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DEVELOPMENT OF PLANNING AND MANAGEMENT STRATEGIES FOR DEALING WITH PROBLEMS OF PROLIFERATED SAND AND GRAVEL MINING IN SELECTED VILLAGES OF THULAMELA LOCAL MUNICIPALITY, LIMPOPO PROVINCE, SOUTH AFRICA

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A Dissertation Submitted to the Department of Ecology and Resource Management, School of Environmental Sciences, University of Venda in fulfillment of the requirements for Master of Environmental Science.

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DECLARATION

I, Tshepiso Pharea Morema, hereby declare that except for references cited, which have been duly acknowledged, this dissertation is the result of my own research. It has never been presented anywhere either in part or whole for the award of any degree.

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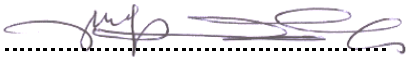
Student

17 August 2020

Date



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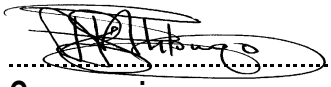

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God bless you all.

ABSTRACT

Sand and gravel resources are the most important raw materials for the construction of infrastructure and buildings. However, extraction activities negatively affect settings for the resources and cause adverse environmental and socio-economic impacts that manifest during and after mining. Sand and gravel mining change natural landscape, contribute to loss of biodiversity and indigenous vegetation, reduce cultivation fields, and result to infrastructure damage and habitat destruction. Poor understanding of these impacts has led to a lack of planning and management strategies to curb such problems.

The main aim of this study was to develop planning and management strategies for dealing with problems of proliferated sand and gravel mining in selected villages of Thulamela Local Municipality. The study involved compilation of a comprehensive inventory of sand and gravel mining in the study area, assessment of environmental impacts of sand and gravel mining activities in the area, examination of the current management of sand and gravel mining in the area and development of action plan for curbing haphazard sand and gravel mining. The research approach used in collecting data involved interviewing key informants, review of existing documents and field observation from thirty-five respondents, eleven informants and fourteen mining operations. The data was analyzed by means of descriptive and thematic analysis methods. The environmental impacts of the mining operations were assessed using Rapid Impact Assessment Matrix. The development of planning and management strategies to deal with problems of sand and gravel mining was through consulting literature and considering the suggestions made by the key informants and sand miners.

The study shows that sand and gravel mining cause adverse impacts on the receiving environment and the operations contravene the provisions of the Mineral and Petroleum Resources Development Act and the National Environmental Management Acts. The adverse impacts identified at the study area include degradation of the natural landscape, loss of biodiversity and indigenous vegetation, reduced cultivation fields, air pollution, soil erosion, infrastructure damage and habitat destruction. However, the study revealed that sand and gravel mining activities offers direct and indirect employment opportunities to machine operators, tipper truck drivers, bricklaying workers and construction workers. It emerged that sand and gravel miners do not possess mining permits and environmental authorisations. A lack of knowledge of statutes regulating sand mining and a lack of compliance inspections and enforcement contributed to these findings. This is a clear indication that there is laxity on the part of the

Department of Mineral Resources in executing its primary and mandatory duty of regulating sand mining operations.

An action plan has been developed for controlling haphazard and reckless sand and gravel mining. The planning and management strategies devised/formulated to address the existing problems at the study area were awareness campaigns, the establishment of sand mining forums, discovering and mapping sand and gravel deposits, environmental impact assessment, compliance inspections, enforcing compliance and rehabilitation of the mined sites. Sand mining operations should be legalized to promote sustainable mining and enhance the economic benefits associated with sand mining. Also, enforcement of regulatory framework for sand mining must be prioritized to reduce social and environmental problems.

Keywords: Sand and gravel mining, environmental impacts, planning and management strategies, sustainable mining

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LIST OF ABBREVIATIONS

BE:	Biological/Ecological
DMR:	Department of Mineral Resources
EA:	Environmental Authorisation
EAP:	Environmental Assessment Practitioner
EIA:	Environmental Impact Assessment
EMP:	Environmental Management Plan
EMRI/s:	Environmental Mineral Resource Inspectors
EO:	Economic/Operational
ES:	Environmental Score
MPRDA:	Mineral and Petroleum Resources Development Act No 28 of 2002
NEMA:	National Environmental Management Act No 107 of 1998
NEMBA:	National Environmental Management Biodiversity Act No 10 of 2004
NEMPAA:	National Environmental Management Protected Areas Act No 57 of 2003
NWA:	National Water Act No 36 of 1998
PC:	Physical/Chemical
RIAM:	Rapid Impact Assessment Matrix
SC:	Sociological/Cultural
TLM:	Thulamela Local Municipality
WUL:	Water Use Act

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Natural sand and gravel are essential resources to sustain construction industry and ecosystems. These resources have been used for decades to construct bridges, roads, buildings, airports, stadiums, schools and other infrastructure (Asabonga, 2017; Peprah, 2013). They are extracted from their settings that include river and stream terraces, hills, mountains, coastal areas, oceans, floodplains and river channels (Ashraf et al., 2011) through mining and transported to areas of demand or utilization (Chevallier, 2014). During mining, the miners adopt either mechanical or manual mining methods.

Because sand and gravel resources play an important role to construction industry and economic development, their demand has increased and this has contributed to miners putting immense pressure on the settings (Devi and Rongmei, 2015; Lawal, 2011). The economic benefits of trading the resources have encouraged miners to conduct indiscriminate illegal activities in the Tangail District of Bangladesh (Khan and Sugie, 2015). Similarly, Ashraf et al. (2011) observed that illegal sand mining continues rapidly in Malaysia despite numerous prohibitions and regulations. India, South Africa and Botswana are not immune to the issue of indiscriminate illegal mining (Mitraand Singh, 2015; Madyise, 2013).

Most of the studies done on sand and gravel mining have focused much attention on environmental impacts and socio-economic issues (Morrison, 2016). According to Sreebha (2008) lack of adequate baseline environmental data of previous periods is a major lacuna on public conscience regarding sand mining impacts on various environmental components. This lack of environmental data possibly compromises efforts to develop management strategies to deal with the adverse impacts of sand mining. This study will compile a comprehensive inventory that provides baseline environmental data used to develop planning and management strategies to deal with problems of proliferated sand mining.

Studies reveal that sand and gravel mining suppresses ecological needs to meet the needs of the construction industry (Sreebha and Padmalal, 2011; Akoet al., 2014). This possibly results from increased demand of the resources in the construction industry (Peprah, 2013) and consequently put immense pressure on the settings where the resources occur (Kori and Mathada, 2012). Owing to this pressure, extraction of sand and gravel is bound to have a considerable adverse environmental impact. According to Ashraf et al. (2011), environmental impacts occur when the rate of extraction of sand, gravel and other materials exceeds the rate at which natural processes generate the materials. Some

of the environmental and socio-economic problems of the indiscriminate sand mining include floodplain degradation, deforestation and habitat destruction, change in land use, infrastructure damage and pollution of air and water (Amponsah-Dacosta and Mathada, 2017; Ako et al., 2014).

Despite the environmental and socio-economic impacts associated with sand mining, the industry has some positive socio-economic impacts. For example, sand mining is associated with poverty alleviation and significantly contributes to the development of rural areas in many places particularly in developing countries (Arwa, 2013). This assertion is supported by Baba (2016) who indicates that sand mining had positively affected the livelihood of Brong Ahafo Region (Ghana) inhabitants as it provided them with jobs and regular access to higher income. However, the positive benefits of the industry to individuals could not cloud its detrimental consequences.

The study conducted by Ako et al. (2014) at Luku in the North Central part of Nigeria shows that sand mining may conflict with other resources such as fisheries, esthetic and recreational functions. Khan and Sugie (2015) observed in Tangail District (Bangladesh) that indiscriminate sand mining increased soil erosion and posed a risk of destroying the homesteads located on the riverbank and caused considerable damage in the road as well as conflicts involving residents. Ako et al. (2014) reveals that the latter occurs because the miners conduct their activities without any attention to the negative environmental impacts.

A better understanding of environmental and socio-economic impacts associated with sand mining is very essential to formulate appropriate strategies for ameliorating and negating the impacts of river sand mining (Padmalal and Maya, 2014). Though there is a considerable literature on environmental and socio-economic impacts of sand and gravel mining around the world only a few studies were conducted in South Africa and Limpopo Province in particular. Amponsah-Dacosta and Mathada (2017) indicate that there is a paucity of information on the environmental and socio-economic impact of sand mining in the Limpopo Province. This possibly compromises attempts to formulate appropriate strategies to curb environmental problems of haphazard sand and gravel mining. Thus, a study needs to be conducted to document and assess the environmental impacts of sand and gravel mining in the study area.

The adverse effects of sand and gravel mining on the ecosystems and human life have called for effective and reliable regulation. Evidently, studies conducted around the world appeal to governments to regulate sand and gravel mining in order to maintain the balance between the environment and sand mining (Pitchaiah, 2017). To satisfy the appeals some governments attempted to preserve the

resources and enacted laws to regulate sand and gravel mining. According to Padmalal and Maya (2014), nations have binding legal policy regulations to control and monitor sand mining operations within their jurisdictions pertaining to stipulated limits and conditions. For instance, the sand mining in India is regulated through the Mines and Minerals (Development and Regulation) Act, 1957 (Padmalal and Maya, 2014), in Botswana Mines and Minerals Act (1999), Environmental Impact Assessment Act (2005) and Mines, Quarries, Works and Machinery (1978) whereas in Nigerian, the Mineral and Mining Act (2007) is used. In South Africa, sand mining is regulated through mineral regulation, environmental regulation and land use planning regulation (Green, 2012).

Despite governments' resolute efforts of enacting laws to regulate sand and gravel mining that threatens human life and the environment, the indiscriminate activities persist. This could result from one or more of the following reasons. The regulatory context is confusing because sand mining may not be regulated explicitly by local jurisdictions, but mining operations are required to comply with existing rules governing stormwater, groundwater protection and waste management (Peckenham et al., 2009). This assertion is supported by Musah and Barkarson (2009) who observed that in East Gonja District laws such as the Environmental Protection Agency Act (1994) and the Minerals and Mining Amendment Act (1993), which are Ghana's major mandated regulations on development and operation of mining, do not give precise and detailed standards and specifications in respect of gravel and sand mining. Whereas in South Africa, Amponsah-Dacosta and Mathada (2017) have found that legislation and regulatory agenda for sand mining are vague and passive, and these make enforcement difficult and complicated. Odd, Saviour (2012) observed that in India weak governance and rampant corruption are facilitating illegal mining posing depletion of water resources.

Despite the identified challenges on the regulatory context of sand and gravel mining, the existing literature address socio-economic and environmental problems associated with sand mining (Morrison, 2016). Morrison's assertion exposes that management and planning aspects of sand and gravel mining have not received necessary research attention. The studies that considered the management aspect of sand and gravel mining include that of Sreebha (2008) and Dung (2011). From the latter, it is apparent that there is a smaller subset of the literature on the management of sand and gravel mining around the world and South Africa in particular. This study therefore was aimed at examining and documenting management practices of sand and gravel mining in Thulamela Municipality.

Most of the environmental problems associated with sand and gravel mining manifest because the activities are conducted haphazardly. Lack of planning for sand and gravel mining exacerbates the conflict between sand mining and other land users. Wernstedt (2000) observed that the proliferating

sand and gravel mining competes with other land use activities such as township establishment and agriculture. Wernstedt (2000) asserts that planners face competing demands to reserve areas rich in minerals for future use, allow enough mining to satisfy local demand and manage mining activities to minimize deleterious effects.

Mining operations of minerals other than sand and gravel resources value mine planning. Among other things, mine planning evaluates potential impacts on air quality, water quality and quantity, flora and fauna of the area, and general aesthetics (Wernstedt, 2000). Hence, the success of mining operation relies on the efficient planning of the mine and efficient management of available resources (Kwiri and Gene, 2017). However, in sand mining industry mine planning is ignored and this result to the industry having adverse environmental and socio-economic impacts. The industry can minimize the impacts and maximize production by adopting and utilizing the mine planning process.

Anon (2016) as cited by Kwiri and Gene (2017) states that mine planning comprises several stages, which include discovering, establishing, exploiting, beneficiating, selling and rehabilitating the land affected by mining. The discovering stage is concerned with the searching and finding of mineral deposits. If the stage confirms the presence of a mineral deposit that can be mined economically, the establishing stage begins. This stage comprises numerous components that include environmental and social impact assessment, regulatory and government approvals, development of operational plans and maps, engineering design and equipment, development of monitoring program and rehabilitation plan. Then the exploiting stage follows. This is the stage of actual mining or extraction of the mineral. At this stage mine schedule is implemented, environmental indicators are monitored, and mineral inventory is compiled. The exploiting stage is followed by the beneficiating stage. At this stage the mineral is processed to meet certain standards or client's specifications. Again, at this stage environmental indicators are monitored, and metal inventory compiled. The exploiting stage precedes the selling stage that is concerned with marketing the product, demand forecast and logistics. The rehabilitation stage is the last stage of the mine plan. This is the stage where rehabilitation plan and models are implemented, and environmental indicators are monitored.

The explained stages of mine planning are concerned with minimization and mitigation of adverse environmental impacts of mining operation and maximizing the production of the mining operation. Hence, large mining operations consider mine planning as the starting point of the mining operation. However, sand mining rarely considers mine planning (Wernstedt, 2000). From the latter, it is deduced that the impacts of sand and gravel mining result from a lack of planning. Thus, this study will develop an action plan to curb haphazard sand and gravel mining.

1.2 Statement of the Problem

Sand and gravel resources are core resources for the construction industry. Comparable to other resources, per capita consumption of sand and gravel is influenced by population growth (Adedeji et al., 2014). The ever-growing population requires durable infrastructure and buildings that utilize sand and gravel. This exerts pressure on the resources demand. Consequently, haphazard illegal mining of sand and gravel manifest. The latter contributes to altering river flow, damaging riparian habitats through destroying vegetation, riverbanks and wetland systems, fragmenting ecological corridors and leaving behind excavations without any rehabilitation (Chevallier, 2014; Kori and Mathada, 2012). These environmental problems together with socio-economic impacts of sand and gravel mining are experienced throughout the world and also in South Africa.

The adverse environmental and socio-economic impacts of sand and gravel mining received much literature attention around the world (Morrison, 2016). However, only a few studies were conducted in South Africa and Limpopo Province in particular (Asabonga et al., 2017; Chevallier, 2014; Kori and Mathada, 2012; Green, 2012; De Lange et al., 2009). Studies conducted in the country explored environmental and socio-economic impacts of and regulatory framework for sand mining. However, Amponsah-Dacosta and Mathada (2017) still observed a lack of information on the environmental and socio-economic impact of sand mining in the Limpopo Province. According to Padmalal and Maya (2014), lack of environmental impact information possibly will avert attempts to formulate appropriate strategies to deal with the problems of indiscriminate sand and gravel mining.

In addition to the observation made by Amponsah-Dacosta and Mathada (2017) on lack of information on the environmental and socio-economic impact, planning and management aspects of sand and gravel mining have not received research attention. Consideration of planning and management aspects is very essential to any mining operation as they promote production rate and minimize adverse environmental and socio-economic impacts (Kwiri and Gene, 2017). Ignorance of these crucial aspects by sand mining possibly contributes to the adverse environmental and socio-economic impacts associated with the industry. Thus, a better understanding of current planning and management practices of sand and gravel mining in the study area was very essential for formulating appropriate strategies for dealing with problems of the industry. This study aimed at developing planning and management strategies for dealing with problems of proliferated sand and gravel mining. The study involved compilation of a comprehensive inventory, assessing and documenting the environmental

impacts, and examining the current management practices of sand and gravel mining in selected villages of Thulamela Local Municipality.

1.3 Research Objectives

This study aimed at developing planning and management strategies for dealing with problems of proliferated sand and gravel mining in selected villages of Thulamela Local Municipality.

The specific objectives of this research were:

- To compile a comprehensive inventory of sand and gravel mining in the study area.
- To assess the environmental impacts of sand and gravel mining in the area.
- To examine the current management practices of sand and gravel mining in the area.
- To develop an action plan for curbing indiscriminate and irresponsible sand and gravel mining.

1.4 Research Questions

The research sought to answer the following questions:

- How is sand and gravel mining conducted in the study area?
- What are the environmental impacts of sand and gravel mining in the study area?
- How effective is the current management system of sand and gravel mining in the study area?
- What is the most effective way of controlling the indiscriminate and irresponsible sand and gravel mining in the study area?

1.5 Significance of the Study

The rivers, valleys and floodplains of Limpopo Province in South Africa experience a drastic increase in sand and gravel mining. The increase in sand mining operations is directly proportional to their effects on the receiving environment. Yet, few studies focusing on sand mining issues were conducted in the province. Those studies conducted in Nzhelele Valley by Amponsah-Dacosta and Mathada (2017), and Kori and Mathada (2012) explored the environmental and socio-economic impacts of and regulatory framework for sand mining. This exposes a lack of information regarding sand and gravel mining in Limpopo Province and Thulamela Municipality in particular. Accordingly, this study will compile a comprehensive inventory of sand and gravel mining in the study area. The inventory will provide information on the number of sand and gravel mining sites (authorized and unauthorized) and their absolute locations, mining methods employed, previous land use of the mining sites, current land use of

the mined sites and rehabilitation of mined sites (if any). The inventory information will be useful to scholars and authorities, who intend to research on and regulate sand and gravel mining, respectively.

Though there is extensive literature on adverse environmental and socio-economic impacts of sand and gravel mining around the world, only a few studies have been conducted in South Africa and Limpopo province in particular (Amponsah-Dacosta and Mathada, 2017; Kori & Mathada, 2012). Thus, Amponsah-Dacosta and Mathada (2017) observed a lack of information on the environmental and socio-economic impact of sand mining in the Limpopo Province. Accordingly, this study will assess and document the environmental impacts of sand and gravel mining in the study area. The knowledge about the nature and extent of the environmental impacts will be used in the development of planning and management strategies for dealing with problems of sand mining. The knowledge regarding the nature and extent of the environmental impacts will have positive impacts to the sand mining communities and authorities as it will inform the formulation of mitigation strategies to reduce the environmental impacts.

South African government made concerted efforts to enact laws to control haphazard and illegal sand and gravel mining operations. However, the lack of effective compliance and enforcement is a setback to curb persisting haphazard sand mining. Yet, studies conducted in South Africa slightly considered the management aspect of sand and gravel mining. The studies provide little information regarding the factors contributing to the non-compliance with the regulatory framework. This study will examine the current management practices of sand mining in the study area with the view of documenting the factors contributing to non-compliance with the current regulatory framework. The established knowledge about the factors will be used in the development of management strategies for dealing with problems of sand mining. The developed strategies will serve as a guideline for the selection of appropriate management strategies for sand and gravel mining operations in the country.

Kwiri and Gene (2017) state that proper planning for and management of an operation promotes production rate and minimization of adverse environmental and socio-economic impacts. However, sand mining operations seldom consider the planning and management aspects. According to Wernstedt (2000), this results in conflicts between sand mining and other land uses. The conflicts manifest because sand mining has adverse impacts on the receiving environment. Similar to the management aspect, the planning aspect of sand and gravel mining had not received research attention. This study will develop an action plan to control haphazard sand and gravel mining activities. The developed action plan will serve as a guideline for planning and managing activities associated with sand and gravel mining operations.

This study will significantly contribute to the existing sand and gravel mining literature through developing planning and management strategies for dealing with problems of proliferated sand and gravel mining. The strategies will promote the sustainable mining of sand and gravel resources.

1.6 Description of the Study Area

This section presents a description of the study area. It begins with information about the location of the sampled areas and proceeds with describing the geology, climate and vegetation of the study area. It concludes by providing information regarding the population and development of the study area.

1.6.1 Location of the study area

The study area comprises Makonde, Thengwe, Tshikontamalema, Muledzhi, Khubvi and Tswinga villages. Sand and gravel mining are predominant activities in these villages and hence were selected for case study. The villages are within the jurisdiction of Thulamela Local Municipality (TLM) in the Vhembe District Municipality, Limpopo Province, South Africa. This category B municipality established in terms of Local Government Structure Act No. 117 of 1998 is covering an area of 2 893.9km². It shares boundaries with municipalities such as Collins Chabane on the eastern side, Musina on the northern side and Makhado on the southwest side. Thohoyandou town is the main town of the municipality. Sand and gravel mined from the mentioned villages supply construction activities conducted in Thohoyandou town and other nearby villages. Makonde, Thengwe, Tshiombo, Thogani, Muledzhi and Khubvi villages are approximately 35kms North of Thohoyandou town whereas Tswinga village is approximately 10kms on the Southern side as it can be observed from Figure 1.1.

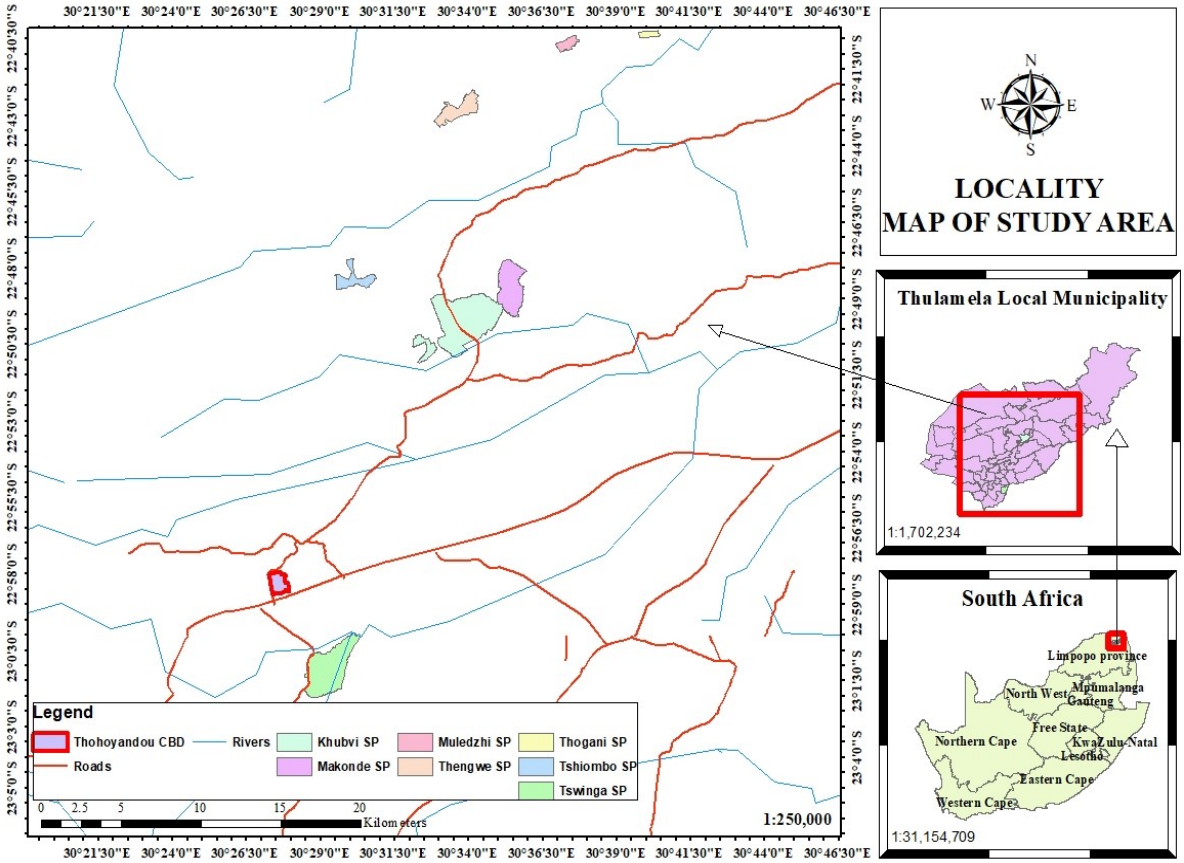

Figure 1.1: Location of the study area with Thulamela Municipality

1.6.2 Geology, climate and vegetation

The study area has a variable landscape that comprises low mountains to extremely irregular plains and hills (Mucina and Rutherford, 2006). Louw (2017) asserts that the geology of the area comprises mainly of quarzitic sandstone, shale and sandy shale of the Fundudzi Formation of the Soutpansberg Group and Gouplaats gneiss. Similarly, Mucina and Rutherford (2006) found that the area has shallow sandy lithosols and the sandstones, lesser amounts of conglomerate, shale and basalt of the Soutpansberg Group.

The climate of the study area is typically subtropical, with mild, moist winters and wet, warm summers characterized by Lowveld and it experiences an annual rainfall of approximately 500mm per annum out of which about 87.1% falls between October and March (TLMIDP, 2017/18). Badisa (2011) asserts that the western parts of Thulamela around Lake Fundudzi and Thohoyandou enjoy high rainfall, ranging from 1000 to 1200 mm/annum.

1.6.3 Population and development

In terms of population, Thulamela Local Municipality with 497 237 people occupies second and first positions in Limpopo Province and Vhembe District Municipality, respectively (TLMIDP, 2017/18). The IDP further reveals that the municipality has 433 131 formal dwelling/ house or brick/ concrete block structures. For 2019/20 financial year the municipality is planning to build 800 RDP houses. These proposed 800 houses will require sand and gravel resources for their construction. The latter supports this assertion by Asabonga et al. (2017) that demand for sand continues to increase at an exponential rate given the fact that the primary mandate of the South African government is based on service delivery that includes the building of schools, health facilities and houses. Thohoyandou is one of the fastest-growing towns in the province. Recently the town experienced the construction of Thavhani Mall and the continuing construction of dwelling houses. In addition to the latter, the University of Venda is busy with the massive construction of students' residence. All these developments require/d sand and gravel resources.

1.7 Organization of the Dissertation

This dissertation has six chapters. Chapter One presents a general introduction to the study. It describes the background of the study, statement of the problem, research objectives and questions, significance of the study, description of the study area and overview of chapters of the dissertation. The background section involves an overview of the management and environmental and social impacts of sand mining.

Chapter Two presents the synthesis of the literature relevant to the specific objectives of this study. The review focused on issues such as impacts of sand mining on livelihood activities, environmental impacts of sand mining, and management and governance of sand and gravel mining.

Chapter Three presents a description of the research design that focuses on the type of design, sampling design, ethical considerations, reliability and validity. It also describes the methods, tools and procedures employed during data collection and analysis.

Chapter Four analyses, presents and discusses the data collected for the study. This covered the implementation of statutes, compliance and enforcement, rehabilitation, legitimacy of the operations, and the impacts of sand and gravel mining in the study area. The results are summarized in the tables and graphs.

In Chapter Five, strategies to address the challenges and impacts of sand mining are proposed. Also, an action plan to curb indiscriminate and irresponsible sand mining is developed. In the last chapter, Chapter Six presents a summary of the study, conclusion and recommendations.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

The purpose of this chapter is to gain an understanding of the existing literature on sand and gravel mining and to show the gap in knowledge that this study aims to fill. The chapter shows how this study fits within the literature of sand and gravel mining. The specific objectives of the study informed the main sections of this chapter. The first section summarizes the methods used to mine sand and gravel, second section covers the importance of sand and gravel, the third and fourth sections deal the environmental impacts and socio-economic impact of sand and gravel mining, respectively. The fifth and sixth sections provide information about the management practices of sand and gravel mining in selected countries and South Africa, respectively. Summary of the chapter is provided at the end.

2.2 Methods of Sand and Gravel Mining

Mining is a process of extracting useful materials such as sand and gravel from the earth by humans for construction and economic development. Nguru (2007) claims that mining processes fall into two main mining methods, open cast mining and underground mining. Underground mining encompasses all sub-surface vertical or horizontal excavations that are made for the extraction of minerals (Nguru, 2007). Opencast mining refers to uncovered excavations made on the ground for the purpose of mineral or rock exploitation such as the open quarries, pits and trenches among others (Nguru, 2007). The selection of the mining methods typically depends on the nature of the deposit and the operator preference. Sand and gravel mining operations employ open cast mining methods, mostly because their deposits are usually found on the ground. The open cast mining methods can be manual or mechanical undertaken (Padmalal and Maya, 2014).

Langer (2003) explains methods and equipment used to mine sand and gravel in water bodies. Langer (2003) indicates that if sand and gravel mining does not penetrate the water table, then the aggregate is dry and can be extracted by using conventional earth-moving equipment, such as bulldozers, front loaders, track hoes and scraper graders. “In some situations where the sand and gravel pits penetrate the water table, such as on low terraces and floodplains, the pit may not be able to be drained and the operator must extract the material by using wet mining techniques. Material may be excavated from the bank by using draglines and clamshells, or by floating barges using hydraulic or mechanical methods” (Langer, 2003). According to the study conducted in the Nzhelele River, approximately 93% of sand

mining activities are mostly carried out manually using rudimentary tools such as picks to expose the materials and shovels to load the material onto trucks (Amponsah-Dacosta and Mathada, 2017).

Green (2012) explains the mining methods and equipment used to mine inland sand and gravel deposits. Green (2012) asserts that a mining operation would require equipment such as a dozer to clear vegetation and builds access roads, an excavator or front-end loader to scoop up sand from the deposit, and trucks to cart the sand away. Similar observations were made in Ogun State of Nigeria (Adedeji et al., 2014). The inland mining operations in Ogun State begin with removing overburden from the top of the sand formation using scrapers or tracked excavators and off-road haul trucks. Once the overburden has been removed, excavators or rubber-tired front-end loaders are used to excavate the sand, and workers use shovels to load to the trucks. Sand and gravel mining operations in the study area use the methods and equipment explained and mentioned by Green (2012) and Adedeji et al. (2014).

2.3 Importance and uses of Sand and Gravel

Sand and gravel resources have various uses in the construction and manufacturing industries (Pitchaiah, 2017) and sustain ecosystems (Sreebha, 2008). The resources are crucial materials for constructing roads, buildings, and various infrastructures (Tang et al., 2011). They make 90% to 95% of the total volume of concrete used for civil works (Apaydin, 2012). Accordingly, the existence and use of these resources in construction sustain the built environment. The importance of these core resources in construction industry cannot be over emphasized. Developing and developed countries continue mining sand and gravel to ensure a continued built environment.

Sand mined in Muvattupuzha, Periyar and Chalakudy rivers located on the southwest coast of India supplies development activities in Kochi city and its satellite towns (Sreebha and Padmalal, 2011). Similarly, sand and gravel mining operations in the Wa area of Ghana and Ogun State in Nigeria provide supply roads, bridges, houses, factories, schools, markets and office construction activities (Peprah, 2013; Adedeji et al., 2014). In Kenyans, sand and gravel mining operations supply the expanding construction industry in Machakos County (Gitonga, 2017; Nthambi and Orodho, 2014). South Africa experiences increased demand for sand and gravel to supply the construction industry (Asabonga et al., 2017). South Africans use sand and gravel to make concrete and bricks, backfill house footings, plastering houses and maintain roads and landscaping (Kori and Mathada, 2012).

In addition to their role in the construction industry, sand and gravel play a critical role in the drinking water purification plants (Peckenham et al., 2009). The resources are used to construct a slow sand filter by creating layers of sand and gravel by arranging the material according to density. Slow sand filtration is the cheapest, simple and efficient method for treating water (Huisman, 1974).

Sand and gravel play a crucial role in the sustenance of the ecosystems (Sreebha, 2008). The resources dominate river channels sediment substratum creating a suitable environment for many psammophile organisms in the river (Padmalal and Maya, 2014). According to Mason (2009), there are species of worms, bivalves, isopods and crustaceans that live in the spaces between the sand grains. These species use sand for nesting, feeding corridors, nursery, or refuge. Hence, over-extraction of sand and gravel in Vembanad Lake of India endangers fish species (Padmalal et al., 2008).

2.4 Environmental Impacts of Sand and Gravel Mining

According to Martin (1998), Environmental Impact refers to any change to the environment, whether adverse or beneficial, wholly or partially resulting from the activities products or services of an organization. The mining operations of sand or gravel probably change natural environment features. Thus, authorities and community members alike have seen sand and gravel mining operations as causing undesirable environmental damage (Adedeji et al. 2014; Khan, 2015). The operations cause varying degrees of environmental damage in mining areas that are often located in remote regions. Most concerns revolve around the concurrent and subsequent physical and aesthetic impacts that sand and gravel mining operations have on the environment. Ashraf et al. (2011) assert that environmental impacts manifest when the resource extraction rate is higher than the regeneration rate. Generally, the operations would result in landslides, soil erosion, loss of vegetation and habitat, noise pollution and water pollution (Gitonga, 2017; Ayenagbo et al., 2011). The following sections provide a brief explanation of the environmental impact of sand and gravel mining operations.

2.4.1 Water pollution

The mining operations of sand and gravel are associated with water pollution and depletion of groundwater. Devi and Rongmei (2015) found that trucks collecting sand and gravel from the rivers pollute the river water through oil or gasoline spillage and disposal of waste. The rivers and wetlands of the Luku area of North Central Nigeria suffer pollution from the sediments originating from the mining operations of sand (Ako et al., 2014). The introduction of sediments increases the turbidity in the receiving river causing water quality deterioration. This affects the distribution of aquatic species

(Padmalal and Maya, 2014). According to Padmalal and Maya (2014), the increasing turbidity due to indiscriminate mining of river sand and gravel create an adverse condition for the survival of some fish species. Jin et al. (2014) claim that water pollution generated during mining inevitably leads to animal migration and death.

2.4.2 Loss of vegetation and habitat

The mining operations of sand and gravel contribute significantly to vegetation and habitat destruction. According to Sreebha and Padmalal (2011), the haphazard operations conducted in the river systems led to the destruction of riparian vegetation which acts as resting and nesting grounds of many migratory birds. In addition, riparian flora and fauna suffer seriously from riverbank slumping, channel incision, lowering of the water table, as a result of the direct removal of vegetation along the river banks, bank undercutting and channel incision. Similarly, Asabonga et al. (2017) found that the operations affect many species that use sand dunes for nesting, feeding corridors, nursery, or refuge. Whereas, on Tatao River Bank in Iran the operations have caused the vegetation around the river to be annihilated and destructed the outlook, beauty, and the greenery of the nearby villages (Farahani and Bayazidi, 2018).

In the study conducted in Luku area of North Central Nigeria, Ako et al. (2014) observed the destruction of vegetation and destroying the natural habitats of some animals associated with sand mining. Ashraf et al. (2011) observed that degrading stream habitats result in loss of fisheries production and biodiversity. Also, the riparian vegetation plays a pivotal role in stabilizing river banks from erosion and also acts as travel corridors for wild animals that connect with other ecosystems (Padmalal and Maya, 2014). The removal of riparian vegetation probably promotes soil erosion, widening of the river channel and affect ecosystems.

The inland sand and gravel mining operations have significantly contributed to vegetation degradation and habitat loss for some fauna species. Green (2012) asserts that sand and gravel mining involves vegetation clearance to build an access road and expose the sand deposits. Madyise (2013) observed this type of practice in Gaborone, Botswana. Sand miners extract pit sand uncontrollably with no regard to the vegetation in the surroundings. Consequently, causing vegetation degradation and encouraging fauna species to migrate to suitable areas. The animals migrate because sand and gravel mining operations claimed their shelter and food source.

2.4.3 Soil erosion and landslides

Mining operations of sand and gravel resources induce soil and landslides. These result from the ground disturbance caused by the mining methods and the type of equipment used. The operations remove the land cover that stabilizes the ground and vegetation that control runoff water, hence the erosion and landslides. The study conducted in O. R. Tambo District of South Africa shows that exploitation of coastal resources such as sand, indigenous forest, and seagrasses causes coastal erosion and landform instability (Asabonga et al., 2017).

Pitchaiah (2017) observed that mining beach sand exposes coastal areas to the ravages of erosion. Most environmental setting in many countries experience soil erosion associated with the operation of sand mining, Tatao River in Iran (Farahani and Bayazidi, 2018), Nzhelele River in South Africa (Amponsah-Dacosta and Mathada, 2017; Kori and Mathada, 2012), Imphal River in India (Devi and Rongmei, 2015), Cau River in Vietnam (Dung, 2011) and Luku area of North Central Nigeria, Ako et al., (2014). Consequently, increased riverbed erosion would increase suspended solids and turbidity of the river water Ashraf et al. (2011).

2.4.4 Natural landscape changes

Sand and gravel extraction is done by open cast mining method where the ground vegetation is cut to clear the land (Nguru, 2007). The topsoil is removed to expose the quality sand or gravel deposits. Finally, the sand or gravel is excavated and loaded into tipper trucks for transportation and trading purposes. Once the sand or gravel deposits are mined and exhausted the operations are abandoned without any rehabilitation (Kori and Mathada, 2012). Similar to instream and floodplain mining operations, aggravated extraction of inland sand and gravel deposits lead to irreversible changes to the settings.

The clearance of vegetation to provide for the establishment of sand mining operation constitutes a change to the natural landscape. Further changes occur during the mining and transporting of mined deposits. Mining operations result in the development of excavations of various dimensions at the settings (Sreebha and Padmalal, 2008). Similarly, Bansah et al. (2018) observed landscapes of abandoned unstable piles of soil/rock, excavated pits and vast areas of barren land are common features at informal artisanal small scale mining. Most of these excavations are not rehabilitated. This not constitutes change of land use and land cover only, but also a change on ecosystem goods and

services (Nguru, 2007). The excavations hold rain water and creating a breeding ground for mosquitoes that cause waterborne diseases (Bansah et al., 2018).

2.5 Socio-economic Impacts of Sand and Gravel Mining

According to Asabonga et al. (2017), impacts are potential changes caused, directly or indirectly, in whole or in part, for better or for worse by industrial development activities. Therefore, socio-economic impact can be defined as changes to the social and/or economic conditions of a community, whether adverse or beneficial, wholly or partially resulting from the activities products or services of an organization/ industry.

Social-economic impacts are an amalgam form of environmental, social and economic factors. Mngeni et al. (2017) maintain that sand mining operations have impacted, in one way or another on the economic, social and environmental aspects of human in mining areas. The impacts led to continuous confrontations between citizen groups, governmental agencies, and the mining industry (Nguru, 2007; Madyise, 2013). The degree of conflict and its nature usually deepened on the current land use and the estimated consequences of observed disturbances. The following sections provide a brief explanation of the socio-economic impacts of sand and gravel mining.

2.5.1 Noise and dust pollution

Sand and gravel operations employ mining methods that use manual or mechanical means to mine sand and gravel deposits from their settings. The mechanical means involve using machines such as bulldozers, front loaders, track hoes, and scraper graders (Langer, 2003). This equipment makes noise and generates dust while carrying out sand and gravel mining activities. Also, the trucks transporting the material to stock piling sites and customers generate noise and dust.

Generated dust and noise produce pollution that affects the environment and people surrounding the mining operation. This claim is aligned with the findings of the study that assessed and evaluated environmental impacts of mining pit sand, river sand and gravel extraction for urban development in the expansion of Gaborone City in Botswana (Madyise, 2013). According to Pitchaiah (2017), large quantities of dust emitted to the atmosphere during sand mining cause respiratory disorders, and noise disturb sleep as most of the mines operate 24 hours. These impacts relating to mining operations worry the youth of Wa area in Ghana (Peprah, 2013).

The respiratory disorder sand and gravel mining operations have caused possibly have financial implications to the affected residents. The respiratory disorder will force the residents to seek medical attention that does not come cheap. This can also affect the ability residents with respiratory disorder to perform some physical duties they use to perform, consequently loss of income.

2.5.2 Infrastructure damage

Sand and gravel deposits are not found everywhere. Without a doubt mining operations of sand and gravel are found at the deposits settings. Some of the deposits settings have existing land uses that maybe affected during the mining of sand or gravel. Thus, most of the mining operations have caused massive damage to public infrastructure and private properties. The study conducted at Tangail District of Bangladesh reveals that activities associated with sand and gravel mining caused considerable damage to Haji-para road (Khan, 2015). Pitchaiah (2017), and Farahani and Bayazidi (2018) claim that heavy vehicles transporting sand cause massive damage to the roads and bridges.

In Dedura Oya in Sri Lanka, the sand mining operations caused complete damage to an ancient dam constructed about 1,500 years ago (Padmalal and Maya, 2014). The operations induce soil erosion that puts the properties adjacent riverbanks and coastal areas at risk of collapsing (Adedeji et al. 2014; Khan, 2015). In the Lusada area of Nigeria, the operations caused damage to electric power lines (Adedeji et al., 2014).

The damage caused to the properties and infrastructure obviously has financial implications to the government and the owner the affected private properties. The government will have to use public funds to fix the roads, bridges and electricity infrastructure damaged during sand and gravel mining. The owner of damage properties will be forced to fix damages caused to their properties and to implement measures to control sand mining induces soil erosion that may cause further damage to their properties. These are the external cost explained in the study “External costs of sand mining in rivers: Evidence from South Africa” by De Lange et al. (2009).

2.5.3 Loss of agricultural land

Some of the agriculture fields are located on top of sand deposits. Sand miners intrude the agricultural fields to mine sand deposits, consequently reducing the agricultural fields (Ako et al., 2014). Mining operations of sand and gravel cause loss of cultivation and grazing fields in Ghana (Baba, 2016; Peprah, 2013; Musah, 2009), in Iran (Farahani and Bayazidi, 2018), in Vietnam (Dung, 2011), in India (Devi and Rongmei, 2015), and in Kenya (Gitonga, 2013). Sand mining erodes the productive soil

suitable for cultivation and removes the vegetation that livestock feed on. This concurs with the findings of the study conducted in the Luku area of North Central Nigeria (Ako et al., 2014). The destruction and reduction of agriculture fields have far-reaching consequences to the community depending on agriculture activities for livelihood.

The loss of agricultural lands has a direct impact on food security and livelihood. One of the informants in the study conducted by Baba (2017) said:

> *'Many farmers in the sand mining areas are under constant threat of losing their lands to sand miners. Some go to their farms only to realise that parts of their lands had been removed over night by sand miners. Several acres of farmlands are lost daily through the activities of sand mining. This situation is not good for agriculture and food security in the communities and the region as a whole'.*

Similarly, Dung (2011) observed that mining operations of sand have affected farmers who cultivate rice, maize spinach, kohlrabi, and cabbage on the banks of the Cau River in Vietnam. This possibly will make the affected farmers desperate and poor. "The livelihood sources of these farmers are shaken leading to the deterioration in their living standards" (Baba, 2017). According to Baba (2017), this situation leads to conflicts between the chiefs, the sand miners, landowners, and farmers in the communities.

2.5.4 Child labour

Sand and gravel mining is not immune from the use of child labour. The industry has attracted pupils of Machakos County in Kenya (Nthambi and Orodho, 2014). Mngeni et al. (2017) observed teenagers among the workers loading sand at Chwebeni, Mngazi and Coffee Bay areas of Eastern Cape Province in South Africa. Some pupils neglect school lessons to mine sand and others choose to engage in sand mining outside the school hours and days. Bansah et al. (2018) observed that child participating in informal artisanal scale mining develop a lack of interest in education, truancy, poor academic performance, and insolence towards education officials.

According to Onwuka et al. (2013), the income generated from mining operations makes pupils lose interest in education and this promotes illiteracy among the inhabitants. This practice probably hinders the development of a country. A lack of opportunity for higher education for pupils deprives the nation of developing higher skills and technological capacities required for economic development and solving problems facing the nation. Edmonds and Theoharides (2020) assert that widespread child employment dampers future economic growth through its negative impact on child development and

depresses current growth by reducing unskilled wages and discouraging the adoption of skill-intensive technologies.

2.5.5 Employment opportunities

The importance of sand and gravel in the construction industry cannot be overemphasized. The materials are core to civil works (Adedeji et al. 2014). Thus, the materials are mined from their settings to supply the construction industry. Apart from being a profitable activity, sand mining provides direct and indirect employment opportunities to truck drivers, excavator operators, clerks, bricklayers, brick-makers and construction workers. The study conducted in Gaborone City of Botswana shows that sand mining has provided locals with employment (Madyise, 2013).

According to Mngeni et al. (2017), sand mining serves as income generator for the Chwebeni and Mngazi communities. Chwebeni and Mngazi communities use sand mining proceeds to build churches and community hall (Mngeni et al., 2017). Also, Chwebeni community uses sand mining proceeds to contribute towards funeral arrangements of any of their community member.

De Lange et al. (2009) argue that the benefits of sand mining are far less than the external costs associated with sand mining. This dispute is based on the fact that sand mining has negative impacts on the aesthetics and ecological functioning of estuarine system, with consequent adverse knock-on effects on key local industries such as tourism and fisheries. Thus, De Lange et al. (2009) argue that sand mining should only be allowed as long as the benefits of doing so out-weight the opportunity costs in terms of the goods and services foregone once the resource is depleted.

2.6 Management of Sand and Gravel Mining in Selected Countries

It is a definite fact that natural resources contribute significantly to the economic development of nations around the world. The same can be said about natural sand and gravel resources. The resources play an important role in the construction industry that provides the nations with necessary infrastructures. However, their increased demand gives rise to various problems requiring urgent action by the authorities (Dung, 2011). The problems include landslides, soil erosion, loss of vegetation and habitat, loss of agricultural land, abscond from school and infrastructure damage (Ladlow, 2015; Arwa, 2013).

The problems oblige authorities to make efforts to manage the mining operation of sand and gravel conducted within their jurisdictions. According to Padmalal and Maya (2014), nations have binding legal policy regulations to control and monitor sand mining operations within their jurisdictions. The United

States of America is the first country to recognize problems of indiscriminate mining operations and put efforts to deal with the problems since the 1970s (Sreebha, 2008).

A Quick Scoping Review was used to survey the scientific literature that describe the management practices of sand and gravel mining. This structured objective approach involved reviewing papers obtained by searching scientific databases using terms relevant to the objective 'to examine the current management practices of sand and gravel mining in the area'. All papers that were relevant to the objective were categorized by geographic location, presence of regulatory framework, environmental and socio-economic impacts, rehabilitation of mined sites and enforcing compliance in sand mining industry. Thus, a Quick Scoping Review offered every country a fair chance to be selected.

The selection of the following countries was influenced by the availability of scientific studies that provide information about the management practices of sand and gravel mining in these countries. The country had to have studies that provide information about the legal framework for sand mining, enforcing compliance with such legislation, and actions of miners to reduce the impacts of the mining operations.

2.6.1 In Malaysia

The populace of Malaysia practices sand mining as other nations around the world. Ashraf et al. (2011) assert that the activity is of great importance to the Malaysian economy. However, instream mining may be the least regulated of all mining activities and regulations vary by state. Despite the numerous prohibitions and regulations, the Selangor state of Malaysia has continuing illegal sand mining. Mined areas are left unrehabilitated. In an attempt to deal with the problems of sand mining, the Department of Irrigation and Drainage in Malaysia has approved a set of river sand mining management guidelines in 2009 (Dug, 2011). The guidelines aimed to ensure sustainable mining of sand and seek to maintain the river equilibrium with the application of sediment transport principles in determining the locations, period, and quantity of sand and gravel to be extracted.

2.6.2 In the United States of America

In the United States of America, mining sand and gravel is an ancient practice. Thus, efforts to deal with problems relating to overexploitation of sand for building constructions and other infrastructural development were put in the 1970s (Sreebha, 2008). For example, in California, the operations conducted in rivers and streams are regulated under the Surface Mining and Reclamation Act of 1975

with 113 different counties and cities designated as lead agencies for approving reclamation plans and issuing special permits (Kondolf, 1994). The act requires the miners to submit to a lead agency a reclamation plan describing the existing environment, the intended ultimate reclamation of the site, and how adverse environmental effects will be prevented. Peckenham (2009) revealed that USA regulations for mining operations of sand and gravel are inferred to provide some protection to water resources.

And, California Environmental Quality Act of 1970 requires thorough environmental impact analyses for instream mines and the lead agency would ensure that requirements for environmental assessment are satisfied, including analysis of alternatives to the proposed project and public notice (Kondolf, 1994). The operations are required to comply with California Fish and Game Code and Clean Water Act Section 404 through applying for a streambed alteration agreement and a permit, respectively. Kondolf (1994) argues that despite numerous existing requirements, the cumulative impacts of instream aggregate extraction in California are rarely analyzed thoroughly, and comprehensive analysis of alternatives is rarely performed. To address this shortcoming Kondolf (1994) proposes that in the present lead agency system, county planning departments need more technical expertise to monitor and evaluate instream extraction.

2.6.3 In India

Similar to the United States of America, Indian government enacted laws that regulate mineral extraction or mining activities that cause environmental problems. Sand and gravel form part of the minerals regulated through those laws. Padmalal and Maya (2014) state that Indian Parliament enacted the Mines and Mineral Act (Development and Regulation) of 1957 to regulate mines and development of all minerals in India including the building materials that comes under the Minor Minerals Category. Section 15 (1) of the Mines and Mineral Act empowers the state government to pass rules for regulating the mining or quarrying of minor minerals hence the Government of Kerala passed the legislation called Kerala Protection of River Banks and Regulation of Removal of Sand Act in 2001. This act provides for undertaking of periodical sand auditing to evaluate the feasibility of the sand mining operations in the rivers of Kerala (Padmalal and Maya, 2014). Padmalal and Maya further indicate that environmental and forest conservation laws are used to influence the resources extraction sector.

According to Mitra and Singh (2014), Haryana state of India has experienced large scale legal and illegal mining of construction material heeding to increasing demand of construction resources but not caring for the provisions made in several central legislations for conservation of environment and mineral resources. Similarly, Devi and Rongmei (2015) have observed that India continues to

experience indiscriminate and illegal mining operations of sand and gravel. Saviour (2012) claims that weak governance and rampant corruption facilitates illegal mining that pose depletion of water resources. Saviour (2012) proposes that laws have to be enforced in an efficient and unbiased way and decisive steps be taken for environmental solution.

2.6.4 In Kenya

Kenya is not immune to the challenges of indiscriminate mining operations of sand and gravel (Gitonga, 2017; Muendo, 2015; Arwa, 2013). The challenges are tackled through the National Sand Harvesting Guidelines of 2007, Environmental Management and Coordination Act of 1999, Mining Act of 2016, County Government Act of 2012 and Environmental Impact Assessment and Audit Regulations of 2003 (Gitonga, 2017; Arwa, 2013). However, Arwa (2013) asserts that none of these legislations undertake the mandate of governing sand harvesting in totality, they touch on sand management as a resource than the process of sand harvesting. This has led to indiscriminate mining of sand in Kenya. Accordingly, Gitonga (2017) and Arwa (2013) blame the inadequacy of the legislation and institutions governing sand harvesting for proliferated indiscriminate mining operations in the country.

Arwa (2013) has found that miners do not rehabilitate the areas where they extracted sand as required by the sand harvesting guidelines. Thus, Arwa (2013) asserts that the sand harvesting guidelines are as good as non-existent as they lack punitive measures that should be undertaken if the provisions are not adhered to. On the other hand, a lack of enforcement capacity and insufficient resources took the blame for the illegal and indiscriminate sand mining. Gitonga (2017) has observed that sand miners in Machakos County are not aware of the regulations governing sand harvesting in the country. This could be the other reason for the proliferating illegal and haphazard sand mining operations in this country.

2.6.5 In Ghana

Sand mining in the Wa area of Ghana is a lucrative business operating under informal sector conditions such as free entry and exit, small scale, unregistered, unregulated by relevant state institutions, the requirement of small startup capital, reliance on local manual labour and small local market (Peprah, 2013). The industry is regulated under Ghana's Mineral Act 703 of 2006 and the act categorizes sand and gravel as industrial minerals. However, the qualification for minerals right is skewed in favour of large and medium scale companies (Peprah, 2013).

Musah and Barkarson (2009) observed that Environmental Protection Agency Act 1994 and the Minerals and Mining Amendment Act 1993 are primary acts that seek to protect the environment and

regulate mining. However, the acts do not give explicit definitions on closure standards and specifications, particularly regarding gravel mining. The government of Ghana empowered the Environmental Protection Agency to regulate and impose fines on illegal sand miners (Peprah, 2013). Despite the existence of the acts and the agency, compliance and sustainable mining of sand and gravel is yet to be realized. This is because regulation of the mining operations is lacking (Musah and Barkarson, 2009).

2.6.6 In Nigeria

Nigeria is not immune to sand and gravel mining and its problems (Adedeji et al., 2014; Lawal, 2011). The country uses the Nigerian Minerals and Metal Act, Mining regulations, and other extant laws such as that of the council of Nigerian Mining Engineers and Geoscientists to regulate the mining of sand and gravel (Akanwa and Ikegbunam, 2017). The Nigerian senate committee on the environment has shutdown 15 quarries in Cross River State that were operating illegally and not complying with the policies of the State (Akanwa and Ikegbunam, 2017). Despite this effort, the country continues to experience illegal mining of sand and gravel (Adedeji et al., 2014). The operations leave behind landscapes characterized by water ponds, heaps of quarry remains, and widespread erosion (Akanwa and Ikegbunam, 2017). A lack of enforcement of bye-laws and guidelines for quarrying operations gives the companies and contractors the freedom to open and abandon quarries haphazardly without considering the proximity of the quarries to communities and their lands (Akanwa and Ikegbunam, 2017). Lawal (2011) proposes that the state government should evolve a policy compelling the miners to reinvest and repair the old mine sites.

2.7 Management of Sand and Gravel Mining in South Africa

As the country that hosts the study area, South Africa is accorded a special standalone section on the management of sand and gravel mining. This is done to provide a comprehensive review of the literature and legislative framework for sand and gravel mining. The section identifies and provides institutions, statutes, and legislative provisions that apply to sand and gravel mining. It also covers issues on enforcing compliance and rehabilitation of areas affected by sand and gravel mining.

Comparable to other countries, South Africa has a legislative framework that regulates sand and gravel mining. However, the country continues to experience environmental problems associated with indiscriminate and illegal operations (Amponsah-Dacosta and Mathada, 2017; Asabonga et al., 2017; Kori and Mathada, 2012). Amongst the problems identified is the excessive growth of invasive alien

vegetation at mine sites that are not rehabilitated (Chevallier, 2014). In the Limpopo Province, Nzhelele valley provides an example of mined sites which do not receive rehabilitation attention (Amponsah-Dacosta and Mathada, 2017). The environmental problems or impacts associated with sand/gravel mining could be resulting from the failure to implement legislation regulating the sector.

The following sections outline the laws and institutions that regulate sand and gravel mining. The laws and institutions give effect to the Constitution of the Republic of South Africa, 1996, particularly Right 24 of the Bill of Rights which states:

> *"Everyone has the right –*
>
> *(a) to an environment that is not harmful to their health or well-being; and*
>
> *(b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that –*
>
> *(i) prevent pollution and ecological degradation;*
>
> *(ii) promote conservation; and*
>
> *(iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."*

2.7.1 Regulatory framework for sand and gravel mining

The regulatory framework regulating sand and gravel mining gives effect to the Constitution of the Republic of South Africa. The enacted laws and established institutions strive for sustainable development of mineral resources including natural sand and gravel resources while promoting environmental conservation and justifiable economic and social development. Sand and gravel mining are currently controlled through mineral regulation, environmental regulation and land use planning regulation (Green, 2012). The statutes used include the National Environmental Management Act (1998), National Water Act (1998), National Environmental Management: Protected Areas Act (2003) and Mineral, Petroleum Resources Development Act (2002) and provincial ordinances together with municipal bylaws. Accordingly, any person intending to mine sand/gravel must apply to the Department of Mineral Resources and Department of Water and Sanitation for mining right or permit and water use license, respectively (Chevallier, 2014).

2.7.1.1 Mineral regulation

The institution responsible for mineral regulation in South Africa in the Department of Mineral Resources and the primary statute used is the Mineral and Petroleum Resources Development Act 28

of 2002 (MPRDA). This statute governs mineral resources and regulates the process of mining the resources (Green, 2012). Sand and gravel resources are minerals according to MPRDA. This is found in the definition of mineral in MPRDA.

> Mineral as defined in MPRDA *"means any substance, whether in solid, liquid or gaseous form, occurring naturally in or on the earth or in or under water and which was formed by or subjected to a geological process, and includes sand, stone, rock, gravel, clay, soil and any mineral occurring in residue stockpiles or in residue deposits,".*

Accordingly, any person who wishes to mine sand/gravel is subject to the requirements of the MPRDA. Section 5A of the MPRDA stipulates that a person may mine any mineral including sand and gravel if such a person has an environmental authorisation, mining permit, or right and had given the landowner or lawful occupier of the land to be mined at least 21 days written notice.

MPRDA specifies that the State is the custodian of mineral resources occurring in the country. The statute obliges the State to protect the environment for the benefit of present and future generations, to ensure ecologically sustainable development of mineral resources and to promote economic and social development. Thus, any person wishing to mine sand or gravel from the environment must apply to the State for the right to do so.

MPRDA empowers the Minister of the Department of Mineral Resources to grant, issue, refuse, control, administer, and manage the following: reconnaissance permission, prospecting right, permission to remove, mining right, mining permit, retention permit, technical co-operation permit, reconnaissance permit, exploration right and production right (Green, 2012). A sand/gravel mine would require mining right or permit depending on the footprint and duration of the mining operation. A mining permit is issued in terms of section 27 of MPRDA to operation within five hectares and the permit is valid for two years. The validity period of mining right granted in terms of section 23 may not exceed 30 years. MPRDA provides for the renewing of both the permit and right.

2.7.1.2 Environmental regulation

The environmental regulation of sand and gravel mining is done through the National Environmental Management Act No. 107 of 1998, Mineral and Petroleum Resources Development Act No. 28 of 2002, National Environmental Management: Protected Areas Act No. 57 of 2003 and National Water Act No. 36 of 1998. The latter Act is administered by the Department of Water and Sanitation whereas the

Department of Mineral Resources administers the post Acts. These statutes impose various obligations to promote conservation and sustainable development of environmental resources.

National Environmental Management Act

The National Environmental Management Act No. 107 of 1998 ("NEMA") is the primary statute governing environmental management in South Africa. This statute regulates human activities that have the potential to cause environmental pollution or degradation. Due to potential environmental consequences associated with mining, sand/gravel mining is subject to NEMA provisions. The statute has obligations to safer guard environmental quality through regulating human activities. These obligations are imposed through three types of regulatory mechanisms that are guided by the environmental principles set out in section 2 of the statute. The mechanisms are a duty of care, specific prohibitions and obligations, and licensing provisions. Each mechanism is used to exercise different levels of control and intervention. For example, a duty of care imposes a general requirement regarding the conduct that is expected of the regulated community without specifying how the duty must be discharged whereas licenses result in detailed and specific control of an activity on an individual basis. One can ask if sand/gravel mining is subject to a duty of care, specific prohibitions and obligations, and licensing provisions. The following sections outline how these obligations regulate sand and gravel mining.

Duty of care

This concept refers to the responsibility or legal obligation of a person or organization to foresee and reasonably avoid acts that might significantly cause harm to others and the environment. Section 28 of NEMA provides for a duty of care. This imposes a duty to everyone who has caused or may cause significant harm to the environment to take reasonable measures to prevent such harm from occurring, continuing or reoccurring, or in so far as such harm to the environment is authorized by law or cannot reasonably be avoided or stopped, to minimize and rectify such pollution or degradation of the environment. Duty of care has a retrospective effect as it is imposed on everyone who causes or has caused significant pollution or environmental degradation. In the event where a person fails to comply with the provisions of section 28 of the NEMA, the Act imposes liability on such person that may be in a form of civil or criminal penalties wherein the perpetrator has to pay a certain amount of money to remedy the harm done to the environment (Chauke, 2017).

Sand/gravel mining has the potential to cause significant environmental degradation. Thus, miners are obliged to take reasonable measures to ensure that their mining activities do not cause significant

degradation of the environment (Green, 2012). Where the miner fails to honour this obligation the Department of Mineral Resources has the power to enforce section 28 of NEMA. The Department can enforce section 28 against any sand miner whether or not such a miner has any permit or authorisation. Green (2012) states that section is a useful tool to use against any person who is causing significant degradation of the environment whether or not such person is legally authorised to do so. Section 28 (4) empowers the Director-General or a provincial Head of Department to direct any person who fails to take reasonable measures to prevent degradation of the environment to commence taking such reasonable measures.

Licensing or authorizing of an activity

Another way of regulating human activities with the potential to cause environmental degradation is through licensing. A license or authorisation contains a number of specific conditions that must be adhered to when conducting authorized development. Licensing of activities is provided for in section 24 of NEMA. This section empowers the Minister of Environmental Affairs to identify and publish a list of activities with potential impacts on the environment. The impacts must before undertaking a listed activity be considered, investigated, assessed and reported to the competent authority. Based on the reports the competent authority would grant or deny authorisation.

The listed activities are published under three listing notices as per section 24 (2) of NEMA. For proper administration of the applications to undertake listed activities, the statute empowers the Minister to make regulations which set out the procedure for and requirements of applying to a competent authority for an environmental authorisation. The regulations are called Environmental Impact Assessment Regulations ("EIAR"). The Environmental Impact Assessment Regulations Listing Notices of 2014 were consulted to verify if sand/gravel mining is among the activities that require an environmental authorisation in terms of section 24 of NEMA.

The Environmental Impact Assessment Regulations Listing Notice 1 of 2014 was reviewed to check activities associated with or incidental to, the activity of sand/gravel mining one finds the following activities listed:

Activity 19

> *"The infilling or depositing of any material of more than 10 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 10 cubic metres from a watercourse; …."*

Considering the study area, a sand miner would trigger this activity if his/her activity is within a watercourse and excavates more than 10m³. Miners are likely to trigger this activity because they mine river sand and they use 6 to 10m³ trucks to load it. The miners target sand abundance rivers and mine sand until they deplete it. Accordingly, such miners must apply for environmental authorisation as they are engaged in a listed activity. They ought to asses, investigate, and communicate the potential impact of their activity following the procedure as prescribed in regulations 19 and 20 of the Environmental Impact Assessment Regulations, 2014. An application form together with information required in terms of regulation 19 must be submitted to the competent authority, in this case, the Minister for Mineral Resources.

Activity 19A

"The infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 5 cubic metres from—

(i) the seashore;

(ii) the littoral active zone, an estuary or a distance of 100metres inland of the high-water mark of the sea or an estuary, whichever distance is the greater; or

(iii) the sea; …"

This activity can only be trigger by the miners who operate within the areas specified. A sand miner operating within the study area would not trigger this activity as the specified areas do not apply to the study area.

Activity 21

"Any activity including the operation of that activity which requires a mining permit in terms of section 27 of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002), including —

(a) associated infrastructure, structures and earthworks, directly related to the extraction of a mineral resource; or

(b) the primary processing of a mineral resource including winning, extraction, classifying, concentrating, crushing, screening or washing;

but excluding the secondary processing of a mineral resource, including the smelting, beneficiation, reduction, refining, calcining or gasification of the mineral resource in which case activity 6 in Listing Notice 2 applies."

As explained in the mineral regulation section sand/gravel mining would require either mining permit or mining right depending on the footprint and duration of the mining operation. A mining permit is issued in terms of section 27 of MPRDA to an operation with a footprint of fewer than five hectares and the

permit is valid for two years. Accordingly, a miner who undertakes sand mining activity which requires a mining permit will automatically trigger Activity 21 of the Environmental Impact Assessment Regulations Listing Notice 1 of 2014, therefore, be subject to section 24 of NEMA. The miner has to apply for an environmental authorisation following the procedure as prescribed in regulations 19 and 20 of the Environmental Impact Assessment Regulations, 2014.

Activity 22

"The decommissioning of any activity requiring –

(i) a closure certificate in terms of section 43 of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002); or

(ii) a prospecting right, mining right, mining permit, production right or exploration right, where the throughput of the activity has reduced by 90% or more over a period of 5 years excluding where the competent authority has in writing agreed that such reduction in throughput does not constitute closure;

but excluding the decommissioning of an activity relating to the secondary processing of a –

(a) mineral resource, including the smelting, beneficiation, reduction, refining, calcining or gasification of the mineral resource; or

(b) petroleum resource, including the refining of gas, beneficiation, oil or petroleum products; –

in which case activity 31 in this Notice applies."

It is a fact that sand/gravel resources get depleted over time and any mining operation of these resources has a limit. Accordingly, sand mining operating under mining permit or right would trigger this activity when it ceases operation. Notwithstanding the latter, operations that are supposed to operate under permit but did not have they still trigger Activity 22. Thus, the operation owner is subject to section 24 of NEMA and must apply for an environmental authorisation following the procedure as prescribed in regulations 19 and 20 of the Environmental Impact Assessment Regulations, 2014.

Activity 27

"The clearance of an area of 1 hectare or more, but less than 20 hectares of indigenous vegetation, except where such clearance of indigenous vegetation is required for-

(i) the undertaking of a linear activity; or

(ii) maintenance purposes undertaken in accordance with a maintenance management plan."

Studies show that before mining of sand, a sand miner would clear off vegetation around the mining site (Farahani and Bayazidi, 2018, Akoet al., 2014; Green, 2012). The miner would trigger this activity if the site being cleared off its vegetation is a hectare or more and such an area was never disturbed in the preceding ten years. Accordingly, such a miner would be required to investigate, assesses, and

communicate the potential impact of the activity following the procedure prescribed in regulations 19 and 20 of the Environmental Impact Assessment Regulations, 2014. An application form together with information required in terms of regulation 19 ought to be submitted to the competent authority, in this case, the Minister for Mineral Resources.

The other listing notice reviewed to check listed activities associated with sand or gravel mining is Environmental Impact Assessment Regulations Listing Notice 2 of 2014. The review exposed the following:

Activity 15

> *"The clearance of an area of 20 hectares or more of indigenous vegetation, excluding where such clearance of indigenous vegetation is required for-*
>
> *(i) the undertaking of a linear activity; or*
>
> *(ii) maintenance purposes undertaken in accordance with a maintenance management plan."*

Studies show that before mining of sand, a sand miner would clear off vegetation around the mining site (Akoet al., 2014; Green, 2012). The miner would trigger this activity if the site being cleared off its vegetation is 20 hectares or more and such an area was never disturbed in the past ten years. Accordingly, such a miner would be required to investigate, assess and communicate the potential impact of the activity following the procedure as prescribed in regulations 21, 22, 23 and 24 of the Environmental Impact Assessment Regulations, 2014. An application form together with information required in terms of the latter regulations must be submitted to the competent authority, in this case, the Minister for Mineral Resources.

Activity 17

> *"Any activity including the operation of that activity which requires a mining right as contemplated in section 22 of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002), including—*
>
> *(a) associated infrastructure, structures and earthworks, directly related to the extraction of a mineral resource; or*
>
> *(b) the primary processing of a mineral resource including winning, extraction, classifying, concentrating, crushing, screening or washing;*
>
> *but excluding the secondary processing of a mineral resource, including the smelting, beneficiation, reduction, refining, calcining or gasification of the mineral resource in which case activity 6 in this Notice applies."*

As explained in the mineral regulation section sand/gravel mining would require either mining permit or mining right depending on the footprint and duration of the mining operation. Mining right is issued in terms of section 22 of MPRDA. It can be assumed that the right is issued to an operation with a footprint of more than five hectares and the right could be valid for thirty years. Accordingly, a miner who undertakes sand mining activity which requires a mining right will automatically trigger Activity 17 of the Environmental Impact Assessment Regulations Listing Notice 2 of 2014, therefore, be subject to section 24 of NEMA. The miner has to apply for an environmental authorisation following the procedure as prescribed in regulations 21, 22, 23 and 24 of the Environmental Impact Assessment Regulations, 2014. An application form together with information required in terms of the latter regulations must be submitted to the competent authority, in this case, the Minister for Mineral Resources.

The Environmental Impact Assessment Regulations Listing Notice 3 of 2014 is the last notice reviewed.

The following activities associated with sand mining were revealed:

Activity 4

"The development of a road wider than 4 metres with a reserve less than 13, 5 metres.

e. Limpopo:

ii. Outside urban areas, in:

(a) A protected area identified in terms of NEMPAA, excluding disturbed areas;

(b) National Protected Area Expansion Strategy Focus areas;

(c) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority;

(d) Sites or areas identified in terms of an international convention;

(e) Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans;

(f) Core areas in biosphere reserves; or

(g) Areas within 10km from national parks or world heritage sites or 5km from any other protected area identified in terms of NEMPAA or from the core areas of a biosphere reserve, excluding disturbed areas;.."

Sand deposits are found in various areas. Some of the areas have existing roads and others do not have roads. Most of the areas without roads would be covered with vegetation. So, for a miner to access the gravel deposits area, an access road is developed (Baba, 2016; Green, 2012). This would result in the clearance of vegetation. It is possible that the miner develops a road with a width that is more than four metres within one of the areas identified in Activity 4. If the miner to access sand

deposits site needs to construct an access road that miner must first establish if the road development would not trigger Activity 4. Where the latter is triggered the miner must first apply for environmental authorisation following the procedure as prescribed in regulations 19 and 20 of the Environmental Impact Assessment Regulations, 2014.

Activity 12

> *"The clearance of an area of 300square metres or more of indigenous vegetation except where such clearance of indigenous vegetation is required for maintenance purposes undertaken in accordance with a maintenance management plan.*
>
> ***e. Limpopo***
>
> *i. Within any critically endangered or endangered ecosystem listed in terms of section 52 of the NEMBA or prior to the publication of such a list, within an area that has been identified as critically endangered in the National Spatial Biodiversity Assessment 2004;*
>
> *ii. Within critical biodiversity areas identified in bioregional plans; or*
>
> *iii. On land, where, at the time of the coming into effect of this Notice or thereafter such land was zoned open space, conservation or had an equivalent zoning."*

Studies show that before mining of sand, a sand miner would clear off vegetation around the mining site (Akoet al., 2014; Green, 2012). The miner would trigger this activity if the site being cleared off its vegetation is 300m² or more and within a specified area that was not disturbed in the preceding ten years. Accordingly, such a miner would be required to investigate, assess and communicate the potential impact of the activity following the procedure as prescribed in regulations 19 and 20 of the Environmental Impact Assessment Regulations, 2014. An application form together with information required in terms of regulation 19 ought to be submitted to the competent authority, in this case the Minister for Mineral Resources.

National Environmental Management: Protected Areas Act

This statute, the National Environmental Management: Protected Areas Act No. 57 of 2003 gives effect to the environmental right enshrined in the Constitution of the Republic. The statute intends to promote the conservation of natural resources through proclaiming areas as protected areas and restricting certain activities within the proclaimed areas. Amongst the activities restricted in the protected areas is mining. Accordingly, NEM: PAA regulates mining and prospecting activities in a special nature reserve or nature reserve, protected environment and protected areas. Sections 48 (1) (a) and (c) of the statute prohibit conducting commercial prospecting or mining activity in a special nature reserve or nature reserve and some protected areas. Contrary to the latter sections, section 48 (1) (b) restricts conducting

commercial prospecting or mining activities in a protected environment if such activity has no written permission from the Minister. Thus, mining operations is conducted in a special nature reserve, nature reserve, protected environment or protected areas will be subject to the provisions of the NEM: PAA. Section 89 of the statute makes it a punishable offense to contravene section 48 (1) and it also prescribes penalties.

Mineral and Petroleum Resources Development Act

The primary purpose of the statute, Mineral and Petroleum Resources Development Act No. 28 of 2002 ("MPRDA") is to ensure sustainable development of mineral and petroleum resources of the country. The statute regulates the process of mining and exploring resources. However, as a secondary concern, the statute also governs environmental issues associated with the development of mineral and petroleum resources.

The statute gives effect to environmental right enshrined in section 24 of the Constitution of the Republic by promoting environmental protection for the benefit of present and future generations. The statute has provisions to ensure the ecologically sustainable development of mineral and petroleum resources and to promote economic and social development. Section 5 (d) of the statute states the use of water for mining, prospecting, or exploration of minerals or petroleum is subject to the National Water Act. Section 5A read with sections 16, 22, and 27 provides that person may mine or remove any mineral if that person has an environmental authorisation issued in terms of section 24 of the National Environmental Management Act. To strengthen latter sections, section 38A (2) provides that *"An environmental authorisation issued by the Minister shall be a condition prior to the issuing of a permit or the granting of a right in terms of this Act."*

The statute considers the environmental management principles set out in section 2 of the National Environmental Management Act. This is found in section 37 of the statute. The section states that the environmental management principles serve as guidelines for the interpretation, administration, and implementation of the environmental requirements of MPRDA. Green (2012) asserts that the incorporation of these environmental principles into MPRDA serves to strengthen the link between mineral regulation and environmental regulation. Green further states that the latter makes it clear that mineral exploitation cannot take place in the absence of environmental responsibilities.

It is interesting to observe that the statute has provisions that impose environmental responsibility post the mining. This is set in section 43 which provides that:

> *"The holder of a prospecting right, mining right, retention permit, mining permit, or previous holder of an old order right or previous owner of works that has ceased to exist, remains responsible for any environmental liability, pollution, ecological degradation, the pumping and treatment of extraneous water, compliance to the conditions of the environmental authorisation and the management and sustainable closure thereof, until the Minister has issued a closure certificate in terms of this Act to the holder or owner concerned."*

"Thus, miners are obliged to manage all environmental impacts during mining and are responsible for rehabilitating the mined area after the cessation of mining" (Green, 2012). Another provision linked to rehabilitation of the mined area is section 46 that empowers the Minister to remedy environmental damage in certain instances. The instances include but not limited to where the holder of required licenses cannot be traced or in the case of a juristic person, have ceased to exist, have been liquidated, or cannot be traced. In these instances, the Minister would take the necessary measures to prevent pollution, or ecological degradation of the environment or to rehabilitate dangerous health and social occurrences or make an area safe.

The statute also promotes environmental conservation through restricting or prohibiting prospecting and mining on certain land. This is found in section 48 (1) that provides:

> *"Subject to section 48 of the National Environmental Management: Protected Areas Act, 2003 (Act No. 57 of 2003), and subsection (2), no reconnaissance permission, prospecting right, mining right may be granted or mining permit be issued in respect of—*
> *(a) land comprising a residential area;*
> *(b) any public road, railway or cemetery;*
> *(c) any land being used for public or government purposes or reserved in terms of any other law;*
> *(d) areas identified by the Minister by notice in the Gazette in terms of section 49."*

However, there are exemptions to this provision and those exemptions are outlined in section 48 (2) of the statute. For instance, the Minister would grant mining right or permit if the mining will take place within the framework of national environmental management policies, norms and standards; and granting such a rights or permits will not detrimentally affect the interests of any holder of a prospecting right or mining right.

National Water Act

The National Water Act No. 36 of 1998 is promulgated to ensure that water resources in South Africa are protected, used, developed, conserved, managed and controlled in ways that take into account, amongst other factors:

- Protecting aquatic and associated ecosystems and their biological diversity.
- Reducing and preventing pollution and degradation of water resources.

The Act does not explicitly provide for the regulation of sand and gravel mining. However, it intends to conserve and protect the water resources against the adverse impacts that could result from any activity including the mining operation. Accordingly, section 21 of the Act specifies a number of water use activities. According to Green (2012), a miner would engage in one of these water use activities specified in the Act,

- taking water from a water resource;
- impeding or diverting the flow of water in a watercourse; and/or
- altering the bed, banks, course or characteristics of a watercourse.

Sand mining operations conducted within a watercourse such as rivers or wetlands would trigger the latter two water use activities. The excavation of sand in the river channel will definitely impede and divert the flow of water in the river. The access roads and stockpiling spaces are in the most case located on the riverbanks, this result to bed or banks altering. A sand or gravel miner engaged in one of the water use activities must apply to the Department of Water and Sanitation for a water use license. Section 151 of the Act makes it a punishable offense to conduct a water use activity without authorisation in terms of the Act.

2.7.2 Enforcing compliance of regulatory framework

Previous sections presented statutes regulating sand and gravel mining in South Africa. This section gives a compliance overview. The statutes indeed mean to promote sustainable development of natural resources such as sand and gravel. Also, they mean to prevent pollution and ecological degradation and promote conservation. However, the promulgation of a statute is only the first step to promote sustainable development of natural resources and ecological conservation (Fang et al., 2009). There are critical steps needed to realize the purpose and objects of a statute. The second important step is compliance, getting the regulated community to fully implement the requirements (Paddock, 2005).

Without compliance, the statute will not achieve the desired results (Fang et al., 2009). To achieve compliance usually involves efforts to encourage and compel behavioral change needed because compliance does not happen automatically once statutes are passed (Shimshack, 2007). According to Fang et al. (2009), compliance is achieved through inspections, monitoring, and enforcement actions. Thus, enforcement action is found to be a compliance pillar. This is because enforcement action serves as a deterrent (Shimshack, 2007). According to Cohen (2000), the latter is influenced by the severity of punishment for a specific violation. This implies that if a sand miner is found and punished for contravening regulations other miners who learn about the punishment would strive to comply with the regulations to avoid similar punishment.

According to the previous section, South Africa has various statutes that regulate sand and gravel mining. Sand mining operations conducted in the country are obliged to comply with the statutes. Despite those statutes, the country continues to experience indiscriminate and illegal mining which threatens environmental quality (Chevallier, 2014) and sustainable development of sand and gravel resources. Chevallier observed that the frameworks governing sand mining lack the necessary financial and human resources capacities to support better environmental compliance. In addition, Amponsah-Dacosta and Mathada (2017) observed that the legislation and regulatory agenda for sand mining is vague and passive and these make enforcement difficult and complicated.

The challenges identified by Amponsah-Dacosta and Mathada (2017) contribute to the raising complaints associated with indiscriminate sand mining from the public. According to Chevallier (2014), private sector associations and legal sand miners call for better regulation in order to deter illegal sand mining. This is because of the proceeds and environmental impacts associated with illegal sand and gravel mining. It is evident from the literature that the regulatory framework for sand and gravel mining is not implemented. This is regardless of the enforcement tools the statutes provide for.

2.7.3 Rehabilitation of areas affected by sand mining

According to Tanner and Möhr-Swart (2007), rehabilitation means putting the land impacted by the mining activity back to a sustainable usable condition. Rehabilitation is also done to deal with the post-mining impacts. However, areas of sand and gravel mining in South Africa are hardly rehabilitated. Amponsah-Dacosta and Mathada (2017) observed excavations of sand mining turned into swimming pools in the Nzhelele River valley. This is a clear indication of unrehabilitated sites of sand mining. In the O. R. Tambo district, Eastern Cape Province of South Africa, unrehabilitated sand mining sites have caused land sliding and exacerbated soil erosion (Mngeni et al., 2017). These findings support the

finding by Chevallier (2014) who observed that the financial provision of R10 000 set out in NEMA is not enough to cover the expected costs of rehabilitating a 1.5 ha site, with the result that no restoration activities take place.

2.8 Summary of the Chapter

In this chapter, the methods used in sand and gravel together with the importance and the use of sand and gravel resources were identified and explained. Both environmental and socio-economic impacts of sand and gravel mining were identified and explained. The management practices of sand and gravel mining around the world and in South Africa were examined.

The literature shows that sand and gravel miners use manual and/or mechanical methods during mining. The selection of the method depends on the miner's choice and material mined. In most cases, gravel is mined through mechanical means such as the use of excavators. Literature also shows that most of the sand mined to supply the construction industry.

Studies reviewed show that sand and gravel mining have environmental and socio-economic impacts. The impacts include landslides, soil erosion, loss of vegetation and habitat, noise pollution and water pollution, damage to infrastructure, loss of agriculture fields, child labour and creation of employment opportunities. However, the beneficial impacts of sand and gravel mining are less than the adverse impacts.

Literature shows that countries around the world enacted statutes to deal with the adverse impacts of sand and gravel mining. South Africa uses the National Environmental Management Act, and Mineral and Petroleum Resources Development Act to regulated sand and gravel mining. These statutes were promulgated to ensure the conservation and development of natural resources including sand and gravel. However, the literature shows that sand and gravel miners operated outside the provisions of these statutes. DMR as a competent authority to regulate sand mining operations failed to enforce the provisions of these statutes. Also, to ensure that areas affected by sand and gravel mining are rehabilitated to prevent post mining impacts. The problems of sand and gravel mining persist due to lack of enforcing compliance, lack of capacity to monitor compliance, corruption, fragmented statutes, and lack of awareness campaign to disseminate information to miners.

In the next chapter, the methodology and the research design will be described. Methods of investigation such as the field survey and schedule meetings will be explained and their advantages and disadvantages highlighted.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the general strategy that explains the methods and procedures used during the research study. This is followed by the research design. Research design is followed by the description of a network of methods and procedures used to solve the research problem and to achieve the objectives. Methods and procedures for data collection and analysis are also explained. Figure 3.1 presents a flow chart for research methodology.

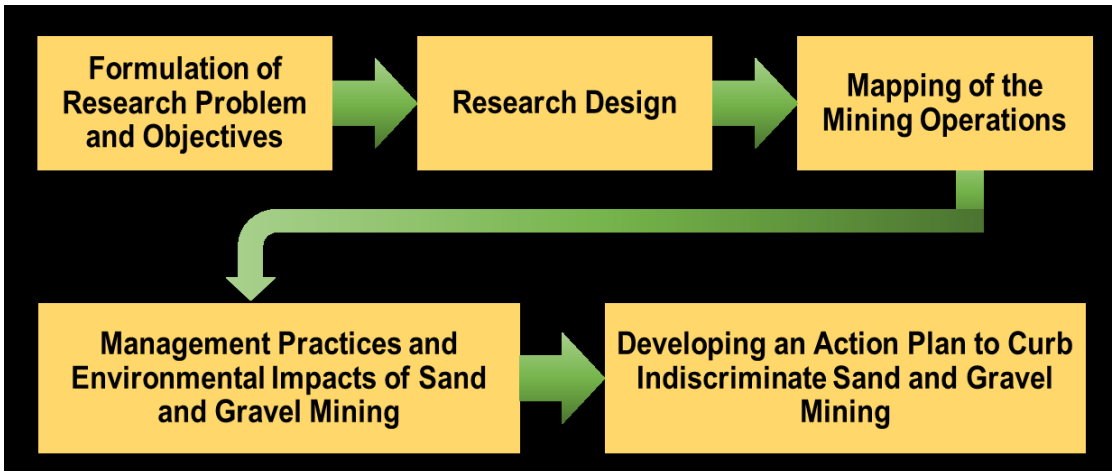

Figure 3.1: Flow chart of research methodology

3.2 Research Design

Empirical research describes, discovers, explains and predicts phenomenon through approaches that include qualitative, quantitative and mixed methods designs (Creswell, 2003). Thus, this study employed concurrent mixed methods design to describe, discover and explain sand and gravel mining in the Thulamela Local Municipality. This approach provided a complete understanding of the research problem that any of the two approaches (qualitative/ quantitative) would not provide. The approach was preferred because the objectives of the study required qualitative and quantitative data that could only be collected and analyzed through mixed methods. Amongst data collection instruments used are schedule forms with open-ended and closed-ended questions. This instrument provided qualitative and quantitative data.

According to Creswell (2003), the focal point of the mixed methods designs is on collecting and analyzing both qualitative and quantitative data in a single study. The study data was collected through some of the qualitative and quantitative methods described by Kitto et al. (2008), and Rau and Wooten

(1980). These methods are schedules, analysis of existing documents, physical observation, and counting and environmental impact assessment. The qualitative methods describe, translate and explain and interpret sand and gravel mining from the perspectives of the respondents whereas quantitative methods provide facts on the environmental impacts and number of sand and gravel mining sites.

According to Bryman (2006), the use of a mixed methods approach in research has become increasingly common in recent years. This could be due to merits identified by Creswell (2003), developing a more complete understanding of changes needed for a marginalized group through the combination of qualitative and quantitative data and having a better understanding the need for and impact of an intervention program through collecting both quantitative and qualitative data over time. These merits were used in this study to document environmental impacts and comprehend the factors influencing management practices of sand mining in the study area. This enhanced the development of an action plan for curbing indiscriminate and irresponsible sand mining.

3.3 Sources of Data

The study data originate from primary and secondary data sources. Kothari (1985) and Gangrade (1982) stated that primary data refers to the information collected for the first time whereas secondary data is the information already collected by others.

The primary data for the study was collected from villages of Thulamela Local Municipalities, namely; Makonde, Tshiombo, Muledzhi, Thogani, Thengwe, Khubvi and Tswinga. These villages were considered because they have predominant sand and gravel mining activities. Accordingly, data was collected from the sand miners, mining sites, chiefs of the villages, and officials from the Department of Mineral Resources and Thulamela Local Municipality. Sand miners refer to sand and gravel dealers, tipper truck drivers, sand excavators, and loaders.

3.4 Data Collection Methods and Instruments

Gangrade (1982) asserted that the heart of any research design is the collection of data. The study data was collected through observation, schedules, analysis of existing documents and environmental impact assessment methods. A detailed account of each method is described in the following sections.

3.4.1 Analysis of existing documents

Documents in a form of books, work and research reports, journals, and newspapers are created daily and they may be used as data sources for a research study (Wildemuth, 2009). According to Miller and Alvarado (2005), documents are produced in and reflect specific social and historical circumstances hence they are center to research study formulation. In this study, documents with sand and gravel mining information were reviewed to get a historical background of work done. This enhanced the identification of the literature gap and shaped the objectives of the study.

According to Miller and Alvarado (2005), documents provide access to events that cannot be observed. Analysis of statutes regulating sand mining, records on licensing of sites, annual reports on compliance and enforcement, and research reports produced important information that could not be gathered through observation and schedule. The statutes were reviewed to understand the current legislative framework regulating sand and gravel mining in South Africa. The documents were obtained from the Department of Mineral Resources, Thulamela Local Municipality, internet, and library. The review of the existing documents method provided information about the current management of and provided information on environmental impacts associated with sand and gravel mining.

3.4.2 Observation and documentation of sand and gravel mining operations

Field observation refers to a research method that involves direct observation of phenomena in their natural setting (Taylor-Powell, 1996). Checklist was employed to collect qualitative and quantitative data at the mining sites on issues relating to environmental impact, rehabilitation of mined sites, and methods and equipment used. To support the observation processes a digital camera, notes pad, wheel measure, and hundred metre tape were used.

The observation method is preferred because of the advantages identified by Kothari (1985) which include elimination of biasness, provision of current information and willingness of independent respondents to respond and as such it is relatively less demanding of active cooperation on the part of respondents. Accordingly, the method provided information about the environmental aspects of sand mining. Also, data collected using the method contributed to the compiling of a comprehensive inventory of sand and gravel mining in the study area.

3.4.3 Key informants schedules

The schedule is a data collection method that uses a form during a personal interview where both the interviewee and interviewer are present (Gangrade, 1982). The form contains a set of questions that are asked and then the columns are filled in by an interviewer in a face to face situation. The method is extensively used in research and population census. Kothari (1985) stated that the population census all over the world is conducted through this method.

Schedule method was used to solicit information from the sand miners, chiefs of the three villages, and officials from the Department of Mineral Resources and Thulamela Local Municipality. Appointments were made with the respondents and they were interviewed at their designated locations. The respondents included officials, sand miners, and chiefs. Sand miners and chiefs were asked questions that sought information about environmental aspects of sand and gravel mining, previous land use of the mining sites, rehabilitation of mined sites, management systems and legitimacy of sand and gravel mining, awareness campaigns on sand and gravel mining, and compliance monitoring at mining site by responsible authorities. Whereas the officials from the Department of Mineral Resources and Thulamela Local Municipality were asked questions on the environmental impact, awareness campaigns, management systems, compliance, and enforcement as they relate to sand and gravel mining.

Just like any other data collection method, the schedule has advantages and disadvantages. However, this study benefited from advantages identified by Kothari (1985) such as flexibility, reliability, usefulness in case the respondents are illiterate, ability of the interviewer to appraise the validity of reports and be able to repeat or rephrase questions to make sure that the respondent understands. The disadvantages of the method were eliminated by making the researcher the only enumerator for the schedule.

3.4.4 Environmental Impact Assessment of sand and gravel mining

According to Lee (1989) Environmental Impact Assessment (EIA) refers to a process designed to ensure potentially significant environmental impacts are satisfactorily assessed and taken into account in the planning, design, authorisation and implementation of all relevant types of action. Whereas, the 2014 Environmental Impact Assessment Regulations of South Africa define EIA as a systematic process of identifying, assessing and reporting environmental impacts associated with an activity. EIA proved to be an important tool to assess the positive and negative impacts of an activity on the

environmental quality and human wellbeing (Lee, 1989). Accordingly, EIA was used to identify, assess and report environmental impacts associated with sand and gravel mining in the study area. There are various methodologies available for the assessment of adversities of activity on the environmental quality and human wellbeing. The methodologies include but not limited to Checklist Method, Overlays, Networks, Matrix Method and Rapid Impact Assessment Matrix through which EIA is conducted.

Rapid Impact Assessment Matrix was a preferred method used to conduct environmental impact assessment of sand and gravel mining in the study area. According to Pastakia (1998), the method seeks to overcome the problems of recording subjective judgments by defining the criteria and scale against which these judgments are to be made and by placing the results in a simple matrix that gives a permanent record in the judgment process. The method is based on a standard definition of the important assessment criteria as well as the means by which semi-quantitative values for each of these criteria can be collated to provide an accurate and independent score for each condition.

Through the Rapid Impact Assessment Matrix, the impacts of sand and gravel mining activities were evaluated against the environmental components and subcomponents. And, each individual component a score was assigned, which provides a measure of the impact expected for the component (Pastakia, 1998). The important assessment criteria fall into two groups namely criteria that are of importance to the condition, and which can individually change the score obtained and criteria that are of value to the situation, but individually should not be capable of changing the score obtained.

Rapid Impact Assessment Matrix requires specific assessment components to be defined through a process of scoping, and these environmental components fall into one of four categories, which are defined as follows (Pastakia, 1998):

- Physical/Chemical (PC) that covers all physical and chemical aspects of the environment.
- Biological/Ecological (BE) that covers all biological aspects of the environment.
- Sociological/Cultural (SC) that covers all human aspects of the environment, including cultural aspects.
- Economic/ Operational (EO) qualitatively to identify the economic consequences of environmental change, both temporary and permanent.

Accordingly, the scoping for this study includes three mining operations with ten PC, two BE, four SC and four EO components. The components are outlined in chapter four.

3.5 Target Population

According to Alvi (2016), the target population refers to all members who meet the particular criterion specified for a research investigation. Accordingly, the target population for this study defined to include officials from the Department of Mineral Resource and Thulamela Local Municipality, chiefs and sand miners. Sand miners included sand and gravel traders, tipper truck drivers, sand excavators, and loaders. These individuals are operating within Makonde, Tshiombo, Muledzhi, Thogani, Thengwe, Khubvi and Tswinga villages.

3.6 Population Sampling

Alvi (2016) defines sample as a group of a relatively smaller number of people selected from a population for investigation purpose. Accordingly, sampling is the process of selecting a smaller number of people from a population for inclusion into a study or investigation (Kothari, 1985). Researchers use diverse methods to select individuals to represent the target population during the study. Such methods include but not limited to random, snowball, opportunistic and purposeful sampling (Creswell, 2003). Purposeful sampling was advanced to select respondents from the defined target population of the study.

According to Creswell (2003), individuals and sites for a study would be selected because they can purposefully inform an understanding of the research problem and central phenomenon in the study. Accordingly, in this study, a purposeful sampling method was used to select sand miners particularly divers and operators. The chiefs having dominion on the mining sites within the study area were considered. In addition, officials holding these positions at the Department of Mineral Resources and Thulamela Local Municipality were selected, official processing applications for a mining permit and license, official processing applications for environmental authorisations for mining activities, official responsible for compliance monitoring and enforcement of sand mining activities and official from town planning section of the municipality.

The study had 35 respondents and 11 informants. The respondents include 10 sand traders, 20 truck drivers, and five operators whereas the informants include 2 officials from DMR, 2officials from Thulamela Local Municipality, and 7 traditional leaders. A total of 14 mining sites were surveyed.

3.7 Data Analysis

The primary data collected from the sand miners, mining operations and key informants was analyzed as per this section. Data analysis of this type of study is based on examining, categorizing, and tabulating evidence to assess whether the evidence supports the initial propositions of the study (Rowley, 2002). Similarly, Kothari (1985) stated that data collected has to be processed and analyzed in accordance with the outline laid down for the purpose at the time of developing the research plan.

Data processing is important for ensuring the presences of relevant data for making contemplated comparisons and analysis. Accordingly, data processing comprises editing, coding, classification and tabulation of collected data for easy analysis whereas data analysis comprises computation of certain measures along with searching for patterns of relationship that exist among data groups (Kothari, 1985). In simple terms, data analysis refers to the process of turning collected data into information that can be used to explain the specific phenomenon. Seemingly, data can be analyzed using qualitative or quantitative techniques. Lancaster (2005) has asserted that some qualitative data can often be translated into and analyzed using some of the quantitative techniques, whereas some quantitative data often needs to be analyzed further using qualitative techniques.

The study data was analyzed through both qualitative and quantitative techniques to develop a richer understanding of sand and gravel mining within the study area. Lancaster (2005) stated that combined techniques could help to check data for aspects such as representativeness, reliability and validity. Thus, descriptive (quantitative analysis) and thematic (qualitative analysis) techniques of data analysis were preferred. Descriptive analysis was used to compare, and contrast data collected on the degree of extraction. Thematic analysis was used to analyze data collected through the schedule meetings.

3.8 Impacts Assessment

The Impact Assessment was done following Rapid Impact Assessment Matrix (RIAM) methods. The assessment criteria used in the RIAM include two groups. Group A: Criteria that are of importance to the condition, and which can individually change the score obtained. Group B: Criteria that are of value to the situation, but individually should not be capable of changing the score obtained. The value ascribed to each of these groups of criteria is determined by the use of a series of simple formulae. These formulae allow the scores for the individual components to be determined on a defined basis.

The scoring system requires simple multiplication of the scores given to each of the criteria in Group A ($a_1 \times a_2$). The use of multiplier for the group (A) is important, for it immediately ensures that the weight of each score is expressed, whereas simple summation of scores could provide identical results for different conditions. Scores for the value criteria Group B are added together ($b_1 + b_2 + b_3$) to provide a single sum. This ensures that the individual value scores cannot influence the overall score, but that the collective importance of all values Group B are fully taken into account. The sum of the group (B) scores are then multiplied by the result of the group (A) scores to provide a final assessment score (ES) for the condition. The judgments on each component were made following with the criteria and scales shown in Table 3.1.The process for the RIAM in its present form can be expressed:

If

$$(a_1) \times (a_2) = aT \quad \ldots\ldots (1)$$

and

$$(b_1) + (b_2) + (b_3) = bT \quad \ldots\ldots (2)$$

then

$$(aT) \times (bT) = ES \quad \ldots\ldots (3)$$

Where, $a_1$and a_2 are the individual criteria scores for Group A; (b_1), (b_2), (b_3) are the individual criteria scores for Group B; aT is the result of multiplication of all (A) scores; bT is the result of the summation of all (B) scores; and ES is the environmental score for the condition.

Table 3.1: Assessment criteria

Criteria	Scale	Description
A1: Importance of condition	4	Important to national/international interests
	3	Important to regional/national interests
	2	Important to areas immediately outside the local condition
	1	Important only to the local condition
	0	No importance
A2: Magnitude of change/effect	+3	Major positive benefit
	+2	Significant improvement in status quo
	+1	Improvement in status quo
	0	No change/status quo
	-1	Negative change to status quo
	-2	Significant negative disbenefit or change
	-3	Major disbenefit or change
B1: Permanence	1	No change/not applicable
	2	Temporary
	3	Permanent
B2: Reversibility	1	No change/not applicable
	2	Reversible
	3	3 Irreversible
B3: Cumulative	1	No change/not applicable
	2	Non-cumulative/single
	3	Cumulative/synergistic

To use the evaluation system described, a matrix was produced for three major mining sites, comprising cells showing the criteria used, set against each defined component. Within each cell, the individual criteria scores will be set down. From this formulae (aT) × (bT) = ES, ES number was calculated and recorded. To provide a more certain system of assessment, the individual ES scores are banded together into ranges where they can be compared. Ranges are defined by conditions that act as markers for the change in bands. The reasons for the setting of range bands are described by Pastakia (1988). Table 3.2 gives the ES values and range bands currently used in RIAM. The final assessment of each component was evaluated according to these range bands. Once the ES score was set into a range band, these were grouped according to component type and presented in table and graphic form.

Table 3.2: Conversion of environmental scores to range bands

Environmental Score (ES)	Range Value (alphabetic)	Range Value (number)	Description of Range Bands
72 to 108	E	5	Major positive change/impacts
36 to 71	D	4	Significant positive change/impacts
19 to 35	C	3	Moderately positive change/impacts
10 to 18	B	2	Positive change/impacts
1 to 9	A	1	Slightly positive change/impacts
0	N	0	No change/status quo/not applicable
-1 to -9	A	1	Slightly negative change/impacts
-10 to -18	B	2	Negative change/impacts
-19 to -35	C	3	Moderately negative change/impacts
-36 to -71	D	4	Significant negative change/impacts
-72 to -108	E	5	Major negative change/impacts

3.9 Data Reliability and Validity

A properly designed and undertaken study provides accurate and quality conclusions. The latter depends on the procedures and instruments used to collect and analyze the required data. The concepts, reliability and validity are used to establish if the procedures and tools for data collection and analysis guarantee accurate and quality conclusions. Accordingly, reliability is "the degree of accuracy or precision in the measurements made by a research instrument" (Kumar, 2011). Kumar (2011) further states that "The greater the degree of consistency and stability in an instrument, the greater its reliability. When you collect the same set of information more than once using the same instrument and get the same or similar results under the same or similar conditions, an instrument is considered to be reliable." According to Drost (2011), validity is concerned with the meaningfulness of research components. If a component measures what it is designed to measure, then it is valid. Hence, Kumar (2011) says validity is the ability of an instrument or a tool to measure what it is designed to measure.

The validity of data collection instruments for this study was established through the logic method. According to Kumar (2011) establishing validity through logic implies justification of each question in relation to the objectives of the study. Accordingly, the schedule form and observation checklist were designed in relation to the objectives of the study. There is a logical link between the schedule questions and checklist variables and the objectives of the study. The instruments were also reviewed by the supervisors.

The reliability of the data collection instruments for this study was established through test-retest (Kumar, 2011; Drost, 2011). The schedule form was tested and retested to verify its consistency and stability to produce the same data. The form was administered to four sand and gravel miners twice and it produced consistent results. Apart from the test-retest, other instruments like the observation checklist and review of existing documents were used to collect the same data as the one to be collected through schedule form. To strengthen the reliability of the schedule, form the enumerator was the researcher who developed the instrument and knew the purpose of each question in the instrument.

3.10 Ethical Considerations

The procedure for the collection of primary data was standardized. The schedule was one of the methods used to collect data. This method involves engaging people who are directly and indirectly involved in sand and gravel mining. As such it was important to consider ethical issues when collecting data through this method. Permission to collect data from the selected villages was sought from the

responsible chief. The chiefs were informed about the purpose of the study and the expected outcomes.

The respondents were told about the research objectives and permission to ask them questions in the schedule form was requested. The respondents were assured that the information obtained would be treated as confidential, that the results would be used for research purpose. No person was forced to participate, and respondents had the freedom to cease participating. In the case of secondary data, due credit to all sources of secondary data used is acknowledged through citing and listing references.

3.11 Summary of the Chapter

In this chapter, the researcher described the research design and the research methodology. The advantages and disadvantages of both the research design and the research methodology were highlighted. The research instruments, the field survey, and the schedules were described and their advantages and disadvantages were highlighted. Purposive sampling was preferred for this research because the selected samples represented relevant sand and gravel miners in Thulamela Municipality for the research.

Before carrying out the research, permission was sought from the headmen and chiefs with jurisdiction over the areas where sand and gravel are mined. Schedule meetings were held with key informants and sand miners. The mining sites were visited to gather information. The data analysis methods were also discussed in this chapter. In the next chapter, the research data gathered will be presented, analyzed, and discussed.

CHAPTER FOUR: DATA ANALYSIS, PRESENTATION AND DISCUSSION

4.1 Introduction

Data collected using review of existing documents, schedule meetings and field survey is analyzed, presented and discussed in this chapter. Data collected from the respondents, informants and mining sites is recorded in different charts and tables and is expressed as percentages of total responses per respondents' category. This percentage system is preferred because it provides a standard measure for easy analysis and presentation.

4.2 Socio-Demographic Characteristics of the Respondents

This section outlines the socio-demographic characteristics of the respondents. Socio-demographic characteristics have a huge influence on the ability to make an informed environmental decision. According to Lizuka (2000), the younger generation tends to be more concerned with environmental quality than the older generation. Education is a critical characteristic with an influence on decision making regarding the use of natural resources (Morar and Peterlicean, 2012). The following sections present gender distribution, age distribution, education level distribution and occupation of the respondents. In addition, the influence of demographic characteristics on sand mining is explained.

4.2.1 Gender distribution

World communities continue with interventions to promote gender equality and the economic empowerment of women. This is evident as many sectors strive to realize goal number five of the United Nations Sustainable Development that is to achieve gender equality and empower women and girls. Despite the later, mining sector remains a male domain sector (Rickard et al., 2017). This is supported by Hinton et al. (2003) that state that approximately 30% of the artisanal miners worldwide are women. This finding corresponds well with that of the study on small-scale gold mining at Giyani Greenstone Belt in South Africa that shows that women make 34.6% of the artisanal and small-scale gold miners in the study area (Magodi, 2017).

Field survey shows that sand mining in the study area is a male domain sector. The respondents were sand miners classified into three categories that are sand traders, truck drivers and plant operators. The survey exposed 15 sand traders and only 10 traders agreed to participate. The truck drivers and plant operators that agreed to participate were 20 and 5 respectively. All the sand miners (100%)

participated in the research are male. These results show that males are directly benefiting from mining and trading sand and gravel in the study area. The results are slightly related to Hinton et al. (2003)'s observation about the participation of South African women in artisanal mining. Thus, setbacks to the achievement of goal number five of the United Nations Sustainable Development that strives to achieve gender equality and empower all women and girls. In order to achieve the latter goal within the sand mining sector, the department responsible for sand mining regulation must through awareness campaigns and mentoring programmes promote the participation of women in this sector.

4.2.2 Age distribution

The age of the respondents is classified into five categories that are youth (19-28), middle-age (29-38), old age (39-48), retiring age (49-58) and pensioners (>59). The percentage distribution of the respondents per age category is presented in Table 4.1. The results show that the miners are between the ages of 19 and 58 whereas there is no miner that falls under the pensioners' category. The old age category leads with 37% and is followed by the middle age category by 29%. The youth category and retiring age account for 20% and 14% respectively. Approximately 95% of the sand traders fall within the old age and retiring age categories and approximately 70% of the truck drivers and plant operators fall within the youth and middle age categories. This finding is consistent with the view that physical work capacity decline as people get older (Ilmarinen, 2012). Driving truck and operating plants in the sand mining sector is a repetitive work that requires good health and strong physical work capacity. This is a good reason why the majority of truck drivers and plant operators fall within the youth and middle age categories. Because of their good health and physical work capacity, they have the potential to handle heavy objects and do repetitive work.

Ilmarinen (2012) states that though health and physical capacity deteriorates as people get older, there are several other functions that improve. Thus, older people are respected for their strategic thinking, ability to rationalize and deliberate, holistic perception and commitment. The survey shows that a high percentage of sand traders fall within the old age and retiring age categories. This finding supports the notion that older people are strategic thinkers and take rational decisions. These miners are responsible for the strategic planning of their sand trading business and committed to employing the truck drivers and plant operators. They are more engaged in negotiating for sand and gravel mining sites with the local chiefs/landowners. They do this to ensure income generation and guarantee continuous service to their clientele. A sand trader is not required to have physical capacity but experience and mental growth to perform to negotiate for mining sites.

Table 4.1: Age distribution of the respondents

Age Categories	Number of Respondents	Percentage of Age Distribution
Youth	7	20%
Middle Age	10	29%
Old Age	13	37%
Retiring Age	5	14%
Total	**35**	**100%**

4.2.3 Education level distribution

The education level of the respondents is classified into four categories that are: no level, primary level, secondary level and tertiary level. The level of education of the respondents is considered because of the view that education can better equip people for high-quality decision making for their lives (Kim, 2018). There are 35 respondents who took part in the study. The results show that all the respondents attended formal education. Accordingly, Table 4.2 presents the percentage distribution of the respondents per education category. The respondents with secondary level account for a high percentage with 83%. This is followed by respondents with tertiary level accounting for 11% and primary level category with a lesser percentage of 6.

An intense examination of the results shows that 80% of the sand traders attended secondary level and 20% attended a tertiary level. Accordingly, it can be assumed that education and experience enable them to run their sand mining businesses. This sector requires a person with strategic planning, analytical and financial management skills. Generally, these skills are acquired through theory or/and experience. Though the sand traders have formal education their knowledge of what constitutes environmental degradation and health risk is lower. This is exposed by their mining practices as their mining sites have unsecured deep excavations.

The results show that majority of the truck drivers and plant operators have secondary education. This could be because their work requires no tertiary qualification. Similar to sand traders, truck drivers and operators lack knowledge about the best environmental management practice. They are engaged in indiscriminate mining activities that threaten human and animal lives. Their sites have deep excavations ranging from 1m to 5m and are easily accessible. The excavations have the potential to cause injury, losses of life to any person or animal that can fall into them. To address the latter, the department responsible for regulating sand and gravel mining must conduct awareness campaigns and compliance inspection at the mining sites.

Table 4.2: Education level distribution of the respondents

Education Categories	Number of respondents	Percentages of Education Level
Primary Level	2	6%
Secondary Level	29	83%
Tertiary Level	4	11%
Total	35	100%

4.2.4 Occupation of the respondents

The respondents for the study were sand miners. Sand miner is the umbrella name for individuals engaged in sand and gravel mining. These individuals have different roles from when the sand is mined at the setting until is sold to the customer. The respondents are classified into three categories which are sand traders, truck drivers and plant operators. The field survey revealed that sand traders are the owners of the trucks and machines used for sand mining. Accordingly, most of the truck drivers and plant operators are working for the sand traders. Thirty-five (35) miners participated in the study where truck drivers were 20, sand traders were10 and plant operators were 5.

Figure 4.1 presents the percentage distribution of the respondents per occupation category in sand mining. The truck drivers account for 57% of the respondents and followed by sand trader category with 29% where plant operator category account for 14% only. The reason for the high percentage to truck drivers' category and lower percentage to plant operators' category is that one excavator or frontend loader can load many trucks whereas many trucks are required to transport the material to different destinations. The results revealed that most of the sand miners own one excavator or frontend loader and more than three tipper trucks. Moreover, those without excavator they hire.

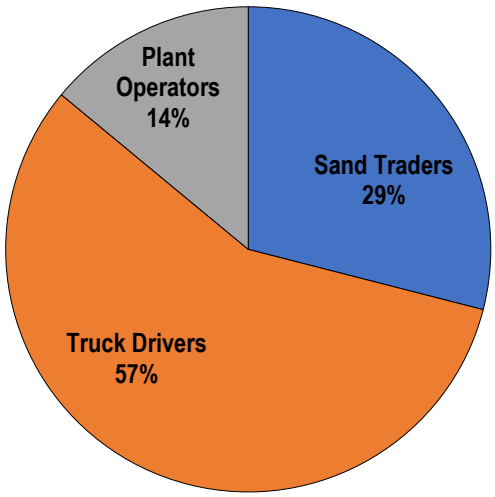

Figure 4.1: Distribution of the respondents per occupation category

4.3 An Inventory of Sand and Gravel Mining in the Study Area

This section presents an inventory of active and inactive sand and gravel mining operations in the study area. The inventory provides a comprehensive tabulation of information regarding the operations. The information was sourced from the miners, chiefs, DMR and mining operations. The inventory presents information about fourteen operations of which eleven operations are sand mining and three are for gravel mining. As presented in Table 4.3, the information includes the exact location, equipment used, access control and infrastructure, surrounding land use, adverse impacts sand and gravel mining, status of rehabilitation of the mine sites, the estimated quantity of mined resources and the lawfulness of the mining sites. This information forms the basis for the assessment of the environmental impacts of the sand and gravel mining operations. Moreover, it informs the development of planning and management strategies to prevent adverse environmental impacts of sand mining.

As shown in Table 4.3, sand and gravel miners generally employ mechanical mining methods. They use front-end loaders and excavators. In all the operations where they mine gravel excavators are used. Very minimal use of shovels observed at the sand mining operations. The inventory shows the type of equipment used to mine sand or gravel at a different sites. The reason for including this information is that the equipment influences the characteristics of the mining site. Thus, front-end loaders created huge and deep excavations than the use of shovels. Huge and deep excavations are the aspects of sand and gravel mining that have a direct influence on the environmental impacts of sand and gravel mining. Accordingly, the aspects of sand and gravel mining information provided in the inventory will form the basis for the assessment of the environmental impacts of sand and gravel mining operations in the study area.

The inventory provides information about the adjacent land use, access control and infrastructure, and rehabilitation. This information will be used for assessing the environmental and socio-economic impacts of the sand and gravel mining operations. For example, a mining unsecured and unrehabilitated excavation located within residential areas poses health and safety risks to the community members. Thus, information regarding the adjacent land use, access control and infrastructure, and rehabilitation are pertinent to the development of planning and management strategies for dealing with problems of proliferated sand and gravel mining in the study area.

The inventory information will be useful to scholars and authorities, who intend to research on and regulate sand and gravel mining, respectively. To scholars that are interested to research on issues of sand and gravel mining in the study area the inventory provides basic information about the mining

operations. The inventory provides important information that regulators can use to plan for monitoring compliance of sand and gravel mining operations in the study area. The inventory provides coordinates of the mining operations and the authorities can use this information to plan for compliance inspections.

Table 4.3: Inventory of sand and gravel mining

Sites No. & Resource	Village Name	Location Coordinates		Legality of the Operation	Mining Equipment	Adjacent Land Use	Sand and Gravel Mining Aspects	Access Control & Infrastructure		Rehabilitation of Mined Site		Estimated Mined Material (m^3)
		South	East					Yes	No	Yes	No	
1: Gravel	Thengwe	22˚ 42' 10''	30˚ 33' 58''	Unlawful	E, TT	LG, R	DG, EW, SE, VC		X		X	32 000
2: Gravel	Khubvi	22˚ 49' 25''	30˚ 34' 6''	Unlawful	E, TT	R	DG, SE, VC		X		X	10 000
3: Gravel	Tswinga	23˚ 3' 24''	30˚ 27' 26''	Unlawful	E, TT	LG	DG, HE, EW, SE, VC		X		X	1 416 800
4: Sand	Makonde	22˚ 47' 56''	30˚ 32' 51''	Unlawful	FL, S, TT	A	HE, RAL, SE, VC		X		X	60 000
5: Sand	Makonde	22˚ 46' 1''	30˚ 33' 45''	Unlawful	FL, S, TT	A, LG	HE, ID, RAL, SE, VC		X		X	2 250 000
6: Sand	Muledzhi	22˚ 40' 57''	30˚ 38' 3''	Unlawful	FL, S, TT, T	A, LG	DG, HE, SE, VC		X		X	56 000
7: Sand	Thogani	22˚ 40' 47''	30˚ 40' 21''	Unlawful	FL, TT	A, LG	DG, HE, SE, VC		X		X	4 500
8: Sand	Tshiombo	22˚ 47' 42''	30˚ 30' 15''	Unlawful	FL, S, TT	A, LG	DG, HE, EW, SE, RAL		X		X	819 000
9: Sand	Tshiombo	22˚ 47' 41''	30˚ 30' 9''	Unlawful	FL, TT	A, LG, R	DG, HE, ID, SE, RAL		X		X	37 800
10: Sand	Tshiombo	22˚ 47' 39''	30˚ 29' 39''	Unlawful	FL, TT	A, LG, R	DG, EW, RAL		X		X	2 100
11: Sand	Tshiombo	22˚ 47' 41''	30˚ 29' 40''	Unlawful	FL, TT	A, LG, R	DG, EW, RAL		X		X	1 040
12: Sand	Tshiombo	22˚ 47' 12''	30˚ 30' 33''	Unlawful	FL, S, TT	A, LG	DG, HE, EW, SE, RAL		X		X	90 000
13: Sand	Tshiombo	22˚ 47' 16''	30˚ 30' 47''	Unlawful	FL, S, TT	A, LG	DG, HE, EW, SE, RAL		X		X	168 000
14: Sand	Tshiombo	22˚ 47' 13''	30˚ 31' 23''	Unlawful	FL, S, TT	A, LG, R	HE, EW, SE, RAL		X		X	192 000

***Note: A** Agriculture, **DG** Dust Generation, **TT** Tipper Trucks, **E** Excavator, **EW** Excavation with Water, **HE** Huge Excavation, **LG** Livestock Grazing, **FL** Frontend Loader, **R** Residential, **RAL** Reducing Agricultural Land, **S** Shovels, **SE** Steep Embankment **T** Tractors, **VC** Vegetation Clearance, & **ID** Infrastructure Damage*

The field survey revealed that sand miners practice inland pit sand mining and gravel quarrying from the hills. The resources are extracted from the woodlands and agriculture fields. Most of the sand mining sites are located in agriculture fields whereas gravel sites are located on areas that had natural vegetation. Approximately 99% of the sites are accessed via existing roads which are used to access communities and agriculture fields.

During mining, the miners employ manual and mechanical mining methods. At gravel mining sites excavators are used to mine and load the resource whereas at sand mining sites frontend loaders and shovels are used to mine and load the resource. Figure 4.2 shows excavators at a gravel mining site at Tswinga. Approximately 99% of the miners use tipper trucks to transport the sand and gravel to stockpile sites or customers. The resources are used for brick making, building and construction work.

Figure 4.2: Excavators at gravel mining operation

Table 4.3 shows that the study area has many sand mining sites than gravel. Tshiombo village hosts most of the sand mining sites. All these sites are located in agriculture fields. The mining sites in the study area are characterized by huge excavations with steep embankments. It was observed that the mining sites are not rehabilitated. This observation is aligned to the responses obtained from the miners relating to rehabilitation of the mining sites. Some sites are now used for waste disposal.

4.3.1 Distribution of mining sites per village category

Fourteen mining sites located in seven villages of the study area were surveyed. The villages are Makonde, Muledzhi, Khubvi, Thengwe, Thogani, Tshiombo and Tswinga. Tshiombo Village accounts for 50% of the mining sites identified and surveyed and it is followed by Makonde Village that accounts for 14.3%. The other villages account for 7.14% each. Table 4.4 shows the percentage distribution of

the mining sites per village category. Figure 4.3 shows a locality map of sand and gravel mining operations in the study area.

The procedure of acquiring the mining site is different from village to village. This could be the reason why Tshiombo village accounts for a high percentage of the mining sites. At this village, the practice is each miner owns a mining site. This is because miners negotiate with agriculture field owners, head man and chief to mine sand from the fields whereas in other villages head man identify an area where all sand miners must mine sand from. With regards to gravel, the miners mine from the same mining sites.

Table 4.4: Distribution of mining sites per village category

Name of Village	Number of Mining Sites	Percentage Distribution
Makonde	2	14.3%
Muledzhi	1	7.14%
Khubvi	1	7.14%
Thengwe	1	7.14%
Thogani	1	7.14%
Tshiombo	7	50%
Tswinga	1	7.14%
Total	**14**	**100%**

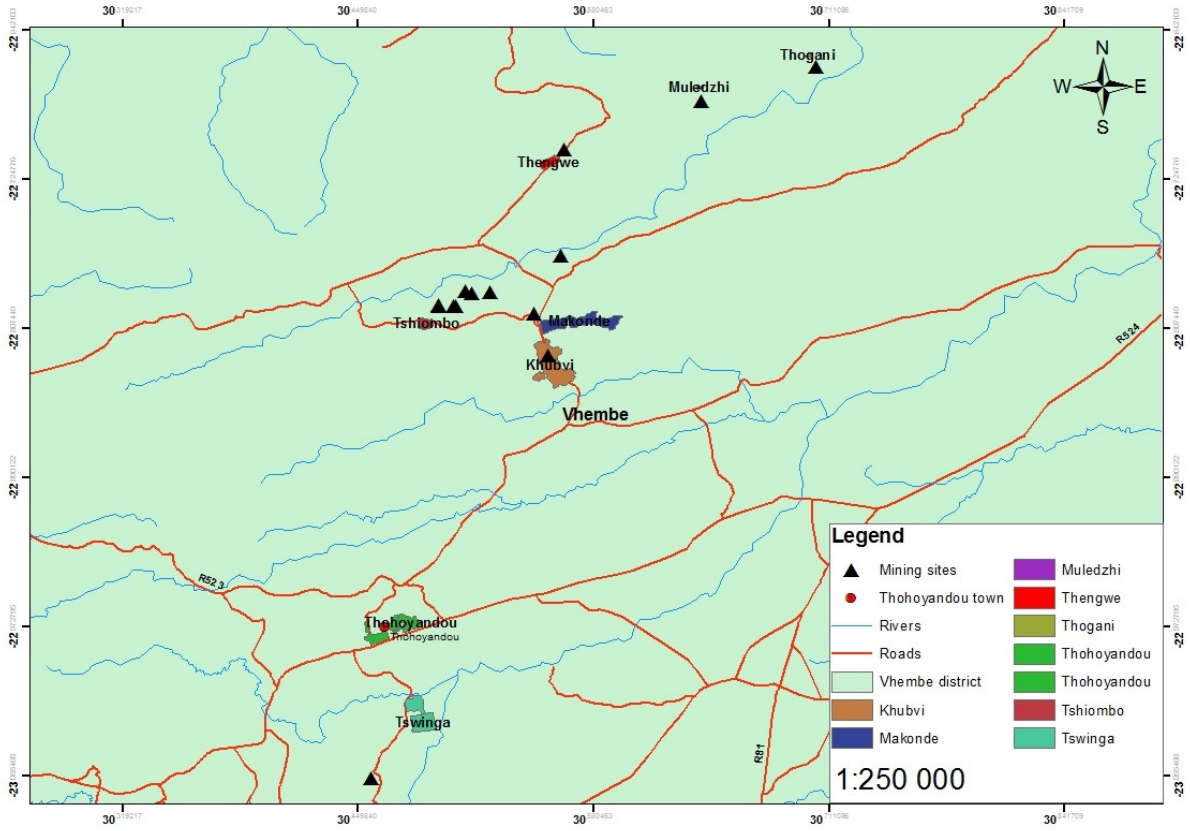

Figure 4.3: Locality map of sand and gravel mining operations in the study area

4.3.2 Compliance of the mining sites

The field survey findings are juxtaposed with provisions of the legislative framework regulating mining in South Africa to determine the sites' compliance status. The provisions of the National Environmental Management Act No. 107 of 1998 (NEMA) and Mineral and Petroleum Resources Development Act No. 28 of 2002 (MPRDA) were considered. The process showed that all the mining sites operate in contravention of Section 27 as read with Section 5A of the MPRDA and Section 24F of NEMA. Accordingly, sand miners operate the sites without mining permits issued in terms of MPRDA and environmental authorisations issued in terms of NEMA. This results from a lack of knowledge about the regulatory framework governing sand mining industry.

4.3.3 Access control and infrastructure of the sites

The mining sites are not fenced off. Thus, accessing them is very easy. The sites are characterized by deep excavations with steep embankment. Easy access and steep embankment excavations pose a safety risk to any person or animal that comes to the periphery of the excavations. Some of the excavations have significant amount of water that promotes swimming. Figure 4.4 shows teenagers swimming in an artificial pond resulting from pit sand mining at Tshiombo Village. This poses a drowning risk. Swimming and drowning of children in excavations created by sand mining are experienced in Botswana (Madyise, 2013). According to the Mirror News Paper of the 14th February 2020, a six year old boy drowned and lost his life at a gravel mining site at Malamulele Village, Limpopo Province. A similar case was reported on the 23rd April 2019 where three children drowned in unrehabilitated illegal mine at Ga-Phasha Village, Limpopo. Lack of fence at those mined sites contributed to these unexplained deaths.

Figure 4.4: Teenagers swimming in artificial pond

Another challenge with unsecured mining and mined sites is the disposal of waste. Communities residing around the sites resort to dispose of waste in the excavations that are not rehabilitated. Figure 4.5 shows waste disposed of in unrehabilitated sand mining site at Makonde Village. A similar situation is experienced in the Nzhelele River Valley (Amponsah-Dacosta and Mathada, 2017) and Lusada area of Ogun State in Nigeria (Adedeji et al., 2014). This practice has indirect impacts including visual and odour pollution arising from disposed waste.

Figure 4.5: Waste disposed in ceased mining operation

The sites have no infrastructure. This could be because mined resources receive no further processing. After mining, the resource is loaded into tipper trucks and transported to the stockpiling sites or customers. Disappointingly the sites lack toilets. Thus, the tipper trucks drivers and plant operators resort to relieve themselves at the bushes surrounding mining sites. Apart from causing a nuisance, this puts the drivers to snakes bite risk.

4.3.4 Adverse general impacts of sand and gravel mining

The general impacts in this context comprise physical, environmental and social impacts. Sand and gravel mining could have severe environmental and social impacts depending on the location, size and equipment used. The following impacts were observed at the operations dust generation, water in the excavations, huge excavations, encroaching agriculture land, vegetation clearance and infrastructure damage. The following sections provide details on each impact observed.

Dust generation

The actual sand mining activities generate little dust. This is because the material is mostly wet. Significant dust is generated along the hauling roads to and from the sites as shown in Figure 4.6. This

forces the communities surrounding the sites to often protest. One of the hauling roads at Tshiombo village was blocked with stones. It was reported that the community closed the road owing to dust generated by the speeding tipper trucks. Similarly, the youth of Wa Municipality in Ghana raised their concern about dust generated on their roads by sand hauling trucks (Peprah, 2013). The issue of dust resulting from sand haulage trucks is also experienced in Kumakwane village of Botswana (Madyise, 2013) and Lukosi village of Ogun State in Nigeria (Adedeji et al., 2014).

Figure 4.6: Tipper truck generating dust

The residents of Tswinga Village are deeply affected by dust from the hauling road. Tipper trucks travel Tswinga road almost every day to source gravel from the quarry located within the village. Dust suppression measures employed to control dust next to Tswinga clinic seem not working. Water sprinkled by a water tanker dry very quickly due to the scorching condition prevailing in the area.

Excavation with water

Sand mining causes huge and deep excavations that contain rainwater. The depth of the excavations ranges between 1m to 15m. Due to the depth and width of the excavations, they contain a significant amount of water. In some instances, the extractions reach the water table hence they get filled with ground water. Water filled excavation turns to be swimming ponds for teenagers residing nearby the excavations as shown in Figure 4.7 where teenagers swimming in one of the excavations at Tshiombo Village. A similar situation is experienced in Ogun State of Nigeria (Adedeji et al., 2014). In some cases, children lose their lives and a recent case is of the six years boy that drowned at an unrehabilitated gravel mining site at Malamulele Village.

Apart from being swimming pools, the excavations become breeding grounds for disease-causing vectors. According to Madyise (2013), grass surrounding water-filled excavations creates an environment for mosquitoes that spread malaria to residents nearing the sites.

Figure 4.7: Excavation filled with groundwater

Huge excavation

Sand and gravel extraction in the study area is characterized by huge and deep excavations that have steep embankment. These unsecured excavations pose various risks to wildlife, livestock and human. Due to their depth, some of the excavations may cause injury or loss of life to any person or animal falling into it. According to one of the sand miners, the gravel mining site at Tswinga caused a loss of livestock particularly cattle. Figure 4.8 shows the depth of the mining site at Muledzhi Village. The average depth of this site is 4m. Similar deep excavations with steep embankments were observed within the villages surrounding Gaborone Town in Botswana (Madyise, 2013).

Figure 4.8: Depth of mining excavation

The mining sites are not rehabilitated upon ceasing operations. The miners leave behind huge and deep excavations that turn to be waste disposal sites and swimming pools. Three ceased mining sites were identified within the study area. These sites are not rehabilitated and are used for waste disposal by the surrounding community as shown in Figure 4.5. The excavations can also be a hiding place for criminals.

Encroaching agricultural land

Mining sites located in Tshiombo Village are on agricultural land. Table 4.3 shows that approximately 1 310 340m^3 of sand have been mined from agricultural land at Tshiombo. Sand mining continues to reduce agriculture land in this village. Whereas 60 000m^3 of sand was mined from agricultural land in Makonde village. This mining site has ceased. Agricultural fields in Tshiombo Village are at risk of being turned into mining sites as sand mining is proliferating. This will affect the production of maize and sweet potatoes. The village is known for producing these foodstuffs. Figure 4.9 shows maize at one of the fields affected by sand mining at Tshiombo.

Figure 4.9: Mining operation on agriculture field

This situation of turning agriculture fields into sand mining sites is also experienced in the Brong Ahafo region of the Republic of Ghana (Baba, 2017). In Wa Municipality of Ghana farmers fail to access their fields as they have no means to cross the water-filled excavations whereas some have lost their fields to sand mining (Peprah, 2013). Similar to the Wa farmers (Peprah, 2013) and Ga farmers (Tagoe, 2005), some of Tshiombo farmers through the headman and chief sold their fields to sand miners.

Vegetation clearance

Natural vegetation is lost to sand and gravel mining. All the gravel and three sand mining sites caused and continue to cause clearance of natural vegetation. The sand miners through frontend loaders and excavators destroy and remove vegetation to access sand and gravel deposits. Sand miners destroyed many matured trees at Makonde village as shown in Figure 4.10. The miners disturbed the natural landscape of the sites as the mining activities caused the destruction of the vegetation and soil profile. The field survey findings concur with Adedeji et al. (2014) on their view that inland sand mining is the major cause of deforestation and forest degradation as commercially valuable sand is found in the ground beneath forests. The trees specimen and patches of vegetation found in a greatly mined site at Makonde show that the area was a forest.

Figure 4.10: Destroyed matured tree at mining operation (source: Ngoepe, 2013)

Sand and gravel mining continue to cause vegetation loss at Tswinga, Khubvi, Thengwe, and Muledzhi villages. In Tswinga and Khubvi, gravel mining affects shrubs and plants. In Thengwe and Muledzhi, sand and gravel mining affect matured trees and shrubs, woodlands. Vegetation clearance in these villages is associated with loss of biodiversity, visual impact, and soil erosion. Similar observations were made in the Luku area of Nigeria (Akoet al., 2014), where sand and gravel mining destroyed the natural habitat of some animals, plant species, and soil profiles inducing soil erosion.

Vegetation cover plays a critical role in soil erosion, dust and carbon dioxide reduction, and ecological support. Conversely, lack of vegetation cover possibly will promote soil erosion, biodiversity loss and global warming. Vegetation cover is both shelter and food source for certain animal species such as rodents and rabbits found within the study area. Jackals prey on the latter fauna species and other flora

and fauna species that are mostly affected by the mining activities. Accordingly, clearance of vegetation for sand/gravel mining affects the functionality of the entire ecosystem of the mining area.

Infrastructure damage

Sand mining in Makonde village resulted in infrastructure damage where the power line and water pipeline are affected. In Tshiombo village, the activity exposed water pipelines and damaged canals that convey water to the cultivation fields. Figure 4.11 shows a falling electric pole exposed by sand mining site at Makonde village. A similar situation was observed in Ogun State of Nigeria (Adedeji et al., 2014). Heavily loaded tipper trucks damage the tar road at Tshiombo Village as the road was not designed for trucks of that magnitude. The tipper trucks cause potholes on the roads. A similar situation was experienced in Ga District of Ghana (Tagoe, 2005).

Figure 4.11: Electricity power line damage by mining operation

4.4 Environmental Impacts of Sand and Gravel Mining

The respondents were asked questions that sought their views about environmental impacts associated with sand mining. The data collected is presented in the following sections.

Impacts associated with sand mining

A question to solicit the views of the respondents about sand mining causing environmental impacts was asked. Most of the respondents indicated that sand mining destroys the environment. These respondents account for 77% and 6% indicated that sand mining does not destroy the environment whereas 17% was not sure if sand mining destroys the environment. The yes category respondents

were further asked a question that sought to record the environmental impacts the respondents have observed.

These are frequent responses recorded:

> "*Our sand mining activities change the natural landscapes of the sites affected as we leave huge and deep excavations. The excavations could cause injury or loss of life to animals or even humans. During rains the excavations are filled with water, this is risky to the kids that swim in those waters."*
>
> *"Sand mining destructs the habitat of wildlife because before the mining can start we must first clear the vegetation which is the shelter of most of the animals. We create new landscapes that are dangerous to other wildlife and good for another. For example, the excavations resulting from our activities host rainwater and this create new habitat for fish and crocodiles."*
>
> *"Sand mining results in big excavations that hold water during rain and this creates a breeding environment for malaria-causing insects like mosquitoes. Kids like to swim in these excavations, and they might drown. Animals fall and die in these excavations."*

These environmental and social impacts observed by the miners are similar to those in the literature. For example, the issue of water-filled excavations becoming swimming ponds for children was observed in Nzhelele river valley (Amponsah-Dacosta and Mathada, 2017). Sreebha and Padmalal (2011), and Ashraf et al. (2011) observed that haphazard sand mining destroys habitat for animal and bird resulting in loss of biodiversity and recreational potential.

Impact assessment study

The respondents were asked a question that sought to establish if Environmental Impact Assessment (EIA) is conducted before mining. All the respondents indicated that they do not conduct any EIA at their proposed mining sites. What they do is to seek mining permission from the chief with jurisdiction over the intended mining location. If the chief grant permission, then mining activity commence. This practice perpetuates the occurrence of adverse social and environmental impacts of sand mining identified in the literature (Amponsah-Dacosta and Mathada, 2017; Sreebha and Padmalal 2011). If considered prior to mining, EIA can help to prevent and minimize the impacts associated with sand mining.

According to Lee (1989), Environmental Impact Assessment is an important tool to assess the positive and negative impacts of an activity on the environmental quality and human wellbeing. Through EIA, positive and negative impacts of the proposed sand mining operation are identified and measures to address adverse impacts are proposed. Very important to this is the appropriate implementation of the mitigation measures to address identified adverse impacts. Accordingly, lack of EIA for mining activities conducted in Thulamela Local Municipality (TLM) could be the root cause of adverse impacts identified by the miners. In addition, lack of EIA supports the view that sand miners and chiefs in TLM violated the provisions of the Mineral and Petroleum Resources Development Act No. 28 of 2002 and National Environmental Management Act No. 107 of 1998.

Opinions of the sand miners on addressing impacts

A question that sought to record the opinions of the respondents about what should be done to combat the adverse impacts of sand and gravel mining was asked. The following frequent opinions were recorded:

> *"The authorities must develop guidelines for sand and gravel mining that every miner must follow and monitor their implementation. This together with enforcement would combat the impacts"*
>
> *"If the Department of Mineral Resources can conduct compliance inspections and enforce compliance where violations detected then the impacts of sand mining would be addressed."*
>
> *"Mined sites must be rehabilitated and recycling building rubble to reclaim sand must be promoted. Mining guidelines to direct sand mining activities must be developed. However, compliance inspections are critical to combating the impacts of sand mining."*

Approximately 80% of the respondents think continuous compliance and enforcement would reduce the adverse impacts of sand mining in the study area. This supports the view that authorities do not conduct site inspections to ascertain compliance of sand mining activities. Compliance with laws regulating sand mining is necessary for responsible and sustainable mining (Amponsah-Dacosta and Mathada, 2017).

4.5 Results of Environmental Impact Assessment

This section presents the results of assessment of the environmental impacts of sand and gravel mining in the study area. Three operations from the study area were selected for the assessment. These were Tswinga gravel, Makonde sand and Tshiombo sand mining operations. They were selected

because they were considered to be the major mining operations in the study area. Approximately 97% of the gravel used for the construction of roads and civil works in Thohoyandou Town and surrounding villages is mined from Tswinga whereas Makonde and Tshiombo operations contribute approximately 75% of building and plastering sand.

Information discussed in sections 4.3 and 4.4 underpin the assessment process. Sections 4.3 and 44 identified these impacts dust generation, huge excavations and excavations containing water, reducing of agriculture land, steep embankment, vegetation clearance and infrastructure damage that this section intends to assess. The impacts and their significance must be assessed in order to develop an action plan to mitigate them. To achieve this, an Environmental Impact Assessment (EIA) was employed and executed through the Rapid Impact Assessment Matrix (RIAM) as per the methodology prescribed in chapter three. It must be noted that this is *ex post facto* EIA where the Environmental Impacts of Tswinga gravel, Makonde sand, and Tshiombo sand mining operations are assessed.

4.5.1 Description of the mining locations

This section provides general information on the settings of mining operations. It describes the previous land use of the operations sites, surrounding land use activities, and any other information important to assessing the environmental impacts.

Tswinga gravel mining operation

This gravel mining operation is located along the road to Ha-Mashawana Village within Tswinga Village. Vegetation surrounding the site comprises shrubs, grass, and indigenous plants. This includes three types of plant species that produce eatable fruits and have medicinal value: *Ximenia caffra*, *Sclerocaryan birrea* and *"Mothwetla"*. Satellite imageries of the dates between 2003 and 2013 on Google Earth show that most parts of the operation site were covered with vegetation. Mining activities have caused and continue to cause vegetation destruction. A grave was identified at the operation site during the field survey.

The site slopes towards the non-perennial stream located on the southern part. Adjacent land use includes livestock grazing and patches of agriculture fields. The site is approximately a kilometer from residential stands. It is accessed through gravel road that passes within residential stands of Tswinga village.

Gravel mined from this operation supply construction industry within the municipality particularly roads and massive building projects. In recent years, Thulamela Local Municipality experiences rapid growth

within the construction sector. The municipality witnessed the development of Thavhani Mall, a massive residence for University of Venda students, and upgrading of gravel roads to tar in Muledane and Maungani villages. Some phases of these projects are yet to be complete. This means that more gravel is required to supply for the completion of the remaining phases.

According to the municipality's integrated development plan for 2019/20, the municipality has approximately 237.7km of tarred roads and 6 582.2km of gravel roads. The municipality anticipates tarring a significant part of the gravel roads by 2030. Gravel roads tarring activities would require a significant quantity of gravel and sand.

Tshiombo sand mining operations

Field survey exposed seven sand mining operations in Tshiombo Village. The operations are adjacent to each other and located on agriculture fields. They are accessed via existing roads used to access the cultivation fields and residential stands. The fields fall under Tshiombo Irrigation Scheme established in 1962 which covers approximately 1 286 hectares (Mudau, 2018). According to the latter researcher, approximately 91% of the farmers in the Tshiombo Irrigation Scheme produce sweet potatoes. Other crops produced include maize, cabbage, and tomatoes. The farmers sell their produce to local markets.

According to Van Averbeke et al. (2011), irrigation schemes contributed positively to rural livelihoods and poverty alleviation in parts of South Africa. This is evident from Tshiombo Irrigation Scheme where majority farmers generate income through selling their produce. However, lack of irrigating water impelled some farmers to sell their fields for sand mining. Possibly this will affect this reputable livelihood activity. As indicated in section 4.3.4 mining activities damage irrigation canals and pipes. This would force more farmers to surrender their field to sand miners.

Vhembe Bioregional Plan was consulted to verify the biodiversity importance of the mining operations. This revealed that the operations are located outside the Critical Biodiversity Areas. Accordingly, operation sites have no significant biodiversity.

Makonde sand mining operation

The operation is adjacent to Agric-Estate in Makonde Village. The northern part of the operation is on the floodplain and riverbank. According to satellite images from Google Earth, the operation is located on land that had agriculture fields and natural vegetation. This complement field survey finding that

exposed that sand mining damaged natural vegetation and farming fields. Evidence of this is the specimen of matured indigenous trees and fruit trees.

Mining activities damaged the electric power line located on the southern part of the operation. Sand miners illegally pass through Agric-Estate and this led to fence damage. The mining is approximately 10m from a river. During the field survey, the operation had minimal mining activities. This is because the area sand reserve is depleted. Most part of the site is covered with grass hence livestock graze on it.

According to Vhembe Bioregional Plan, the operation is located within a Critical Biodiversity Area 1. Thus, the area had significant biodiversity prior to sand mining. Both flora and fauna species found in this area required protection and conservation. In contrast, the mining activities destroyed the biodiversity of the area leaving behind huge excavations with steep embankments. The activities affected riparian vegetation and extended the river bank.

4.5.2 Scoping

Rapid Impact Assessment Matrix (RIAM) requires specific assessment components to be defined through a process of scoping. The components must fall into one of these categories Physical/ Chemical (PC), Biological/ Ecological (BE), Sociological/ Cultural (SC) and Economic/ Operational (EO). Accordingly, the scoping for this study includes three mining operations with 10 PC, 2 BE, 4 SC, and 4 EO components. The components are results of field survey, schedules meetings and review of sand, and gravel mining literature. Considered components and the scoring for each operation are shown in the RIAM matrix in the following section.

4.5.3 RIAM analysis results

The assessment of the environmental impacts of sand and gravel mining followed the methodologies laid in chapter three. This section presents the results. The results (scoring tables) are presented in Table 4.5, 4.7 and 4.9 for transparency and illustrated in Figures 4.12, 4.13 and 4.14. Tables 4.6, 4.8 and 4.10 provide a summary of the scores presented in the latter tables.

In general, the operations have adverse impacts on the Physical/ Chemical components. In contrast, Economical/ Operational components enjoy positive impacts. This is because of the direct and indirect employment opportunities created through sand mining. The results for each mining operation are presented after the Figures 4.12, 4.13 and 4.14.

MAKONDE SAND MINING OPERATION

Table 4.5: Environmental Impact Assessment (EIA) of Makonde sand mining operation using RIAM matrix method

COMPONENTS OF ENVIRONMENT			IMPACT ACTIONS						
Environmental Conditions		**Sub-Components**	**A_1**	**A_2**	**B1**	**B2**	**B3**	**ES**	**RB**
PC	**Land/ Floodplain**	Land Use	2	-2	3	3	3	**-36**	**-D**
		Land Stability	1	-2	3	2	2	**-14**	**-B**
		Soil Conservation	2	-3	3	3	3	**-54**	**-D**
		Landscape	2	-3	3	3	2	**-48**	**-D**
		Aesthetic	1	-2	2	2	2	**-12**	**-B**
		Floodplains	1	-2	3	3	3	**-18**	**-B**
	Air	Dust	2	-1	3	2	1	**-12**	**-B**
		Noise	1	-1	3	2	1	**-6**	**-A**
	Water	Groundwater	1	-2	1	1	1	**-6**	**-A**
		Surface Water	2	-2	2	2	2	**-24**	**-C**
BE	**Flora & Fauna**	Terrestrial Vegetation	3	-2	3	3	3	**-54**	**-D**
		Riparian Vegetation	3	-1	3	3	3	**-27**	**-C**
SC	**Socio-Cultural**	Heritage Resources	1	-1	2	2	1	**-5**	**-A**
	Socio-Health	Accidents	1	-1	2	1	1	**-4**	**-A**
		Health Effects	1	-1	2	2	2	**-6**	**-A**
	Socio-Livelihood	Farming	3	-2	3	3	3	**-54**	**-D**
EO	**Socio-Economic**	Employment	3	3	2	2	2	**54**	**D**
		Construction Sector	3	2	2	2	2	**36**	**D**
		Infrastructure Damage	2	-2	2	2	2	**-24**	**-C**
		Economic	3	3	2	2	2	**54**	**D**

A1 *Importance of Condition,* ***A2*** *Magnitude of Change,* ***B1*** *Permanence,* ***B2*** *Reversibility,* ***B3*** *Cumulative,* ***ES*** *Environmental Score,* ***RB*** *Range Band (description of range bands is provided for in Table 2)*

Table 4.6: Summary of scores- Makonde

Class	-E	-D	-C	-B	-A	N	A	B	C	D	E
PC	0	3	1	4	2	0	0	0	0	0	0
BE	0	1	1	0	0	0	0	0	0	0	0
SC	0	1	0	0	3	0	0	0	0	0	0
EO	0	0	1	0	0	0	0	0	0	3	0
Total	**0**	**5**	**3**	**4**	**5**	**0**	**0**	**0**	**0**	**3**	**0**

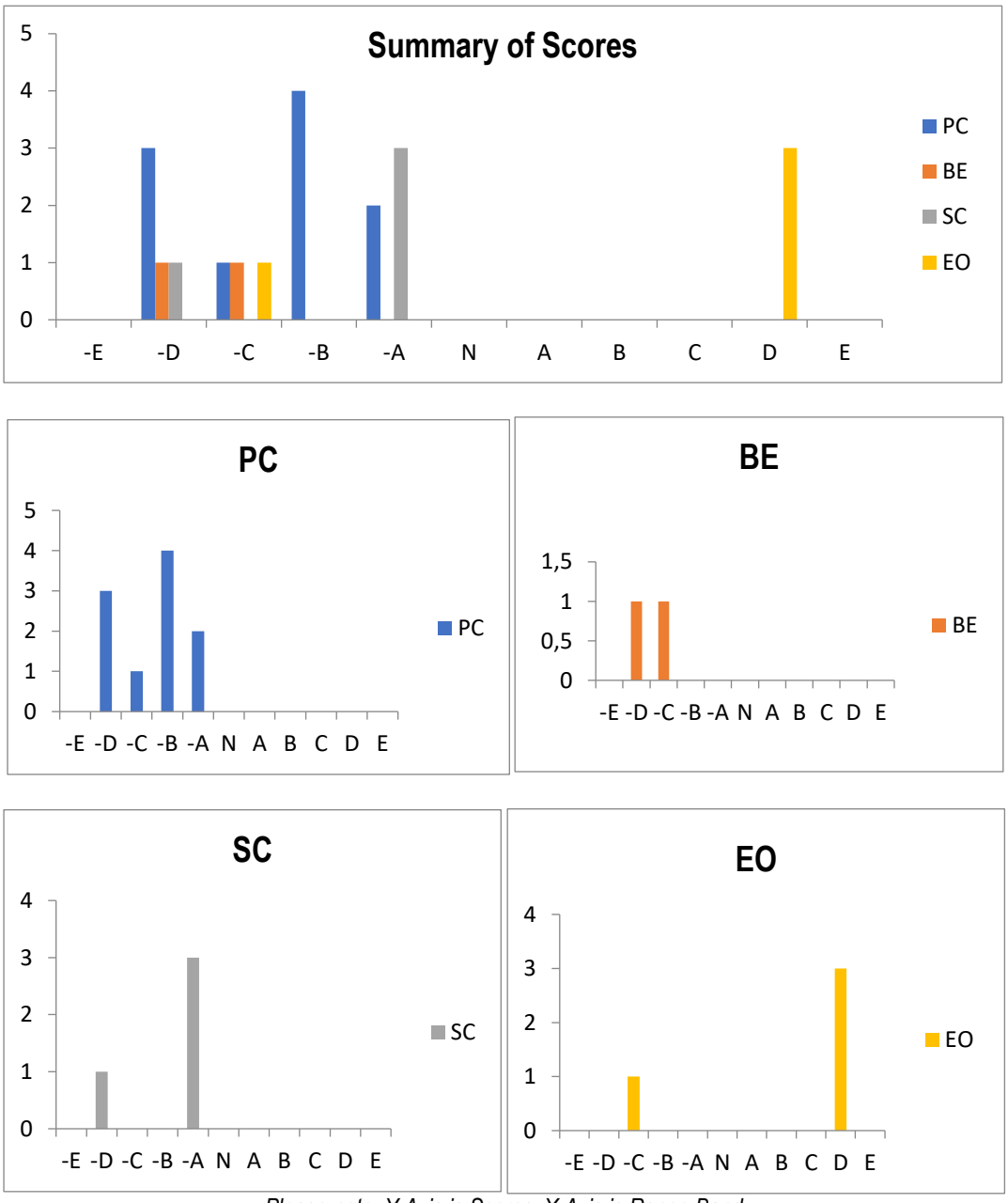

Figure 4.12: RIAM results for Makonde mining operation

Sand mining is a destructive activity associated with various adverse environmental impacts that surface during and post-mining. The environmental impacts of Makonde Sand Mining Operation were assessed using RIAM method. The analysis shows that the operation had adverse impacts on PC, BE, and SC components and positive impact on EO.

Mining activities induced significant negative change on existing land uses, agriculture, and natural vegetation. Farmlands are reduced, and this possibly limits cultivation and production opportunities of the nearby communities. This view is consistent with that of Baba (2017). Baba argues that farmers

whose fields have been destroyed might be discouraged from engaging in farming and be influenced to commit crimes for their survival. This would affect the food security of the region thereby exacerbating poverty.

Most parts of the operation site were covered with natural vegetation. Mining activities induced a significant negative impact on the natural vegetation and soil conservation of the area. This was also observed in the Brong Ahafo Region of Ghana (Baba, 2017). Vegetation clearance is associated with the destruction of fauna species' habitat. Field survey exposed that the operation site was a habitat area for rabbits, jackals, warthogs, and other animals. Due to vegetation clearance, some of these animals migrated to the nearby areas with vegetation that can support their survival. This possibly resulted in shifts in species composition, a decrease in species diversity and abundance, and loss of ecosystem integrity.

Manual and mechanical mining of sand caused a significant negative impact on the natural landscape and low negative impacts on the land stability of the mining site. Specimens of cleared off matured trees are left in large excavation with steep embankments. This has a low negative aesthetic impact. Emerging vegetation lowers the aesthetic impact. Sreebha (2008) asserts that if natural landscapes in any sector were eye-catching, the loss of the same through mining would be aesthetically bad and a possible loss of tourism potential of the area.

Mining activities induced low negative impacts on the floodplain and moderate negative impacts on the riparian vegetation of the river passing on the northern side of the mining operation. This affected the stability of the river bank thereby enlarging the width of the river and increasing the turbidity level of the flowing water. This had slightly negative impacts on the surface water. According to Sreebha (2008), turbidity reduces vision and mask odours, both important for the survival of many fishes.

Despite the adverse impacts associated with Makonde Sand Mining Operation positive impacts were also recorded particularly on EO. Significant positive impacts observed on economic development and employment opportunities. Sand mining has provided direct and indirect temporary and fulltime employment opportunities. People enjoying the benefits of sand mining include but not limited to truck drivers, plant operators, sand traders, bricklaying sector, and construction sector. However, this cannot cloud the negative impacts associated with sand mining. Moderate negative impacts on infrastructure were observed. This includes damage to the electric power line, farm fence, and water conveyance system.

TSWINGA GRAVEL MINING OPERATION

Table 4.7: Environmental Impact Assessment (EIA) of Tswinga gravel mining operation using RIAM matrix method

COMPONENTS OF ENVIRONMENT			IMPACT ACTIONS						
Environmental Conditions		**Sub-components**	**A_1**	**A_2**	**B1**	**B2**	**B3**	**ES**	**RB**
PC	**Land/ Floodplain**	Land Use	2	-2	3	3	3	**-36**	**-D**
		Land Stability	1	-2	3	2	2	**-14**	**-B**
		Soil Conservation	2	-3	3	3	3	**-54**	**-D**
		Landscape	2	-3	3	3	2	**-48**	**-D**
		Aesthetic	1	-2	3	2	2	**-14**	**-B**
		Floodplains	0	0	1	1	1	**0**	**N**
	Air	Dust	2	-2	3	2	1	**-24**	**-C**
		Noise	2	-1	3	2	1	**-12**	**-B**
	Water	Groundwater	1	-2	1	1	1	**-6**	**-A**
		Surface Water	1	-1	1	1	1	**-3**	**-A**
BE	**Flora & Fauna**	Terrestrial Vegetation	3	-2	3	3	3	**-54**	**-D**
		Riparian Vegetation	0	0	1	1	1	**0**	**N**
SC	**Socio-Cultural**	Heritage Resources	1	-1	2	2	1	**-5**	**-A**
	Socio-Health	Accidents	1	-1	2	1	1	**-4**	**-A**
		Health Effects	1	-1	2	2	2	**-6**	**-A**
	Socio-Livelihood	Farming	2	-2	3	2	2	**-28**	**-C**
EO	**Socio-Economic**	Employment	3	3	2	2	2	**54**	**D**
		Construction Sector	3	2	2	2	2	**36**	**D**
		Infrastructure Damage	0	-0	1	1	1	**0**	**N**
		Economic	3	3	2	2	2	**54**	**D**

A1 Importance of Condition, **A2** Magnitude of Change, **B1** Permanence, **B2** Reversibility, **B3** Cumulative, **ES** Environmental Score, **RB** Range Band *(description of range bands is provided for in Table 2)*

Table 4.8: Summary of Scores- Tswinga

Class	-E	-D	-C	-B	-A	N	A	B	C	D	E
PC	0	3	1	3	2	1	0	0	0	0	0
BE	0	1	0	0	0	0	0	0	0	0	0
SC	0	0	1	0	3	0	0	0	0	0	0
EO	0	0	0	0	0	1	0	0	0	1	0
Total	**0**	**4**	**2**	**3**	**5**	**2**	**0**	**0**	**0**	**1**	**0**

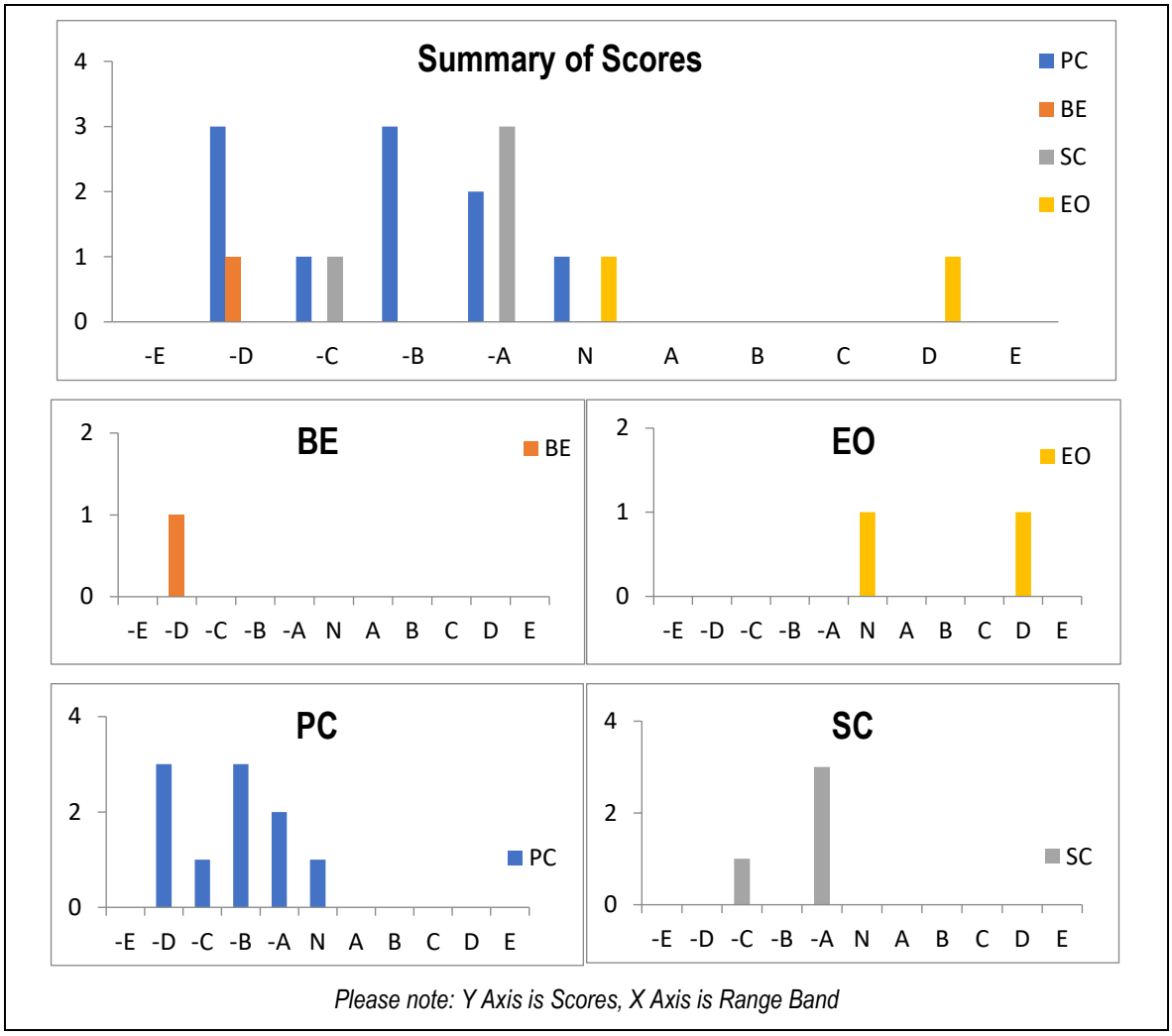

Figure 4.13: RIAM results for Tswinga gravel mining operation

Mining activities at Tswinga Gravel Mining Operation are continuing. The activities had/have beneficial and adverse environmental and socio-economic impacts. The analysis exposed that the activities have significant, moderate, and low negative impacts on PC, BE, and SC components. Significant positive impacts observed on EO components. The results are slightly different from those of the Makonde Sand Mining Operation.

The mining activities had significant negative impacts on land use, soil conservation, landscape, and natural vegetation components. Moderate negative impacts on farming and dust components are recorded. Negative changes in land stability, aesthetics, and noise components are recorded. The economic, construction sector and employment components experience significant positive impacts.

Most of the inland mining activities lead to the clearance of indigenous vegetation. It is true with Tswinga Operation as natural vegetation was cleared off to expose gravel deposits. Considering types of plants that constitute surrounding vegetation, clearance activity caused a loss of *Ximenia caffra*,

Sclerocaryan birrea, and *"Mothwetla".* These plant species have nutritional and medicinal value. Their destruction shall affect the traditional healers that use them for various diseases healing. Apart from the latter, vegetation cover is a habitat for most of the fauna species. Any destruction to vegetation cover means the destruction of fauna habitat. Adedeji et al. (2014) assert that clearing vegetation poses the most serious threat to biodiversity.

Mining activities at the operation site leave behind huge excavations with steep embankments. This is real evidence of natural landscape destruction. Adedeji et al. (2014) and Ako et al. (2014) state that landscape destruction is a significant effect of mining because mining activities usually scar the landscape with excavations and leaving behind unsightly views, which as well render the land unsuitable for any production. During rainy seasons, the excavations collect water and as a result, attract malaria causing insects.

Livestock drink water from the excavations. The steepness and depth most of the excavations make it difficult for cattle that accessed the excavations to drink water to get out. Thus, the livestock lost lives in the excavations. This is a big loss to the farming sectors as grazing land is lost to mining. According to Ako et al., (2014) this denies animals and inhabitants in the area their means of livelihood. Apart from the latter, residents of Ha-Mashawana Village collect and use water from the excavations for washing clothes. In most cases, women with their children are the ones found at the site doing laundry. Studies expose that water-filled excavations encourage swimming, and this pose drowning risks (Amponsah-Dacosta and Mathada, 2017; Madyise, 2013). The operation excavations have swimming potential, and this poses serious life risk to the teenagers that might be tempted to swim.

A moderate negative impact on ambient air is recorded. Dust generated along with the hauling route account for the latter finding. Actual mining activities produce a slight negative impact on ambient air quality. However, the trucks transporting gravel from the operation to customers generate significant dust on the gravel roads. The particulate matter released could affect residents with respiratory problems. This has forced the local headmen to arrange a water tanker that suppresses dust on the gravel road next to Tswinga clinic. According to Akoet al. (2014) air pollution is also one of the environmental impacts of mining of sand and gravel.

Despite the mentioned adverse impacts of Tswinga Gravel Mining Operation, beneficial impacts were recorded. Significant positive impacts observed on economic, employment, and construction sector components. The operation has provided direct and indirect temporary and fulltime employment opportunities. People are enjoying the benefits of gravel mining including but not limited to truck drivers, plant operators, gravel traders, and the construction sector.

TSHIOMBO SAND MINING OPERATIONS

Table 4.9: Environmental Impact Assessment (EIA) of Tshiombo sand mining operations using RIAM matrix method

COMPONENTS OF ENVIRONMENT					IMPACT ACTIONS				
Environmental Conditions		**Sub-components**	**A_1**	**A_2**	**B1**	**B2**	**B3**	**ES**	**RB**
PC	**Land/ Floodplain**	Land Use	3	-2	3	3	3	**-54**	**-D**
		Land Stability	3	-2	3	2	2	**-42**	**-D**
		Soil Conservation	3	-3	3	3	3	**-81**	**-E**
		Landscape	2	-3	3	2	2	**-42**	**-D**
		Aesthetic	1	-2	3	2	2	**-14**	**-A**
		Floodplains	0	0	1	1	1	**0**	**N**
	Air	Dust	2	-1	3	2	1	**-12**	**-B**
		Noise	1	-1	3	2	1	**-6**	**-A**
	Water	Groundwater	1	-2	1	1	1	**-6**	**-A**
		Surface Water	1	-1	2	2	2	**-6**	**-A**
BE	**Flora & Fauna**	Terrestrial Vegetation	0	0	1	1	1	**0**	**N**
		Riparian Vegetation	0	0	1	1	1	**0**	**N**
SC	**Socio-Cultural**	Heritage Resources	1	-1	2	2	1	**-5**	**-A**
	Socio-Health	Accidents	1	-1	2	1	1	**-4**	**-A**
		Health Effects	1	-1	2	2	2	**-6**	**-A**
	Socio-Livelihood	Farming	3	-3	3	3	3	**-81**	**-E**
EO	**Socio-Economic**	Employment	3	3	2	2	2	**54**	**D**
		Construction Sector	3	2	2	2	2	**36**	**D**
		Infrastructure Damage	2	-2	3	2	2	**-28**	**-C**
		Economic	3	3	2	2	2	**54**	**D**

A1 Importance of Condition, **A2** Magnitude of Change, **B1** Permanence, **B2** Reversibility, **B3** Cumulative, **ES** Environmental Score, **RB** Range Band *(description of range bands is provided for in Table 2)*

Table 4.10: Summary of Scores- Tshiombo

Class	-E	-D	-C	-B	-A	N	A	B	C	D	E
PC	1	3	0	1	4	1	0	0	0	0	0
BE	0	0	0	0	0	2	0	0	0	0	0
SC	1	0	0	0	3	0	0	0	0	0	0
EO	0	0	1	0	0	0	0	0	0	3	0
Total	**2**	**3**	**1**	**1**	**7**	**3**	**0**	**0**	**0**	**3**	**0**

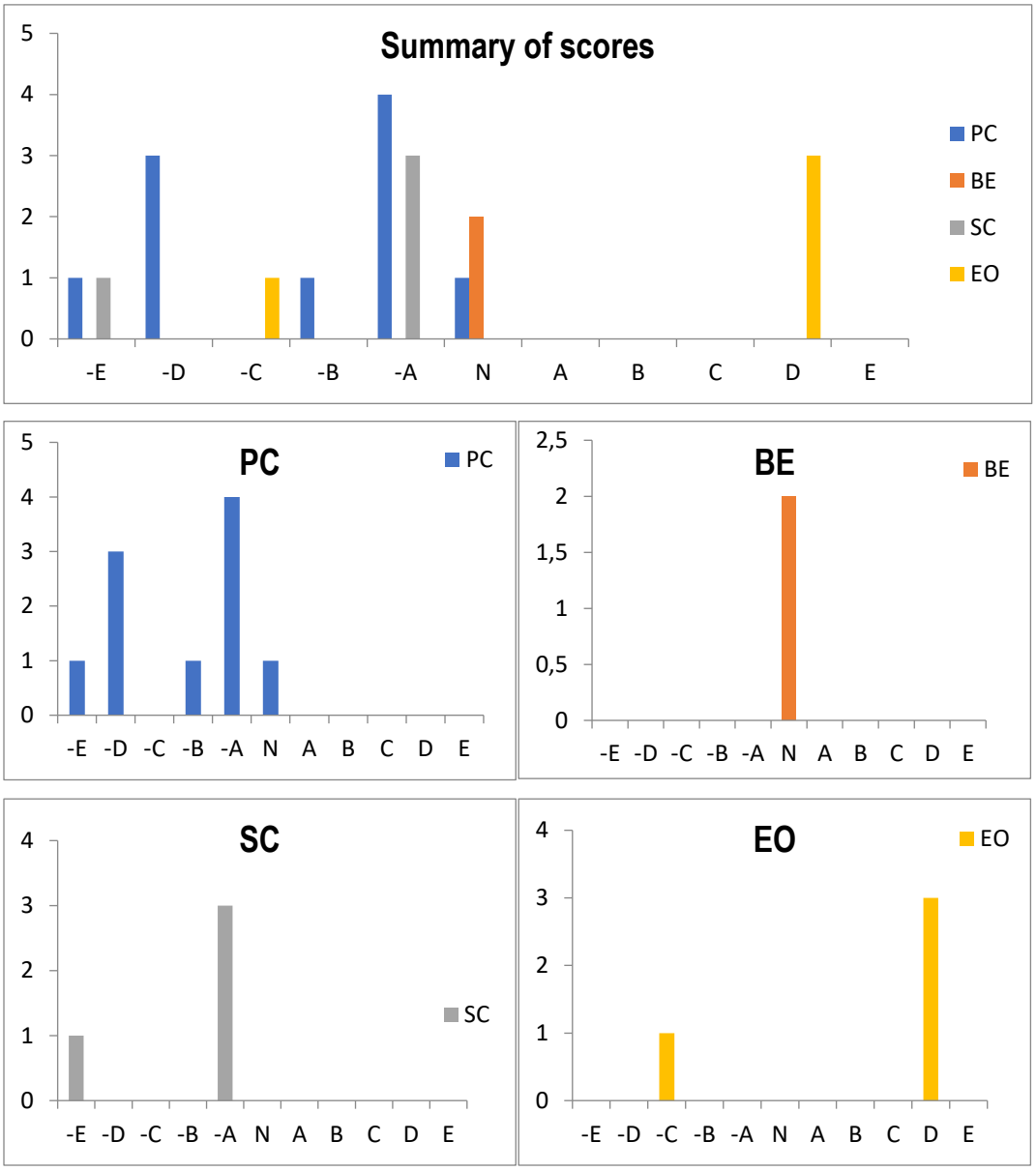

Figure 4.14: RIAM results for Tshiombo Sand Mining Operations

Tshiombo Sand Mining Operations are located in agriculture fields. The analysis shows that the operations have significant negative impacts on PC and SC components. No changes recorded on BE components and positive impacts are recorded on EO components. Sub-components experiencing major negative impacts are soil conservation and farming. Sand mining induces significant negative impacts on land use, land stability, and landscape sub-components. Sub-components experiencing no change include floodplains, terrestrial, and riparian vegetation.

The operations change agriculture fields and leaving behind unproductive land characterized by huge excavations with steep embankments. Continuing mining activities possibly reduce the land available

for cultivation in Tshiombo Irrigation Scheme. A similar situation was observed in Ga District of Ghana where farmers lose their farmland to sand mining (Tagoe, 2015).Sand mining activities deplete topsoil that supports cultivation activities. Probably this will affect food production in a negative way.

Significant positive impacts observed on economic, employment and construction sector components. The operations provide direct and indirect temporary and fulltime employment opportunities. People enjoying the benefits of sand mining include but not limited to truck drivers, plant operators, gravel traders and the construction sector.

4.6 Management of Sand and Gravel Mining

Thirty-five sand miners responded to the schedule questions that sought to get information about the management of sand and gravel mining in the study area. Table 4.11 presents the results of some of the schedule questions on the management aspect. The questions required the respondents to provide yes or no answers.

Table 4.11: Management of sand and gravel mining

Aspects covered by the questions	Percentage distribution of responses	
	Yes	No
Awareness of legislation for sand and gravel mining	11%	89%
Availability of forum where sand mining issues are discussed	0%	100%
Knowledge about prosecution of non-compliant sand miners	3%	97%
Compliance inspections at the mining site by authorities	17%	83%

The table 4.11 shows that 89% of the respondents are not aware of legislation regulating sand mining in South Africa and the remaining 11% is aware. A question sought to establish the respondents' awareness level shown that the entire 11% have little knowledge. All the respondents indicated that there is no forum where issues relating to sand mining are discussed. Only 3% is aware of prosecution of a sand miner that violated legislation regulating sand mining and the entire 97% have never heard of any prosecuted sand miner. Many respondents indicated that no authority that conducts compliance inspection at the mining sites. These respondents account for 83% and those whose mining sites were inspected by the authority accounts for 17%. The respondents constituting 17% indicated that the authority that visits their mining sites is the Department of Mineral Resources. The responses expose that compliance inspection did not fully exist and overall results indicate poor management of sand and gravel mining in Thulamela Local Municipality.

There are two more questions covered that are not presented in Table 4.11. The questions sought to establish mining site owners and the legitimacy of the sites. A question on the type of permit or license the miner has to mine sand shows that all the miners got permission from the chief with jurisdiction over

the mined area. This correlates with the results of the question that sought to establish the mining site owners. All the respondents indicated that the mining sites are owned by the chiefs. According to Chevallier (2014), any person intending to mine sand/gravel must apply to the Department of Mineral Resources for mining rights or permits. Possibly the miners and chiefs are contravening provisions of the Mineral and Petroleum Resources Development Act No. 28 of 2002 and National Environmental Management Act No. 107 of 1998.

Lack of awareness campaigns, compliance and enforcement, and compliance promotions contribute to this possible contravention of legislation regulating sand mining. According to Shimshack (2007), compliance is influenced by regulatory monitoring and enforcement, investor pressure, and management knowledge. In order to ensure compliance, environmental protection and improved living conditions, the department responsible for the regulation of sand mining must consider implementing mining legislation through compliance factors indicated by Shimshack (2007).

4.6.1 Statutes regulating sand and gravel mining

The schedule revealed that DMR uses the National Environmental Management Act No. 107 of 1998 (NEMA) and Mineral and Petroleum Resources Development Act No. 28 of 2002 (MPRDA) to regulate the mining of sand and gravel. These statutes give effect to section 24 of the Constitution of the Republic of South Africa. Despite having authority over the lands used for the mining of sand and gravel, traditional authorities acknowledged that they lack laws to regulate mining. Land-use schemes of Thulamela Local Municipality are applicable for activities conducted within urban areas. Municipality officials indicated that the mining sites are located in rural areas where land-use schemes have no jurisdiction. These findings shaped the following sections that report much about how DMR regulates the mining of sand and gravel in the study area.

4.6.2 Application for mining license

The schedule revealed that any person intending to mine sand/gravel must apply to DMR for a mining permit/ license and environmental authorisation. This individual must appoint an Environmental Assessment Practitioner (EAP) to asses, analyze, predict and record the impacts of the proposed mine. Also, to the latter the EAP would manage the application. An evidence of application for an environmental authorisation is a prerequisite to apply for a mining permit/license. The department would process both applications simultaneously. Public participation is fundamental to the processing of environmental authorisation application.

DMR would issue the license and authorisation once all the requirements of MPRDA and NEMA are satisfied. Permit/license and authorisation are issued with conditions that the applicant is obliged to comply with. These findings correspond with those of Green (2012) and Chevallier (2014). However, during their studies, the Department of Environmental Affairs and the provincial department handling environmental affairs issues were the competent authorities on the matter of mining regulated through NEMA. The amendment of NEMA in December 2014 saw the Minister of Mineral Resources becoming a competent authority on the environmental matters relating to mining activities.

4.6.3 Legitimacy of the mining operations

The officials of DMR were asked questions intended to gather information about the lawfulness of the mining operations in the study areas. The questions exposed that the DMR officials are not sure of the lawfulness of the mining operations. However, the officials are convinced that most of the mining operations are operating without required permits. Their views are supported by the mining permits and licenses database provided on the website of the department. According to the database, none of the listed operations is located within the study area. This finding complements field survey finding on the lawfulness of the mining sites as presented in Table 4.3. Similarly, Nzhelele River Valley experiences illegal mining of sand (Amponsah-Dacosta and Mathada, 2017; Kori and Mathada, 2012). Lack of awareness campaigns, environmental education, compliance inspection, and enforcement contribute to the happening of these illegal and detrimental mining operations.

4.6.4 Methods used to implement mining legislation

The respondents and key informants were asked two questions that sought to the establish methods used to implement legislation regulating sand and gravel mining within the study area. The questions covered these aspects awareness campaigns, compliance inspections and investigations, enforcing compliance and rehabilitation.

Awareness campaigns on mining

The respondents were asked if they received awareness programmes focusing on sand and gravel mining. All the respondents indicated that there are no awareness programmes on sand mining conducted within their areas. This corresponds well with the finding of the schedule meetings with DMR officials that revealed that the Limpopo Region of DMR does not conduct awareness campaigns, research and environmental education on issues relating to the mining of sand and gravel. Also, these results complement the results of the question that sought to establish if the miners are aware of the legislation regulating sand mining in South Africa where 89% of the respondents said they are not aware of the legislation. What an unfortunate situation where miners are not aware of the legislation

that governs their daily activities. This is the root cause of the possible contravention of the provisions of the Mineral and Petroleum Resources Development Act No. 28 of 2002 and National Environmental Management Act No. 107 of 1998.

According to Mukwindidza (2008), a lack of effective methods to implement the policy hinders the successful implementation of the policy. Thus, the study area continues to experience haphazard and detrimental mining activities of sand and gravel. The Department of Mineral Resources as the responsible authority must educate the public and sand miners on the contents and purpose of the statutes regulating sand mining. It is when the regulated community understands the contents and purpose of a specific statute that they can accept and comply with it.

Compliance Inspections and Investigations

The schedule had questions intended to gather information about compliance inspections and investigations conducted at the mining sites. The questions revealed that DMR officials seldom conduct compliance inspections. This is due to a lack of staff. The department has fourteen Environmental Mineral Resource Inspectors (EMRI/s) that service the entire country and only two are in the Limpopo Region. EMRIs are designated in terms of section 31BB of the National Environmental Management Act No. 107 of 1998, amongst other things to monitor and enforce compliance, and investigate any act in respect of which there is a reasonable suspicion that it constitutes an offense or a breach of a condition of an authorisation issued in terms of NEMA or Specific Environmental Management Act as it relates to mining activities.

The schedule exposed that DMR officials prioritize complaints than searching for mining sites that operate in contravention of the statutes. Despite investigating few cases around the study area, the department is yet to institute a criminal prosecution against the perpetrators. This finding corresponds well with the finding that exposed that sand miners operating in the study area are not aware of any person prosecuted for mining of sand or gravel. This contributes to proliferating illegal mining of sand and gravel associated with adverse environmental and social impacts. According to Shimshack (2007), enforcing compliance deters future violations and improves environmental performance. If DMR invests in compliance promotion, compliance inspection and enforcement programmes witnessed adverse impacts possibly will be addressed.

Prosecution of sand mining crimes

A question that sought to establish if the respondents were aware of prosecution relating to illegal mining of sand was asked. The results show that 97% of the respondents disagree that offenders of sand mining legislation are prosecuted. Only 3% that is equivalent to one respondent indicated that

prosecution is sometimes. This respondent indicated that he read from the papers about the company that was prosecuted for violating laws regulating sand mining.

The reason why this 97% of the respondents believe that offenders of legislation on sand mining are not prosecuted is that no sand miner that was prosecuted in their area. Accordingly, the prosecution of sand mining crimes would deter many miners from violating statutes governing sand mining. Deterrence Theory shows that the state's punishment of offenders serves as an example for others in the general population who has not yet participated in criminal events. This is meant to make them aware of the horrors of official sanctions in order to put them off committing crimes.

Miners' opinion on methods to implement mining legislation

The respondents were asked a question that sought their opinion about methods that would improve the implementation of legislation regulating the mining of sand and gravel. The following frequent opinions were recorded:

> *"The responsible authority must conduct awareness campaigns through traditional authorities. We must be told the purpose and contents of those laws"*
>
> *"The stakeholders must form the sand miners association. It is at this platform where laws of and best practice for sand mining would be discussed. "*
>
> *"I think the responsible authorities must educate the traditional leaders about those laws and the traditional leaders will pass the information to us the sand miners."*

Approximately 97% of the respondents proposed that the responsible authority must conduct awareness campaigns where the sand miners would be educated about the contents and purpose of the laws regulating the mining of sand and gravel. Their call is similar to that of Amponsah-Dacosta and Mathada (2017) that environmental awareness training should be conducted for the communities in the vicinity of the extraction sites.

4.6.5 Rehabilitation of mined sites

The respondents were asked a question about the rehabilitation of mined sites. The respondents that said no rehabilitation done account for 77% and those that said yes account for 23%. These results are associated with the identified post-mining impacts of sand mining in the literature (Amponsah-Dacosta and Mathada, 2017). When asked about the impacts of sand mining, some of the miners mentioned excavations that hold rainwater. This poses drowning risk and becoming a breeding ground for malaria-causing insects. Rehabilitating mined sites possibly would prevent these post-mining adverse impacts.

According to Drebenstedt and Singhal (2014), impacts in the natural and social environment during and after mining are relatively balanced through rehabilitation. Lack of rehabilitation within the study area perhaps results from a lack of environmental awareness on the part of both the sand miners and chiefs. There is an urgent need to educate miners, chiefs and public about the adverse impacts of sand mining that would hunt their communities post the mining. This must be led by authorities responsible for regulating sand and gravel mining.

4.7 Summary of the Chapter

The data was analyzed, presented and discussed in this chapter. The results revealed haphazard and illegal sand and gravel mining operations that have adverse environmental and social impacts. The operations contravene the provisions of the National Environmental Management Act and Mineral and Petroleum Resources Development Act. Inappropriate methods of implementing the latter statutes could be blamed for proliferating illegal and haphazardly conducted mining activities. Lack of capacity on the part of the Department of Mineral Resources exacerbates illegal operations.

The following chapter presents an action plan for curbing indiscriminate and irresponsible sand and gravel mining. The development of this action plan is informed by the developed inventory for sand mining, assessed environmental impacts, and examined management practices of sand and gravel mining operations in the study area.

CHAPTER FIVE: ACTION PLAN FOR MANAGEMENT OF SAND AND GRAVEL MINING

5.1 Introduction

This chapter focuses on developing an action plan to control indiscriminate and reckless mining of sand and gravel resources. The action plan is constructed on information provided in chapter four with a particular focus on identified adverse impacts associated with and current management practices of sand mining. The plan is developed to adequately address the most pressing challenges and adverse impacts of sand mining. The chapter covers a summary of challenges and impacts of sand and gravel mining, planning and management strategies, action plan and conclusion.

5.2 Challenges and Impacts of Sand and Gravel Mining at the Study Area

The desire is to use the natural resources to benefit the needs of today and that of tomorrow generation. However, this desire is clouded by unsustainable consumption patterns of natural resources. The unsustainable consumption depletes the resources. Sand and gravel resources are not immune from depletion. Literature reveals that consumption of these resources is higher than the replenish rate (Ashraf et al., 2011, De Lange et al., 2009, Wernstedt, 2000). The unsustainable consumption and lack of governance have contributed to adverse environmental and social impacts associated with sand mining.

Comparable to some parts of the country, Thulamela Local Municipality experiences illegal sand mining accompanied by adverse environmental and socio-economic impacts. Accordingly, this section summarizes the challenges and impacts of sand and gravel mining experienced within the municipality. These are serious challenges and impacts requiring immediate attention:

- Sand miners, headmen and Chiefs are not aware of the environmental impacts of sand mining.
- Sand miners, headmen and Chiefs lack knowledge on laws governing sand mining.
- Regulatory authority, DMR, rarely conducts compliance inspections and enforces compliance.
- DMR cannot ensure proper implementation of laws governing sand mining. Methods being used to implement the laws are ineffective.
- Sand miners do not conduct Environmental Impact Assessment (EIA) before mining the resources.
- Mined sites are not rehabilitated and secured to prevent easy access. Consequently, some of the sites are being used for waste disposal.

- Unrehabilitated excavations contain water and become swimming ponds for teenagers. This poses a drowning risk. Also, the ponds become breeding grounds for disease-causing vectors such as mosquitoes.
- The indiscriminate illegal and reckless sand mining damage public infrastructure such as power lines and water conveyance systems.
- Sand mining activities are conducted on cultivation lands and critical biodiversity areas. They result in loss of biodiversity and indigenous vegetation, reduced cultivation fields, air pollution, soil erosion and habitat destruction.

These challenges and impacts call for strict measures to promote the sustainable development of sand and gravel resources. Thus, strategies and action plans are required to address the challenges and impacts. Accordingly, the following sections present strategies and action plans that are relevant to the challenges and impacts of sand and gravel mining.

5.3 Strategies for Addressing the Challenges and Impacts of Sand Mining

This section presents planning and management strategies to deal with the challenges and impacts of sand mining. The strategies were informed by the literature review and the results of the schedule meetings held with the respondents and key informants. Co-operation between the stakeholders of sand mining is central to the proper implementation of these strategies. Chiefs and headmen must co-operate with the authority, DMR, to ensure that the strategies help to achieve sustainable development of sand mining within their communities.

5.3.1 Awareness campaigns

Sand miners, headmen and chiefs are not aware of the laws governing sand mining as per field survey. This finding concurs with the finding that shows that no awareness campaigns focusing on the regulation of sand mining were conducted within the study area. Consequently, all sand miners are engaged in indiscriminate illegal mining that presents challenges and impacts discussed in chapter four.

DMR must disseminate information about the laws governing sand mining. This can be achieved through awareness campaigns focusing on sand miners, Provincial House of Traditional Leaders, headmen and chiefs. A priority must be given to the headmen and chiefs. This proposal is made on the finding that sand miners sought permission from these authorities prior to mining. Accordingly, if these authorities are knowledgeable about sand mining laws probably, they will inform the miners approaching them to seek permission to mine communal lands.

The campaigns must be accompanied by documents summarizing crucial requirements for authorizing and permitting sand mining operations. The documents must be in clear and understandable language to the miners and traditional leaders. Probably acquired knowledge would encourage miners to comply and conduct their activities in an environmentally sound manner. This will avert the impacts of the low level of public awareness and concern on the environment as observed by Ostrovskaya and Leentvaar (2011).

5.3.2 Sand mining forums

The authority lacks the resources needed to effectively and appropriately administer the implementation of laws regulating sand mining. This is supported by the finding that shows that the authority has fourteen Environmental Mineral Resource Inspectors around the country to monitor and enforce compliance. Two EMRIs are at Limpopo Regional Office. In addition, this office has no directorate that deals with the dissemination of mineral regulation information (education). To surmount this capacity challenge the authority must establish sand mining forums at villages where sand mining is prevalent.

The forums must include Municipality Official from Planning Section, Officials of DMR, Member of Provincial House of Traditional Leaders, Sand Miners, Headmen and Chief. The forums must be established at the chief level and be chaired by the chairpersons of the tribal councils. This arrangement is based on the finding that shows that sand miners operate with the consent from the chief with jurisdiction over the mined area. The important thing about this finding is sand miners respect headmen and chiefs. This makes it easy for traditional leaders to assemble sand miners. For this reason, the DMR must win the support of traditional leaders.

The forums will provide a platform to discuss laws governing sand mining and share information about government funds to uplift small scale miners (including sand miners). In addition, discussions will cover illegal activities, ways to avert impacts, modern technology and challenges of sand mining. It is at this platform where miners can adopt the best mining practices. The municipality will have a chance to share land use plans and this will ensure that proposed mining sites do not conflict with municipality plans. The forums will notify the authority about illegal mining.

5.3.3 Discovering and mapping sand and gravel deposits

Sand mining conflicts with other land uses. As Wernstedt (2000) said, “When an area is growing, more extraction of local construction minerals may be needed, but the growth itself competes with mining activities for land”. This view is supported by the finding that shows that sand mining operations are located on agriculture fields at Tshiombo Irrigation Scheme. The land-use conflicts result from the lack

of and poor spatial planning. The municipality land use ordinances do not regulate land uses in rural areas. Thus, the miners are able to use agriculture fields for sand mining.

This conflict can be resolved through discovering and mapping sand and gravel deposits around the municipality. After mapping the areas DMR must communicate the finding to the municipality and establish sand mining forums. The municipality and chiefs must integrate the information spatial planning. This will ensure that the areas are reserved to allow enough mining to satisfy future local demand.

5.3.4 Environmental impact assessment

Sand and gravel operations cause air pollution, loss of indigenous vegetation, soil erosion, habitat destruction, natural landscape change, loss of agriculture fields and loss of biodiversity. These impacts manifest because sand miners do not conduct EIA prior to mining. It is appropriate that sand mining is conducted only after scientific assessment and adopting best practices to prevent associate impacts. This will support the sustainable development of sand and gravel resources and promote environmental conservation and limit social impacts while underpinning sustainable economic growth.

Apart from identifying and analyzing the significance of impacts, EIA is meant to develop mitigation measures to address adverse impacts and enhance beneficial impacts of the proposed project. According to Glasson et al. (2013), mitigation measures are developed to avoid, reduce, remedy, or compensate for any significant adverse impact and to enhance the positive benefits of the project. Accordingly, adoption of EIA by sand miners will go a long way to ensure prevention of adverse impacts associated with their operations.

5.3.5 Compliance inspections

The parliament of the Republic of South Africa enacted statutes to regulate the mining of mineral resources. The statutes intend to encourage sustainable development of mineral resources. However, the country is yet to realize this. Most of the small-scale miners (including sand miners) continue to contravene provisions of MPRDA, NEMA and sometimes NWA. Amongst the factors contributing to this non-compliance is the lack of compliance inspections by the regulating authority, DMR. Consequently, mining operations causing adverse environmental and socio-economic impacts escalate.

Compliance inspection, as the cornerstone of enforcement, helps authorities to gather the information that assists to judge compliance level of operation. Without compliance inspections, the authority will not know if the regulated sector complies with the law. If conducted, the inspections will assist to

identify indiscriminate illegal sand mining activities that threaten the environmental quality and sustainable social development. In addition, inspections will strengthen the visibility of the Environmental Mineral Resource Inspectors and inform enforcement actions. According to Shimshack (2007), inspections and enforcement activities directly affect future compliance and environmental performance. People are likely to comply if they know that the regulator can inspect their operation at any time.

5.3.6 Enforcing compliance

The study exposed that mining operations of sand and gravel violate provisions of MPRDA and NEMA. The operations have no environmental authorisation and mining permit from the authority, DMR. Despite this, the authority had not instituted any enforcement actions against the miners. This contributes immensely to proliferating mining operations that undermine the conservation and protection of ecosystems that support the livelihood of communities.

The authority must, if it intends to protect environmental quality and secure sustainable social development, institutes enforcement actions to bring non-compliant sand miners into compliance with the provisions of MPRDA and NEMA. According to Shimshack (2007), enforcement is one of the critical determinants of environmental behavior. This is because enforcement actions generate substantial specific deterrence. Thus, DMR must start instituting criminal cases against non-compliant sand miners. This will send a strong message to the community that violators of these statues are prosecuted and sentenced. As general deterrence to motivate environmental compliance, DMR must consider more vigorously publicizing its enforcement actions.

5.3.7 Rehabilitation of mined site

The study shows that miners leave behind unrehabilitated huge excavations characterized by the steep embankment. The excavations have post mining risks. During rain, they contain a significant amount of water that poses drowning risks to people, wildlife and livestock. In some case, the excavations are used for illegal waste disposal, this promotes environmental pollution. Accordingly, rehabilitation of mined sites will prevent these post-mining impacts and provide for sustainable post-mining land use.

According to the Minerals Council of Australia (1998), the main objective of rehabilitation is to protect the safety and health of the people living in areas surrounding the site. Rehabilitation is achieved through re-shaping, grading and establishing a forest or wooded habitat on land affected by mining. Apart from the latter, the mined sites can be developed for wetlands, recreational areas, industry, agriculture, aquaculture, or numerous other uses. In order to easy the rehabilitation process operation

plan must include rehabilitation procedures and processes. This will ensure that rehabilitation is undertaken progressively during the life of the mine. Finally, rehabilitation must satisfy the expectations of the community adjacent to the mined site.

5.4 Action Plan for Controlling Indiscriminate and Irresponsible Sand Mining

The results of this study presented in chapter 4, strategies presented in section 5.3, literature on sand mining have been used to develop the action plans. The section present the importance of planning and of an action plan, a brief discussion of the benefits of and the components of an action plan is provided and the actual action plan.

5.4.1 The importance of planning

According to Alipour et al. (2013), planning is the process of identifying the project work and plans to move future and making decisions about what should be done to reach the goal. Planning leaves written record of plans to guide the behavior of those integrate the organization so that future does not develop randomly but in the way it was planned. This helps an organization to reach goals, create opportunities for implementing decisions, implement systematic plans, increase growth at the macro level and boost the morale of teamwork (Alipour et al., 2013). The systematic plan is the output of planning. This plan communicates organization goals, actions needed to achieve those goals and the entire critical elements developed during the planning process. Thus, a strategic plan provides an overall framework within which all players can find their appropriate roles and make their appropriate contribution.

A strategic plan is implemented through action plans. Because an action plan helps people know what needs to be done to complete a task, project, initiative or strategy. An action plan has programs of commitment to perform certain activities to active the goals (Alipour et al., 2013). Thus, an action plan seeks to address the question “how do we get there?” of the strategic planning. In this study the action plan will assist to answer the question “how to ensure sustainable development of sand and gravel resources?”

5.4.2 Benefits of and components of an action plan

An effective action plan helps to realize the vision of an organization set down in the strategic plan. Thus, without action plans, valuable strategic planning efforts of an organization may be wasted (Alipour et al., 2013). The plan is required to powerfully communicates the goals and provide clear directions. An effective action plan creates an environment in which individuals, team and organizations

are better able to achieve their aspirations. In this context, the following action plans will create an environment where the miners, chiefs and authorities are able to reach sustainable development of sand and gravel resources and achieve conservation of biodiversity. An action plan generally has steps, milestones, and measures of progress, as well as responsibilities, specific assignments and a time line (Alipour et al., 2013).

5.4.3 Action Plan for sand and gravel mining

The primary and long-term goal of this action plan is to promote curbing of indiscriminate and irresponsible sand mining operations and sustainable development of sand and gravel resources. The main features of the plan that must contribute to the achievement of this goal are outlined in several broad areas as follows:

- To encourage dissemination of information on regulatory requirements to stakeholders.
- To create platforms to promote stakeholders' interaction to share information on requirements and technologies applicable to the sector.
- To develop a comprehensive knowledge of Thulamela Local Municipality's sand and gravel endowment.
- To promote Environmental Impact Assessment at proposed sand or gravel mining site prior to mining.
- To encourage streamlining and simplifying the process for acquiring authorisation and permit for sustainable mining.
- To ensure that sand and gravel mining is done in an environmentally sustainable and socially responsible manner.
- To promote compliance with regulatory requirements through enforcing compliance where non-compliance detected.
- To ensure that mined sites are rehabilitated to prevent post-mining impacts.

These features are used to develop Action Plans. Activities are grouped into eight programme clusters based on the necessities of the sand mining sector as expressed by the features. The recommended programme clusters are as follows:

- Programme Cluster 1 – Awareness Campaigns and Education
- Programme Cluster 2 – Establishing Sand Mining Forums
- Programme Cluster 3 – Discovering and Mapping Sand and Gravel Deposits
- Programme Cluster 4 – Environmental Impact Assessment
- Programme Cluster 5 – Integrated Sand Mining Authorisation

- Programme Cluster 6 – Continuous Compliance Inspections
- Programme Cluster 7 – Enforcing Compliance
- Programme Cluster 8 – Rehabilitation

For each programme cluster, the main goal, outcomes, activities and preliminary indicators for tracking the achievement of objectives and outcomes have all been defined. Implementation timeframe is given.

Programme Cluster 1 – Awareness Campaigns and Education

The goal of this cluster is to promote the continuous dissemination of information relating to regulating requirements for sand mining.

The study shows that sand miners, headmen and chiefs lack knowledge on laws regulating sand mining. This has led the miners to engage in mining activities that contravene provisions of MPRDA and NEMA. Lack of awareness campaigns, education programmes, and workshops focusing on sand mining regulation is blamed for this contravention. The regulator, DMR, lacks a directorate that deals with dissemination of information to the public at Limpopo regional office. DMR must establish and operate Mineral Regulation Education Directorate. The directorate must provide awareness campaigns, education programmes, and workshops focusing mineral regulation to sand miners, headmen, chiefs and Provincial House of Traditional Leaders. This would assist miners to comply with the requirements of MPRDA and NEMA. In addition, sustainable development of sand and gravel resources that support economic growth and ecological protection would be achieved. Table 5.1 presents an Action plan for programme cluster 1.

Table 5.1: Programme Cluster 1 Action Plan

Accomplishment	Activities	Time Frame	Monitoring Indicators	Responsible Bodies & Main Actors
Improved knowledge of laws regulating sand mining on the part of sand miners and traditional leaders.	Establish a directorate dealing with awareness campaigns and education programmes.	Once	Availability of the directorate at DMR Limpopo Regional Offices.	DMR
	Develop programmes to upgrade knowledge, skills and technology in sand mining sector.	Continuously	Degree to which knowledge and skills of sand miners improve. Level of improvement in operations of sand mining.	DMR
	Provide programmes to upgrade regulatory requirements knowledge of sand miners and chiefs.	Continuously	Sand miners and chiefs with improved knowledge on regulatory requirement. Increased number of applications for mining permits.	DMR
	Distributing documents providing crucial information on sand mining requirements to traditional authorities.	Annually	Number of traditional authorities who received the documents.	DMR

Programme Cluster 2 – Establishing Sand Mining Forums

The goal of this cluster is to encourage the establishment of a platform where stakeholders can interact and share information on governance and management of sand mining.

Lack of resources needed to implement statutes regulating sand mining is amongst the reasons why DMR fails to ensure effective implementation of MPRDA and NEMA. DMR has limited capacity to facilitates and ascertain compliance with these statutes. In order to surmount this challenge DMR must establish sand mining forums at the villages where sand mining is prevalent. DMR must through the Provincial House of Traditional Leaders (PHTL) request the chiefs to participate in the forums. In addition, the chairpersons of tribal councils must be requested to chair the forums. DMR must workshop the chairperson on laws regulating sand mining and request them to disseminate this information to the public during tribal council meetings. This is on the view that sand mining occurs on the lands controlled by the chiefs and in most cases, sand miners seek permission from tribal councils.

The forums will be platforms where environmental impacts, management of illegal activities, modern technology and challenges of sand mining are discussed. In addition, the municipality will share land use plans, and this will ensure that proposed mine sites are not in conflict with the plans. Table 5.2 presents an action plan for programme cluster 2.

Table 5.2: Programme Cluster 2 Action Plan

Accomplishment	Activities	Time Frame	Monitoring Indicators	Responsible Bodies & Main Actors
Presence of platforms where sand mining stakeholders discuss issues concerning their sector.	Establish sand mining forums at Chief level.	Continuously	Presence of working sand mining forum at tribal councils.	DMR, Chiefs and Sand Miners
	Hold quarterly meetings to share sand mining information and address challenges.	Quarterly	Meeting agenda and minutes, attendance register.	PHTL, Forum's Chairperson
	Maintain forum membership register.	Continuously	Forum memberships register.	Forum's Chairperson

Programme Cluster 3 – Discovering and Mapping Sand and Gravel Deposits

The goal of this cluster is to promote the development of comprehensive knowledge of Thulamela Local Municipality's sand and gravel endowment.

The location of the mining operation cannot be freely chosen but is connected to the deposit that means in location-bound. Thus, the availability of basic geological information would allow sand miners, TLM and DMR to make informed decisions on sand mining developments. DMR must collect and store basic geological information and make it readily available to the public. Because understanding the extent of the available sand and gravel deposits is a fundamental starting point for sustainable mining development. This information will help to prevent land-use conflicts associated with sand mining as the municipalities and traditional leaders will be able to include mapped deposits areas into the spatial development plans. This will ensure that deposits areas are reserved to allow enough sand and gravel mining to satisfy future local demand. In addition, sustain continuous socio-economic growth through supporting city and village development and securing employment opportunities in construction and bricklaying sectors. Accordingly, Table 5.3 presents an action plan to achieve a goal of programme cluster 3.

Table 5.3: Programme Cluster 3 Action Plan

Accomplishment	Activities	Time Frame	Monitoring Indicators	Responsible Bodies & Main Actors
Developed geological information systems on sand and gravel resources to underpin sand mining development.	Discovering and mapping sand and gravel resources deposits.	Continuously	Investigation reports	DMR, Sand Miners
	Develop a data base of areas with sustainable sand and gravel resources.	Continuously	Presence of the data base.	DMR
	Sharing the data base with local government and traditional leaders.	Continuously	Number of municipalities and traditional leaders with the data base.	DMR
	Keeping a data base of already mined sand and gravel areas	Continuously	Number of municipalities and traditional leaders with the data base.	DMR, Sand Miners, Chiefs

Programme Cluster 4 – Environmental Impact Assessment

The goal of this cluster is to create a sand mining sector that is environmentally friendly, socially responsible and appreciated by all stakeholders.

Sand and gravel operations cause air pollution, loss of indigenous vegetation, soil erosion, habitat destruction, natural landscape change, loss of agriculture fields and loss of biodiversity. These impacts manifest because sand miners do not conduct EIA before mining. It is appropriate that sand mining is conducted only after scientific assessment and adopting best practices to prevent associate impacts. This will support the sustainable development of sand and gravel resources, and promote environmental conservation and limit social impacts while underpinning sustainable economic growth. As part of the EIA process, sand miner must develop Mine Plan, Rehabilitation Plan, and Environmental Management Programme. These plans must clearly outline mitigation measures to address impacts identified during the EIA process. Table 5.4 presents an action plan to realize programme cluster 4 goal.

Table 1.4: Programme Cluster 4 Action Plan

Accomplishment	Activities	Time Frame	Monitoring Indicators	Responsible Bodies & Main Actors
A sand mining sector that is environmentally friendly, socially responsible and appreciated by communities.	Identify, assess and report impacts of proposed sand mining operation.	Once	Increased number of EIAs relating to sand mining.	Sand miner
	Encourage public participation during EIA process.	Continuously	Public participation invitations, attendance registers and comments.	Sand miner
	Develop mine plan, rehabilitation plan and environmental management programme. These plans must outline mitigations measures to address the impacts.	Once	Increased number of rehabilitated sand mining sites. Reduced complaints associated with sand mining impacts. Reduced environmental and social impacts of sand mining.	Sand miner
	Lodge applications for environmental authorisation (EA).	Once	Increased number of sand mining operations with EA.	Sand miner
	Lodge applications for mining permits or rights.	Once	Increased number of sand mining operations with mining permits.	Sand miner

Programme Cluster 5 – Integrated Sand Mining Authorisation

The goal of this cluster is to encourage streamlining and simplifying the process for acquiring authorisation, license, and permit for sustainable mining.

A person wishing to mine mineral resources in South Africa is required to obtain an environmental authorisation in terms of NEMA, a mining permit or right in terms of MPRDA and water use license in terms of the National Water Act. This person is required to lodge separate applications for these legal documents. Proof of application for an environmental authorisation is a prerequisite to apply for a mining permit or license. It is a legal requirement that an applicant hire services of an Environmental Assessment Practitioner when applying for an EA. However, it is different when it comes to mining permit and water use license. Despite having the luxury to apply on their own for the latter legal documents most of the applicants prefer to use consultants. This becomes a financial burden to small scale miners (including sand miners) and a barrier for them to apply for required legal documents. The integration of licenses possibly will easy this financial load and encourage miners to apply.

It is pleasing to observe that the process of EA is within the same time frames that apply to mining permit. However, the same cannot be said with process of approving water use licenses. This will continue to create a challenge for sand miners whose proposed mining sites are within a watercourse. According to Azhar et al. (2018), building an integrated mining licensing system in the framework of environmental maintenance can be done through the synchronization of legislation related to mining licensing. Thus, an integrated licensing system can resolve this challenge. Table 5.5 presents an action plan for programme cluster 5.

Table 5.5: Programme Cluster 5 Action Plan

Accomplishment	Activities	Time Frame	Monitoring Indicators	Responsible Bodies & Main Actors
Integrated processes for applications of environmental authorisation, mining permit and water use license.	Develop integrated mining licensing system that includes NEMA, NWA and MPRDA requirements.	Once	Presence of integrated mining licensing system.	DMR, DWS
	Issue integrated mining license for sand mining.	Continuously	Increasing number of integrated licenses.	DMR, DWS

Programme Cluster 6 – Continuous Compliance Inspections

The goal of this cluster is to encourage the implementation of mitigation measures and provisions set out in legislation, mine plan, authorisation, rehabilitation plan, and environmental management programme to achieve sustainable sand mining.

A compliance inspection is central for ascertaining compliance with the provisions of legislation and conditions of licenses. This is amongst the crucial methods for implementing the regulatory framework for mining. DMR seldom conducts compliance inspections at sand mines. This has led to the contravention of NEMA and MPRDA by most of the sand miners. Their operations cause adverse environmental and socio-economic impacts. To address this, DMR must conduct compliance inspections at sand mines. The inspections must inform enforcement actions necessary to address detected non-compliances. It should be noted that environmental impact assessment, compliance inspections, and enforcement actions will ensure that sand mines are developed, operated and closed in an environmentally and socially acceptable manner. This is contributing to sustainable development. Table 5.6 presents an action plan for programme cluster 6.

Table 5.6: Programme Cluster 6 Action Plan

Accomplishment	Activities	Time Frame	Monitoring Indicators	Responsible Bodies &Main Actors
Continuous compliance with sand mining legislation and implementation of mitigation measures to prevent adverse impacts.	Conduct compliance inspection at sand mining operations to ascertain compliance with license conditions.	Quarterly	Increased compliance with EA conditions. Proper implementation of EA conditions.	Sand miner, DMR
	Conduct blitz at unlicensed sand mines to ascertain compliance with laws.	Quarterly	Site inspection reports.	DMR
	Verify implementation of mitigation measures set out in mine plan, rehabilitation plan and environmental management programme.	Quarterly	Inspection feedbacks letters detailing areas requiring improvement. Responses to inspection feedback letters. Availability of internal audit reports.	Sand miner, DMR
	Compile and submit compliance audit report compiled in terms of authorisation conditions.	Biannually	External audit reports compiled by independent auditor submitted to DMR. Feedback letters relating to the review of external audit reports.	Sand miner, DMR

Programme Cluster 7 – Enforcing Compliance

The goal of this cluster is to ensure deterrence through instituting enforcement actions against a violator of laws regulating mining of sand and gravel.

All sand and gravel mines in the study area are operating without environmental authorisation and mining permit. DMR is yet to institute enforcement actions against the sand miners. This contributes immensely to proliferating mining operations that undermine the conservation and protection of ecosystems that support the livelihood of communities. The authority must, if it intends to protect environmental quality and secure sustainable social development, institutes enforcement actions to bring non-compliant sand miners into compliance with the provisions of MPRDA and NEMA. Opening criminal cases against and issuing compliance notices or directives to non-compliance sand miners would send a strong message that violators of NEMA and MPRDA are prosecuted and sentenced. As general deterrence to motivate environmental compliance, DMR must consider more vigorously publicizing its enforcement actions. This can be achieved through implementing activities indicated in Table 5.7 for programme cluster 7.

Table 5.7: Programme Cluster 7 Action Plan

Accomplishment	Activities	Time Frame	Monitoring Indicators	Responsible Bodies &Main Actors
A decrease in number of violations of legislation regulating sand mining.	Instituting administrative enforcement action against non-compliant sand miner.	When necessary	Compliance notice and directives issued to sand miners. Warning letters issued to sand miners. Response letters to notices directives and warning letters from the miners.	DMR
	Instituting criminal charge against non-compliant sand miner.	When necessary	Increasing prosecutions relating to illegal sand mining.	DMR, NPA
	Secure court order to force miners to rehabilitate mined sensitive areas.	When necessary	Court order copies.	DMR, Magistrate
	Publicizing enforcement actions against non-compliant sand miners.	After every enforcement action.	Notices informing the public about enforcement actions taken against miners.	DMR

Programme Cluster 8 – Rehabilitation

The goal of this cluster is to ensure that mined sites are environmentally and socially safe post-mining.

Rehabilitation is an essential part of developing mineral resources following the principles of sustainable development. Some of the risks associated with mining are eliminated through rehabilitation. Due to the lack of rehabilitation of the sand mining sites in the study area post-mining impacts manifest. To combat the impacts, sand miners must rehabilitate all areas affected by mining. This shall protect the safety and health of the people living in areas surrounding the site. Every rehabilitation activity must be carried out as per the rehabilitation plan and mine plan. Rehabilitation must be undertaken progressively during the life of the mine. The already mined spaces within the mining operation can be re-shaped and grated while mining progress. This would easy the revegetation activity and it would be easy for the miner to water the vegetation while still operating the site. Final landforms of the site must be per the wishes of the people as recorded in the Rehabilitation plan. This can be realized through implementing the activities indicated in Table 5.8 that presents an action plan for programme cluster 8.

Table 5.8: Programme Cluster 8 Action Plan

Accomplishment	Activities	Time Frame	Monitoring Indicators	Responsible Bodies & Main Actors
Mined sites without environmental and social risks to benefit safety and health of the people living in areas surrounding the sites.	Monitoring implementation of rehabilitation plan.	Continuously	Conserved top soil, preparation of mined spaces for revegetation.	DMR
	Management of top soil at the operation.	Continuously	Conserved top soil at the operation site.	Sand miners
	Re-shaping and grading of already mined spaces at the operation.	Continuously	Re-shaped and graded already mined spaces at operation site.	Sand miners
	Revegetating landform created through re-shaping and grading.	Continuously	Presence of revegetation activities on created landforms as per rehabilitation plan.	Sand s miner

5.5 Summary of the Chapter

This chapter focused on developing an action plan to control haphazard and careless sand mining in Thulamela Local Municipality. The chapter has four main sections which are the introduction, a summary of the challenges and impacts of sand mining, planning and management strategies for sand mining and action plan.

Sand mining challenges and impacts identified and assessed in chapter four were summarized to allow development of planning and management strategies. The strategies include awareness campaigns, establishing sand mining forums, discovering and mapping sand/ gravel deposits, environmental impact assessment, compliance inspections, enforcing compliance and rehabilitation of mined sites. An action plan with primary and long-term goals was developed based on the strategies. The plan has eight main features that contribute to the achievement of the plan goal. The features turned into programme clusters with defined main goal, outcomes, activities and preliminary indicators for tracking the achievement of objectives and outcomes.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

The primary purpose of this study was to develop planning and management strategies for dealing with problems of proliferated sand and gravel mining in selected villages of Thulamela Local Municipality. This chapter presents a summary of the study, conclusion and recommendation.

6.1 Summary of the Study

Sand and gravel resources are fundamental to construction industry and their mining contributes to economic development of a country. However, the mining operations of sand and gravel are associated with environmental and socio-economic impacts. Their adverse impacts that include degradation of floodplains, habitat destruction and damage of riparian zones, dust and noise pollution, change in land use, deforestation, infrastructure damage, alteration of the water table and water pollution. Although sand and gravel mining pose noticeable threat to the environment and public health and safety, no planning and management strategies to deal with problems of proliferated sand and gravel mining in the study area. Lack of knowledge about environmental and socio-economic problems of sand mining has led to lack of mitigation strategies to reduce the impacts on the receiving environment.

The main aim of this study was to develop planning and management strategies for dealing with problems of proliferated sand and gravel mining in selected villages of Thulamela Local Municipality. The study involved compilation of a comprehensive inventory of sand and gravel mining in the study area, assessment of environmental impacts of sand and gravel mining activities in the area, examination of the current management of sand and gravel mining in the area and development of action plan for curbing haphazard sand and gravel mining. The research approach used to achieve these objectives involved conducting a comprehensive site observation and characterization of the operations in order to document and assess the environmental problems and physical hazards at the operations.

Data was collected through schedules, review of existing documents and field survey. Data collected from thirty-five respondents, eleven informants and fourteen mining operations. The respondents were requested to answer questions put into five categories. The questions sought information on demographics, management and impacts of sand mining, implementation methods of sand mining legislation, and respondents' opinion on what must be done to improve implementation of sand mining legislation and to combat impacts of sand mining. The informants were asked questions on laws, how the laws are implemented, compliance and enforcement actions, permits application processes and

compliance status. Information collected through field survey includes location, equipment used, access control and infrastructure, surrounding land use, environmental and social aspects, rehabilitation status, the estimated quantity of mined resources and lawfulness of the mining operations.

Data was processed and categorized to ensure it is relevant to the objectives of the study and for easy analysis. It was then presented in a tabular form where it was analyzed. Responses from each category were expressed as percentages of total responses per category. Average responses and summaries of all responses were recorded. The results were discussed and compared with relevant literature. Management challenges and impacts of sand mining were identified and discussed. An environmental impact assessment through Rapid Impact Assessment Matrix (RIAM) was undertaken to assess environmental impacts associated with sand mining.

Sand mining operations in Thulamela Local Municipality are mainly located on agriculture fields and lands covered with indigenous vegetation. Gravel mining operations are mainly at hills covered with indigenous vegetation. Approximately 98% of the miners use excavators and front-end loaders to excavate and load the resources into tipper trucks. These unsecured and indiscriminate operations are characterized by deep excavations with steep embankments.

The operations have adverse environmental and socio-economic impacts that manifest during and post-mining. The impacts include changing natural landscape, loss of biodiversity and indigenous vegetation, reduced cultivation fields, air pollution, soil erosion, infrastructure damage and habitat destruction. The miners do not rehabilitate mined sites. Thus, the excavations contain rainwater and in some cases are used for illegal disposal of waste. This causes environmental pollution and poses a health and safety risk to people, livestock and wildlife. Incidents of livestock falling into the excavations were reported.

Sand mining impacts manifest because of a lack of proper planning and management of mining operations. The miners do not conduct any environmental impact assessment to identify and assess the impacts of their operations on the natural environment and nearby communities. They have no plans to guide operational activities.

Despite its impacts, the sector (sand and gravel mining) has created direct employment opportunities for plant operators and tipper truck drivers. It supports employment opportunities in bricklaying and construction sectors.

Sand miners respect their traditional leaders. They always seek permission from village headmen and chiefs before mining communal lands.

Statutes regulating mining of mineral resources are ineffective in Thulamela Local Municipality. All identified operations operate outside the provisions of MPRDA and NAME. The mining operations do not have a mining permit and environmental authorisation. The study revealed that miners lack knowledge of statutes regulating sand mining. This must be the major contributing factor to proliferating illegal operations. Another contributing factor is the lack of compliance inspections and enforcement by DMR. This is a clear indication that there is laxity on the part of DMR in executing its primary and mandatory duty of regulating mining activities.

To have a compliant mining operation, a sand miner must have a mining permit issued in terms of MPRDA and an environmental authorisation (EA) issued in terms of NEMA. If the operation is going to be in a watercourse, a water use license (WUL) in terms of NWA is required. The post statutes are administered by DMR and the latter by the Department of Water and Sanitation. Application processes for these licenses are fragmented and their time frames are not the same. To apply for an environmental authorisation, a miner must appoint an environmental assessment practitioner (EAP). It is very expensive to pay for the services of EAP. Fragmented application processes and cost attached to the applications possibly would discourage small scale miners to apply.

6.2 Conclusion of the Study

This section provides the conclusion of the study originating from the research findings. The main of the section is to present the achievement of the research objectives and provide answers to the research questions. One of the specific objectives of this study was to compile a comprehensive inventory of sand and gravel mining in the study area. This was achieved through a comprehensive site observation and review of existing records relating to authorized and licensed sand and gravel mining operations. This inventory provides information about the location, equipment used, access control and infrastructure, surrounding land use, environmental and social aspects, rehabilitation, the estimated quantity of mined resources and lawfulness of the mining operations. The inventory information will be useful to scholars and authorities, who intend to research on and regulate sand and gravel mining, respectively.

The study assessed the environmental impacts of sand and gravel mining in the study area. This was done through the use of Rapid Impact Assessment Matrix (RIAM). Accordingly, sand and gravel mining was found to have adverse environmental and socio-economic impacts that manifest during and post-mining. The impacts include changing natural landscape, loss of biodiversity and indigenous vegetation, reduced cultivation fields, air pollution, infrastructure damage and habitat destruction. This

will have far-reaching consequences on food production and tourism industries in the Thulamela Local Municipality.

The study also examined the current management practices of sand and gravel mining in the area. The objective was achieved through the use of schedules and reviewing reports and statutes regulating sand and gravel mining. The results show that sand and gravel miners operate outside the requirements of the regulatory framework. They mine sand and gravel without mining permits and environmental authorisations. Factors contributing to the latter include lack of knowledge on statutes regulating sand mining by a miner, lack of compliance inspections and enforcement by the regulator. This is a clear indication that there is laxity on the part of the Department of Mineral Resources in executing its primary and mandatory duty of regulating sand and gravel mining operations. In order to curb illegal sand and gravel mining Department of Mineral Resources must enforce compliance.

The last objective of the research was to develop an action plan for curbing indiscriminate and irresponsible sand and gravel mining. The action plan was developed based on planning and management strategies such as awareness campaigns, the establishment of sand mining forums, discovering and mapping sand and gravel deposits, environmental impact assessment, compliance inspections, enforcing compliance and rehabilitation of the mined site. The primary and long-term goal of the action plan is to promote the curbing of indiscriminate and irresponsible sand mining operations and sustainable development of sand and gravel resources. Also, the action plan will serve as a guideline for planning and managing activities associated with sand and gravel mining operations.

The research has made a substantial contribution to knowledge with regard to the study of sand and gravel mining and its effects on the receiving environment. It will serve as a framework for further studies into issues relating to impacts of sand and gravel mining and management of sand mining in sand and gravel mining fringe communities.

6.3 Recommendations of the Study

Sand and gravel mining operations in Thulamela Local Municipality contravened provisions of MPRDA and NEMA. The operations have various adverse impacts on the environment, infrastructure, and communities. An action plan and management strategies have been developed to avert adverse impacts and promote the beneficial impacts of sand mining. Major recommendations from the study are:

- The regulating authority, DMR, must educate small scale miners (including sand miners) and traditional leaders about the laws that regulate sand mining. Information about processes to apply for a mining permit and environmental authorisation must be provided. This will promote compliance with the regulatory framework.

- DMR together with traditional leaders must facilitate the establishment of sand mining forums. The forums will provide platforms for sharing information on regulatory requirements, funds available to support small scale miners, technologies for effective mining and discussing issues of sand mining. This will promote sustainable development of sand and gravel resources that would benefit current and future generations of the communities where sand is mined.

- DMR must approach the Provincial House of Traditional Leaders to request it to integrate into its meeting agendas an item on regulatory requirements for mining activities. This possibly will facilitate the dissemination of mining regulatory framework information to the communities. Accordingly, compliance with laws regulating sand and gravel mining will be promoted.

- DMR must start inspecting sand mining operations and enforcing compliance where non-compliance is detected. This will promote compliance and ensure a decrease in conflicts between the sand miners and communities affected by the impacts of mining operations. Also, enforcement of statutes will ensure that sand and gravel mining do not have harmful effects on the miners and the surrounding communities.

- Miners must conserve topsoil for replacement during rehabilitation. Likewise, indigenous vegetation and land-use practices that existed before the mining must be reintroduced. The rehabilitation will reduce health and safety risks associated with mined sites. Also, rehabilitation will reduce land degradation and ecosystems disruptions.

- Mining operations must be secured and must have access control. The embankments of the excavations must have approximately 50-degree gradient. This will limit safety and health risk to the surrounding communities, their livestock and miners.

- Sand mining in agriculture fields must be discouraged in strong terms. Mined sites must be identified and rehabilitated to prevent post-mining impacts. If not addressed, mining agriculture

fields will adversely affect food production and increase the level of poverty in sand mining-affected communities. Thus, a conflict between the miners and farmers will arise.

- DMR together with the local municipalities must identify and map areas suitable for sand and gravel mining. This must be accompanied by EIA. The EIA will ensure the identification of impacts associated with the proposed sand mining and proposes mitigation measures to prevent and minimize identified impacts adverse impacts. Also, EIA will promote the sustainable development of sand and gravel resources and reduce conflict between land use activities.

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APPENDIX 1: SCHEDULE FORMS AND FIELD SURVEY FORM

SCHEDULE FORM

I am Tshepiso Morema, a University of Venda student (student number 18020792) doing a Master of Environmental Sciences degree. I request your participation in my research. The research is about the development of planning and management strategies to deal with problems of proliferated sand and gravel mining activities in Thulamela Local Municipality. Your honest answers to the following schedule questions will help me to achieve the aim and specific objectives of the research. In addition to the latter, stakeholders will benefit from a document with strategies for dealing with problems of proliferated sand and gravel mining activities the study will produce. Please note that information provided will solely be used for the research and you are assured confidentiality, privacy and anonymity for such information.

SECTION A

BACKGROUND INFORMATION

1. Sex

Male		Female	

2. Age

19 – 28		29 - 38		39 - 48		49 – 58		>59	

3. Level of education:

None		Primary		Secondary		Tertiary	

4. Respondent's occupation:

Sand trader		Truck driver		Plant operator	

SECTION B

MANAGEMENT OF SAND AND GRAVEL MINING

5. Are you aware of any legislation that regulates sand and gravel mining in South Africa?

Yes		No	

6. To what extent do you understand that legislation?

Lower		Moderate		High	

7. To what extent do other miners understand legislation regulating sand and gravel mining?

Lower		Moderate		High	

8. Do you have a forum where you discuss issues on sand or gravel mining?

Yes		No	

9. What type of permit or licence do you have for the site where you mine sand or gravel?

Mining permit		Mining licence		Environmental authorisation		Chief's permit	

10. Who are the usual owners of the sand and gravel mining sites in the community?

Individuals		Chief		Municipality		Other	

10.1. If the answer to question 10 is other please specify .....

11. Are you aware of any prosecution against any miner of sand or gravel?

Yes		No	

12. Is there any official that visit your mining site to ascertain compliance with mining legislations?

Yes		No	

12.1. If the answer to question 12 is yes please provide the name of the institution the official represents .....

.....

SECTION C

ACTIVITIES LEADING TO ENVIRONMENTAL DEGRADATION

13. Do you think sand or gravel mining activities destroy the environment?

Yes		No		Not sure	

14. What are the environmental impacts of sand and gravel mining that you have observed? .....

.....

.....

15. Is there any environmental impact study conducted at the area planned for mining sand or gravel?

Yes		No	

16. Do miners always rehabilitate the area they have dug up as they search for sand or gravel?

No		Sometimes		Always	

17. Is there any method whereby sand and gravel mining is controlled?

No		Sometimes		Always	

17.1. If the answer to question 17 is sometimes or always, please describe the method used: .....

.....

.....

SECTION D

METHODS USED TO IMPLEMENT MINING LEGISLATIONS

18. Are there awareness programmes focusing on sand and gravel mining within your area?

Yes		No	

19. If, answer to the question 18 is yes, who conducts awareness programmes?

None		Dep. of Mineral Resources		Thulamela	

20. Is it true that offenders of legislation regulating sand and gravel mining are prosecuted?

Yes		No		Sometimes		Always	

SECTION E

PERSONAL OPINION

21. In your opinion what do you think should be done to improve the implementation methods of mining legislation in order to ensure sustainable mining of sand and gravel? .....
.....
.....
.....
.....
.....

22. What suggestions would you give to combat the adverse impacts of sand and gravel mining on the environment? .....
.....
.....
.....
.....

SCHEDULE FORM

I am Tshepiso Morema, a University of Venda student (student number 18020792) doing a Master of Environmental Sciences degree. I request your participation in my research. The research is about the development of planning and management strategies to deal with problems of proliferated sand and gravel mining activities in Thulamela Local Municipality. Your honest answers to the following schedule questions will help me to achieve the aim and specific objectives of the research. In addition to the latter, stakeholders will benefit from a document with strategies for dealing with problems of proliferated sand and gravel mining activities the study will produce. Please note that information provided will solely be used for the research and you are assured confidentiality, privacy and anonymity for such information.

SECTION A

AWARENESS OF LEGISLATION REGULATING SAND AND GRAVEL MINING

1. Does your institution have any mandate to regulate sand and gravel mining?

Yes		No	

2. What legislations do you use to regulate sand and gravel mining? .....
.....
.....
.....
.....

3. How do you implement those legislations? .....
.....
.....
.....
.....
.....

4. What is the state of compliance with the legislations indicate in question 2 with regard to sand and gravel mining activities in Thulamela Local Municipality ("TLM")?

Compliant		Non-compliant		Uncertain	

5. What do you think are the driving factors to compliance status indicated in question 4? .....
.....
.....
.....
.....

6. How often do you conduct compliance inspections at the mining sites within TLM?

Monthly		Quarterly		Biannually		Annually		None	

7. Have you ever received any complaint regarding sand mining activity conducted in TLM?

Yes		No	

7.1. If the answer to question 7 is yes, how did you address the complaint? .....

.....

.....

.....

8. Do you have a list of lawful mining sites that are in TLM?

Yes		No	

8.1. If the answer to question 8 is no, what factors contributes to this outcome? .....

.....

.....

.....

9. Do you know the locations of unlawful mining sites in TLM?

Yes		No	

9.1. If the answer to question 9 is no, what factors contributes to this outcome? .....

.....

.....

.....

10. What actions do you take against illegal sand and gravel miners? .....

.....

.....

11. Is any of the actions indicated in 10 ever been instituted against any miner mining sand or gravel illegally in TLM?

Yes		No	

12. Describe miners' attitude towards legislations regulating sand and gravel mining?

Positive		Negative	

13. Who are the usual owners of the sand and gravel mining sites in the community?

Individuals		Chief		Municipality		Other	

13.1. If the answer to question 13 is other please specify: .....

SECTION B

ACTIVITIES LEADING TO ENVIRONMENTAL DEGRADATION

14. Do you think sand and gravel mining destroys the environment?

Yes		No		Sometimes		Always	

15. What are the environmental impacts of sand and gravel mining that you have observed? .....

.....

.....

.....

16. Do miners always rehabilitate the area they have dug up as they search for sand or gravel?

Yes		No		Sometimes		Always	

17. Are there any methods used to control sand and gravel mining?

Yes		No		Not always	

18. Do you think sand and gravel miners conduct impact study at their planned mining sites prior mining commence?

Yes		No		Sometimes		Always	

18.1. If the answer to question 18 is no, what factors contributes to this outcome? .....

.....

.....

SECTION C

METHODS USED TO IMPLEMENT ENVIRONMENTAL LEGISLATION

19. Does your institution conduct any awareness programmes on mining regulation in TLM?

Yes		No	

20. Are there any special awareness programmes for sand and gravel miners?

Yes		No		Not sure	

21. Is it true that offenders of legislation regulating sand and gravel mining are not prosecuted?

Yes		No		Sometimes		Always	

SECTION D

PERSONAL OPINION

22. In your opinion what do you think should be done to improve the implementation methods of mining legislations in order to ensure sustainable mining of sand and gravel? .....

.....

.....

.....

.....

23. What suggestions would you give to combat the adverse impacts of sand and gravel mining on the environment? .....

.....

.....

.....

.....

FORM FOR FIELD SURVEY

This form will be use during the observation and documentation of sand and gravel mining operations.

1. Location of the mining site:

Khubvi village		Makonde village		Tswinga village	

1.1. Coordinates of the mining site:

South		**East**	

1.2. Type of environmental feature affected by mining:

Flood plain		River channel		Hill		Open field		Other	

1.2.1. If other specify .....

2. Access to the mining site:

Controlled access		Uncontrolled access	

2.1. If access to the mining site is controlled please descript the control measures in place:.....

.....

3. Mining at the site is through:

Manual method		Mechanical method	

4. Mining equipment used at the site:.....

.....

5. Infrastructure present at the mining site:.....

.....

.....

6. Land use of the site's surrounding areas:.....

.....

.....

7. Water table reached during mining:

Yes		No	

8. Mining result to vegetation clearance:

Yes		No	

9. Dust generate by mining activity and trucks collecting the resources:

Yes		No	

10. The footprint of the mined site:

Length in meters		Width in meters	

11. The depth of the mining pit:.....

12. Legality of the mining site:

Licensed		Unlicensed	

13. Evidence of landslide at the mining site:

Yes		No	

14. Presence of water in the excavations resulting from mining:

Yes		No	