted in all the active extraction and abandoned sites. The types of equipment and methods used for extraction were also taken into

consideration during this survey. Aerial photographs taken at different periods were used to determine the changes that have taken place along the river, particularly areas devoid of vegetation and the excavations created over time as a result of the sand mining activities. This approach of determining the devastation caused by sand mining was complemented with field identification and measurement of dimensions of features such as open excavations or pits of floodplain extraction sites.

Interviews were used to collect data on the mining operations and perceptions of people from the host villages. Target groups selected for interviews included individual landowners, individuals actively involved in the mining activities, and individuals from nearby communities. The interview approach and the questionnaires employed allowed a more in-depth investigation into the unique understanding of each interviewee on sand mining and its associated impacts. Issues of closure and rehabilitation of the mined sites were also taken into consideration.

### **Results and Discussion**

Analysis of the different laws and comprehensive study of the situation of small-scale sand miners indicated lack of understanding of the laws and laxity in implementation and enforcement on the part of the regulatory authorities. The laws that govern sand mining in South Africa should be simplified to a level that will enable these miners to understand.

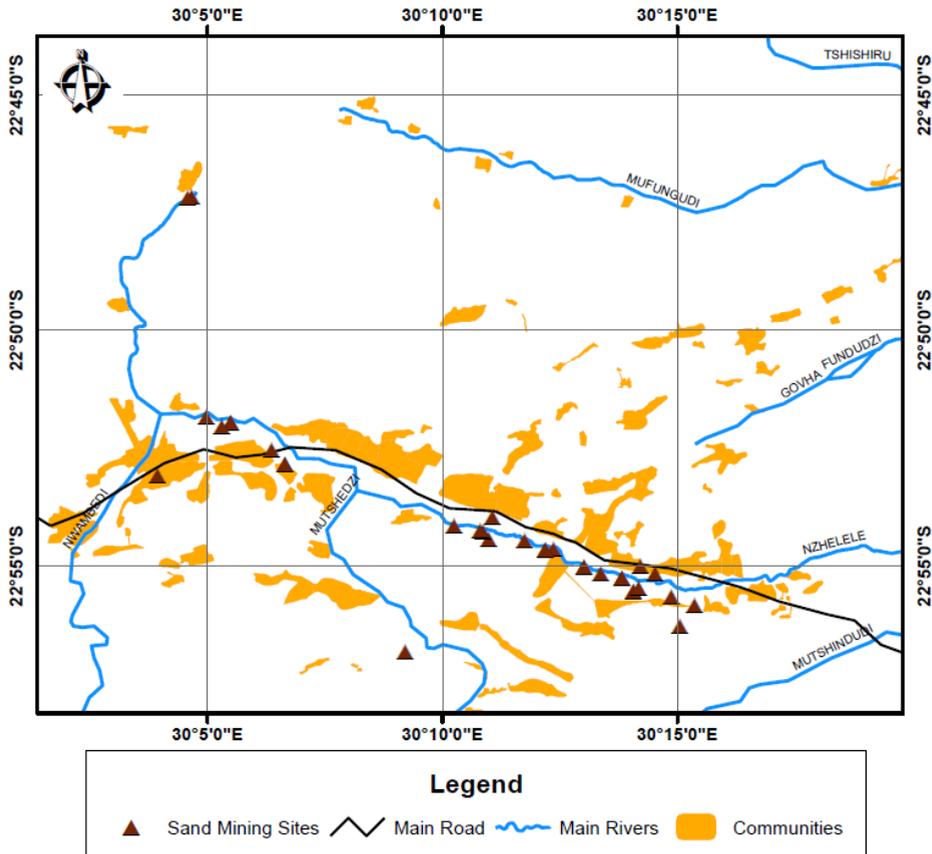
The activities of illegal sand mining along the Nzhelele River needs to be controlled. It emerged from the study that most of the sand mining activities are conducted without due regard to environmental protection. In addition, the sand miners do not undertake rehabilitation of the mine sites. The traditional authorities and landowners who give out lands for such activities should be taken to task in that they seem to condone and connive with these illegal sand mining activities in their areas of jurisdiction. The mode of operations of these illegal small-scale sand mining requires critical scrutiny and regulation. This calls for a lot of supervision from the appropriate state agencies and Kusimu (2014) suggests creation of more offices of these agencies in localities where these activities are rife.

The study showed that two types of sand mining, namely instream and flood plain mining, are practiced along the Nzhelele river valley. Instream mining involves the extraction of coarse sand suitable for concrete slabs whilst flood plain mining involves the extraction of fine sand suitable for brick laying and plastering. Results of the field investigation revealed that instream mining is the prevalent type of sand mining in the study area and accounts for about 51% of the sand mining operations along Nzhelele River whilst flood plain mining only constitute 44%. A very small percentage (5%) of the operations employ both instream and floodplain mining in the study area. It was found that floodplain mining was rarely practiced around the mouth of the river and because more deposition of river sand occurs along these communities. Communities closer to the source of the river host both instream and floodplain mining. Field studies confirmed that floodplain sand extraction activities are causing severe impacts on agricultural lands and the vegetation on the floodplains. Data collected from the field revealed that sand mining activities are mostly carried out manually

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(93%) using rudimentary tools such as picks to expose the materials and shovels to load the material onto trucks.

One of the specific objectives of this study was to map the location of sand mining sites along the Nzhelele River. In this regard, a spatial distribution map of sand extraction sites was created and is depicted in fig. 2.



*Figure 2* Spatial distributions of sand mining sites

More sand mining sites are located just some few kilometres from the source of the river. At this area, there is high deposition of sand because of the gradient of the river. Steeper gradients promote more erosion whereas gentle gradients promote more deposition. This also attracts the miners in large numbers as the sites are easily accessible and the material is in abundance. Distance to the market is considered also as a factor of choosing these sites. During the interview with some of the miners, they indicated that the closer the site is to the market the more profit they make as they save on transportation costs.

Assessment was conducted on morphological and environmental impacts of sand mining along Nzhelele River. This analysis was done under thematic themes such as observed changes in river depth, changes on water resources usage, observed social impacts, change in land use, infrastructure damage, artificial lakes, riverbank erosion, and degradation of the aesthetic beauty of the surrounding environment. The nature and magnitude of the impacts depends on the physical characteristics of the location, the technology used for extraction and size of the operation.

The illegal sand mining activities conducted along Nzhelele River pose threat to bridges, river banks and nearby structures. They affect uses that local people make of the river and create deep and wide pits on the riverbed. These pits affect the natural flow of water into the river. Fig. 3 shows trucks loading sand from one of the extraction pits at Dopeni village. The site is approximately 100 m in length with an average depth of excavations of 4 m. Interview with the miners revealed that sand at this site is the best in the market and this was confirmed during field survey by the number of trucks loading simultaneously at the site. Several cases of banks collapsing and injuring/killing the miners have been reported during field surveys as the miners always go for the softer material underneath the original ground.



**Figure 3** Sand mining operation at Dopeni village

Sand mining activities disturb the functionality of the ecosystems and Langer (2003) indicated that some sand mining activities transform the land use of an area to that of less value or no value at all. This study confirmed this assertion and fig. 4 shows an abandoned sand extraction site near Mphephu Resort which is now used as an illegal municipal waste dumping site. The site was previously used as a good grazing land for cattle and other domestic animals.

Floodplain sand mining has transformed some parts of the study area into large and deep open pits. Water accumulates in these open pits thereby forming water ponds which pose a threat to the community. It was observed that children use the ponds as swimming pools and risks of drowning are very high. Fig. 5 shows children swimming in one of the artificial lakes created by sand mining in the area. Some community members reported cases of livestock drowning in these ponds.



**Figure 4** Change of pastoral land use to waste dump site



**Figure 5** Children swimming in artificial pond created by sand mining

Assessment of the impacts of sand mining showed that erosion of the river banks is exposing the foundation of bridges and exposing water pipelines. This kind of scenario was also observed by Kondolf (1997) in a study on the effects of gravel mining on dams and river systems. Instream sand mining alters the channel morphology directly resulting in erosion of river banks, channel incision, channel instability and infrastructural damages. The erosion of the river banks degrades the habitat of both aquatic and terrestrial species in the vicinity. The degradation even extends further down or upstream of the area. This poses a threat to availability of drinking water for the communities within the study area.

### **Mitigation of Impacts of Sand Mining**

Sand mining is crucial for the sustenance of man; provides job opportunities and income; and enhances local economy. However, sand needs to be mined in a more responsible and sustainable manner. Based on the major issues that emanated from this study, the following mitigation measures have been suggested to address the problems:

Compliance with legislation and regulations on sand mining is mandatory and necessity for responsible and sustainable sand mining. In this regard, the present and future legislations and regulations should be tailor-made for the sand mining sector and it should be simplified for an ordinary man to comprehend and adhere to. Self-regulation should be encouraged to the extent that it can demonstrate compliance with legislation and regulations.

River model studies should be employed in identifying the aggradation zones and quantities suitable for mining. This will ensure that the river is protected from bank and bed erosion beyond its stable profile.

In terms of mitigating the environmental effects of sand mining, the operations need to be conducted in a more responsible manner, environmental awareness need to be created, environmental management and mine site rehabilitation need to be conducted. This study concurs with the suggestion made by Gunaratne (2010) that an environmental trust fund

needs to be established to pay for environmental restoration and the community should play a significant role in effective management of this resource.

Monitoring plans are to be designed to provide data on profile changes and sediment transport capacity to enable the authorities to evaluate the long-term effect of the mining activities both upstream and downstream of sand extraction sites.

A policy guideline needs to be developed to provide criteria for sustainable in-stream and off-channel extraction of sand. Implementation of the principles and processes of this guideline will limit the negative externalities of sand mining by restricting mining activities in terms of number, location and production rate.

### **Conclusion**

Sand mining contributes to construction of buildings and infrastructure development and provides both economic and social benefits. However, intensive sand mining with disregard to environmental protection significantly erodes these gains and creates a series of socio-economic and environmental problems.

The legislation and regulatory agenda for sand mining activities is vague and passive and these make enforcement difficult and complicated. Lack of clear and precise guidelines for dealing with sand mining operations coupled with inability of the regulatory authorities and other stakeholders to monitor these uncontrolled activities and employing effective enforcement principles means not much attention is being directed to curbing unscrupulous sand mining activities and concomitant environmental degradation.

There are so many sand mining sites along the Nzhelele River due to easy access to the materials. Over exploitation of river sand threatens the very existence of the river and leads to significant environmental degradation and ecological disorders. Sand mining has degraded and altered Nzhelele River and its floodplain at an alarming rate. These impacts have affected many people in host communities. The major impacts of sand mining in the study area were found to be alteration of the water table, change in land use, infrastructure damage and collapsing of river banks. The most deplorable legacy of unregulated sand mining in the study is the life threatening artificial lakes formed by accumulation of water in open excavations.

Even though there are no specific guidelines on sand mining operations, it is suggested that local municipalities come up with bylaws to help preserve the ecological beauty of their areas. Environmental awareness training should be conducted for the communities in the vicinity of the extraction sites. This will help in monitoring and enforcement of the bylaws. Studies focusing on the impacts of sand mining on water quality should be conducted. This will help the community and the government authorities to know and understand the nature and severity of impacts of sand mining on water quality in the area.

Findings and recommendations of this study will help create public awareness on the ecological and social economic values of rivers, guide the concerned regulatory authorities for

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more serious consideration of the potential long term consequences of widespread sand mining, and contribute to formulation of policies to protect and conserve the river and river valleys from destruction by sand mining. This study can also be replicated for other rivers that are threatened by irresponsible sand mining.

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