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SCHOOL OF ENGINEERING

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

EVALUATION OF SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACTS OF RIVER SAND QUARRYING ALONG NANSENGA STREAM.

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"EVALUATION OF SOCIO-ECONOMIC AND EVIRONMENTAL IMPACTS OF RIVER SAND QUARRYING ALONG NANSENGA STREAM"

BY

CHIFUNDA ISAAC

"REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR OF ENGINEERING AT THE UNIVERSITY OF ZAMBIA"

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DEDICATION

All the efforts and material contained in this report are dedicated to my late parents Mr and Mrs Chifunda for their support and my lovely brothers and sisters for their inspiration.

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I wish to thank my project supervisor **Mr. J. M. Tembo** for his help and guidance during the period the project was carried out, for without him, this project would have not been a success.

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I would also like to thank my family for being supportive in my whole academic career. I thank also all friends and classmates I made during my life in school and also the community and the miners in all the sites for their cooperation.

Lastly, I would like to thank God for according me an opportunity to complete my career and finish my research successfully.

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ABBREVIATIONS

ECZ- Environmental Council of Zambia
LCC- Lusaka City Council
MENR- Ministry of Environment and Natural Resources
NHCC- National Heritage conservation commission
MoL- Ministry of Lands
MMMR- Ministry of Mines and Mineral resources

ABSTRACT

Small scale quarrying is an important informal sector activity providing employment and means of subsistence to a number of residents in the country, and in Nansenga, Katuba and Kasisi in particular. It has been demonstrated that quarrying is a demand driven activity with strong linkages with the construction industry. Its profitability has attracted a lot of entrants (largely unemployed low skilled individuals) into the sector seeking to secure employment and income.

Evidence from this area confirms that small scale quarrying activities can generate quite conflicting effects. For instance, it has been observed that the sub sector incorporates both an important socio-economic potential and serious environmental destructive element. The socio-economic potential pertains to employment and income generation while the destructive aspect relates to areas such as health and safety standards, environmental practices.

Focusing on these aspects, the research looked at economic, social and environmental impacts of river sand quarrying along Nansenga stream. The research revealed that river sand quarrying business has provided a number of disadvantaged people, with very few job alternatives, with employment but however, the activities have resulted into land degradation, soil depletion, unsustainable utilization of resources etc. Based on findings and observations of the research, environmental impacts were assessed and mitigation measures suggested aimed at reducing or eliminating the negative aspects of the sub sector while strengthening its positive contribution and appropriate recommendations were made.

Name of supervisor: J. M. Tembo

Signature: .....

Date: 07/02/2007

SUMMARY

Small scale quarrying is an important informal sector activity providing employment and means of subsistence to a number of residents in the country, and in Nansenga, Katuba and Kasis in particular. It has been demonstrated that quarrying is a demand driven activity with strong linkages with the construction industry. Its profitability has attracted a lot of entrants (largely unemployed low skilled individuals) into the sector seeking to secure employment and income.

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Focusing on these aspects, the research looked at economic, social and environmental impacts of river sand quarrying along Nansenga stream. Based on findings and observations of the research, environmental impacts were assessed and mitigation measures suggested reducing or eliminating the negative aspects of the sub sector while strengthening its positive contribution and appropriate recommendations were made.

CHAPTER ONE

1.0 INTRODUCTION

Most mining policies of the Sub Saharan Africa and the World have mainly focused on large scale mining and quarrying. However there is a strong relationship which exists between the scale of operation and the barriers to entry.

The barrier to entry relates to the requirements for the establishment of a new operation in terms of capital, infrastructure, implementation time and minimum reserves. Low barriers to entry are an essential characteristic of small scale quarrying.

Quarrying activities are rapidly growing into lucrative business in many developing countries. The presence of such activities has however been a source of environmental concern. There is great demand for aggregates, especially limestone, in their form of ''crushed rock'' and it is also an essential constituent in other building and construction materials. For instance, creating one kilometre length of road with a width of 10 metres could use over 500 lorry loads of crushed stone. This means quick business for those providing materials, especially sand and stone.

To feed this construction boom, builders and contractors have gotten into this lucrative resource-extraction business: quarrying sand and stone with scant consideration of the environment. But quarrying activities not only have an impact on the environment, they also often have adverse effects on ''amenity'' or life style of people that live near quarries. Certainly, development in the form of income generation for the people who need it the most, even if haphazard, has come about at the cost of environment degradation.

Not surprising the affected local communities have had to live with increased dust, soil erosion, noise pollution and water contamination resulting in water borne diseases.

In addition, the removal of vast quantities of rock inevitably results in changes in the very shape of our environment. Quarrying can also destroy whole hillsides and layers of

valuable soil. This makes the land hard to use for agricultural purposes and greatly disadvantage those living in the vicinity. There should thus be a time-limit imposed on those who seek to quarry sand, they should not be permitted to quarry for an indefinite time. It is also imperative that those involved in quarrying activities are made to ''reinstate'' the land, though this involves years of careful drainage and land management.

Sadly, however, it has to be noted that it is practically impossible to return the land to the way it was before rock was extracted. This means that species of flora and fauna that were disturbed and destroyed may never be able to re-establish themselves in that area again. For this reason, the trade-off between environmental degradation and people's benefits from the quarrying activities raises a lot of questions: Are the governments and businesses at all serious about implementing sound extraction practices, mitigating environmental degradation, providing greater health and economic security of the affected communities?

Mining operations has been a serious source of land degradation. Small scale quarrying is an important informal sector activity, providing employment and means of substance to a number of residents in the country, Lusaka in particular. It has been demonstrated that quarrying is a demand driven activity with strong linkages with the housing sector. Its profitability has attracted a lot of entrants (largely unemployed low skilled individuals) into the sector seeking to secure employment and income. In many respects, small scale quarrying is an economic and profitable activity with potential to attract tax if properly regulated.

1.2 PROBLEM STATEMENT

Zambia is one of the most urbanized countries in the Southern African region. It has a total land area of 752,614 square kilometres with an estimated population of slightly over ten million people. Of the ten million people, about 40% are in urban areas and the remainder in rural areas.

Despite growing urban population, formal employment has continued declining as social and economic reforms deepened, which implied mass redundancies, both in the private and public sectors of the economy. As a result of general poor economic performance and specifically high levels of unemployment, poverty has over the years become an urban phenomenon and its severity highly differentiated by gender. Poverty broadly defined

includes among others, access to adequate housing, health, education, security and a bundle of goods and services necessary for survival. As population and urbanization increased and urban poverty deepened, the informal sector activities increased side by side with high demand for housing. One of the seemingly lucrative-demand driven informal sector has been the growth of the small scale quarrying in Zambia. Small scale quarrying is the mining of marbles called dolomite, river sand and building sand.

Of concern to government, informal sector experts, environmental activists and residents is the environmental impact of small scale quarrying activities in Lusaka and surrounding areas like Kasisi, Kafue and Katuba. There is observable evidence that small scale quarrying as has been practiced in Zambia leads to a number of negative environmental impacts. These impacts essentially include landscape denudation, dust emissions and implied respiratory infections, various types of pollution (water noise and air) and many others.

Studies intended to investigate the economic and environmental impacts of small scale mining operations are important especially if they are to produce critical policy relevant information that can prove the design and implementation of economic and environmental policies in Zambia.

Therefore the study seeks to undertake an evaluation of social, economic and environmental impacts of river sand quarrying along the Nansenga stream.

1.3 OBJECTIVES

The main objective of the project was:

- To establish social-economic and environmental impacts of river sand quarrying along the Nansenga stream.

The specific objectives of the project were:

- Assess the extent of damage caused by quarrying along the Nansenga stream;
- To suggest mitigation measures aimed at remedying the effects of river sand quarrying; and
- To establish the level of awareness on environmental degradation due to quarrying among the miners and the surrounding community.

1.4 SCOPE OF STUDY

The study focused on the area surrounding the Nansenga stream, it also looked at government institutions like National Heritage Conservation Commission (NHCC), Environmental Council of Zambia (ECZ), Meteorological Department, and Geological Survey Department.

1.5 METHODOLOGY

In order to achieve the objectives of the research the following was done;

- Literature Review;
- Administration of scheduled structured questionnaires to the villagers and the miners in Nansenga;
- Interviews with the miners; and
- Field observation and verification.

CHAPTER TWO

LITERATURE REVIEW

2.0.0 GENERAL CHARATERISTICS OF SMALL SCALE QUARRYING AND MINING

A quarry is a specialised open pit operated to extract construction materials. Quarrying is therefore the act of extracting useful materials from a pit.

To many people, quarrying is perceived as a collection of informal activities, an alternative breathing space created by the poor, lacking regulation and sensible forms of operation. In many developing countries, these activities are also conceptualised as a response by people to handle poverty themselves in its various forms. Among its salient features that lead to this conceptualisation include, easiness of entry, i.e., it does not require investment in training and high level of skills, it is labour intensive and attracts cheap labour thus giving employment to a lot of people. It operates outside the Government structured administration and institutional framework and therefore one enters as opportunities arise. and is not bound to adhere to any licensing or procedural requirements. In most cases payment of tax may also be evaded.

This negative conceptualization has also led to some definitional problems for these activities.

According to Priester et al., 1993, the definition of small scale quarrying in developing countries is usually based on subjective criteria some of which characterize this sector as a craft-activity. These criteria are:

- Absence or low degree of mechanization due to high proportion of heavy manual labour;
- Low safety standards;
- Poorly trained personnel;
- Lack of technical personnel;
- Low pay scale;
- Low work productivity;
- Chronic lack of capital; and
- Some illegal operations due to quarrying without concession rights.

2.1.0 RIVER SAND QUARRYING

Small scale miners use very little systematic exploration before and during mining operations. In the rainy season the miners use simple tools mainly the shovels and hoes. During dry season when the earth is dry they also use picks to extract sand from the earth. The excavated river sand is now heaped waiting to be transported to the construction site.

2.2.0 RECENT STUDIES ON MINING AND QUARRYING ACTIVITIES IN DEVELOPING COUNTRIES

2.2.1 JAMAICA CASE STUDY

According to the research conducted on river mining in Jamaica (DFID project R7814, 2003). Mining activities have significant social and environmental impacts in all phases of development, positive as well as negative and the appropriate technical and strategic mitigation measures to address these impacts were identified. The sites broadly designated for investigation included all significant legal and illegal operations on the Yallahs river basin South East of Kingston and the lower Mihno river basin West of Kingston on the Southern side of Jamaica.

As might be expected, the two principle impact of river quarrying activities was physical and aquatic. The remaining impacts were largely secondary ones that arose from the physical and water impacts. However, some 'socio' impacts cannot strictly be assigned to the environmental aspects alone, as they are a hybrid of environmental, social, and economic parameters. Some of these parameters may improve the social condition (such as income and local revenue generation) and some may reduce it (such as loss of access to clean water).

The critical factors that affected the nature and degree of environmental and social impacts include;-

- The legal status of the miners;
- Agency funding and corruption;
- Government agency coordination; and
- Regulatory development and enforcement.

2.2.1.1 POTENTIAL IMPACTS OF RIVER MINING

2.2.1.1.1 Physical impacts

The study revealed that river sand quarrying causes undermining of bridge piers and structures, and exposure of buried pipelines, cables e.t.c. quarrying also increased channel instability, triggered bank erosion in previously stable areas, increasing sediment yield and resulting in ecological effects such as loss of riparian vegetation, wildlife habitat, shade and cover to the channel.

Figure 2.1: Extraction of river terrace deposits

Figure2.2: Undermining of road causeway.

2.2.1.1.2 Water impacts

The study revealed that river sand quarrying has potential to produce an environmental effect or impact. Typically the regulated and non regulated discharge of solid and liquid wastes and products were the main contaminants of water.

2.2.1.1.3 Biological impacts

The study revealed that exploration operations varied, to a degree, disturbed soils, vegetation, fauna, and sites of cultural significance and contaminated or polluted ground, and air resources.

In general the excavation of material did not cause direct biological impacts as was the case with exploration these were typically mediated through physical and water impacts. These caused changes in nature and diversity of flora and fauna in, or down stream of the extraction area.

2.2.1.1.4 Socio-health impacts

The study revealed human health impacts were typically mediated through physical and water impacts for example, changes in flow regime caused the prevalence of certain illnesses or diseases via vectors such as mosquitoes, or caused health problems due to the deterioration of the quality of water used for drinking, bathing, and other domestic purposes. The effects ranged from minor, subtle, and interceptible effects involving dust, run-off, seepage, and vibration to major permanent and irreversible ecological transformations, rendering mined areas useless for subsequent socio-economic development.(Godoy,1985).

Figure: 2.3 Local people use the river for washing and drinking water.

2.2.1.1.5 Socio-Economic impacts

The revealed that many new quarrying sites, indigenous landowners received compensation for the use of their land and damage done to it. This presented a positive socio-economic impact for communities affected by quarrying activities. Other negative impacts presented emanated from inequitable compensation payments caused by; -

- Arbitrary land valuation procedures;

- Confusion overland entitlement;
- Fluctuations in profits of the company; and
- A tendency to distribute compensation to the land lords rather than tenants.

2.2.1.1.6 Socio-livelihood

The study revealed that river sand quarrying potential for employment creation that was particularly important with regard to livelihood. Although this potential had been reduced with the tread toward mechanisation, Radetzki (1994) showed that the operational investment of mining could extend into domestic economy and create employment.
The other impacts associated with socio livelihood included:

- Loss of access to clean water
- Loss of land and access to land.

Figure2.4: Accumulation of coarse waste

2.2.2 Kilimanjaro case study

According to the case study of the Kilimanjaro volcanic rocks and coastal sands and limestone in Dar-res-salaam area in Tanzania (S.S.M.C, 1998), mining activities have been found to be in conflict with nature. The activities deal with displacement and destruction of rock masses, which is always associated with various negative impacts. (S.S.M.A.C 1998).

It was revealed that the quarrying activities have both negative and positive effects on the social community and the environment. Most of the positive impacts are linked with socio-economy, while the negative impacts are mainly related to the environment.

Most of the issues discussed in relation to mining activities have always been negative. Some few important positive factors have remained unmentioned and these are:

- Socio-economic changes – provides security of employment and income in many rural communities and have been a source of alternative employment.
- Provision of construction and building materials- plays an important role for the infrastructure development of rural areas.
- Provision of drinking water reservoirs-water accumulation in abandoned quarries can solve water storage problems.

Although the mining activities provided employment and income in the rural areas, the study revealed that mining activities have become a source of total environmental degradation if they were not controlled. Several negative effects were not in the mining centres, and some of the most important impacts are presented below.

2.2.2.1 Change of Landscape

The study revealed that large and small open quarries that were left unattended after mining activities ceased were the major cause of the landscape destruction and some quarries had given rise to severe gully erosion that leaves vast areas of wasteland.

2.2.2.2 Land degradation

The study showed that during the dry season, land surface was covered with fine sediments, that caused siltation of the water during rainy season and mud cracks, which destroys top humus soils.

2.2.2.3 Destruction of roads, bridges and houses.

The study showed that sand mining in urban river banks has accelerated erosion that disturbs bridges, houses and roads near such rivers.

2.2.2.4 Air quality

Dust emission during quarrying was the main source of air pollution, and this red dust coats leaves of plants, buildings and land surface and it was this material carried by rainy water that caused siltation.

2.2.2.5 Industrial Waste Dumping Site

The abandoned quarries were used as industrial waste disposal which had rapidly surfaced as a potential health hazards surrounding urban areas.

2.2.2.6 Poor Health and Sanitation

The working environment for the miners was very poor. The miners suffered from occupational hazards such as mine accidents, inhalation of toxic fumes from working machines and dust. They worked without protective gears.

2.2.3.0 COPPERBELT PROVINCE CASE STUDY

According to the case study of the mining activities in Kitwe, Zambia (Zambia Consolidated Copper Mines, 1994). Mining activities are likely to have a considerable adverse impact on land, water, air, and biological resources and also initiate social impacts because of increased demand for housing and services in mining areas. These impacts are part of the price paid for the benefits of mineral consumption. It is unrealistic to expect that we can mine our resources without affecting some aspect of the local environment. We must however, hold the adverse impact to a minimum (Keller, 1988).

2.2.3.11Impacts on land

Mining activities disturb the land by directing removing material in some areas, thus changing topography, and by dumping waste in others. At best these actions produce severe aesthetic degradation.

2.2.3.2 Impacts on the Hydrosphere

Water resources are particularly vulnerable to degradation even if drainage is controlled and sediment pollution reduced ; surface drainage is often altered at mine sites, and surface runoff from precipitation (rain) may infiltrate waste material, leaching out trace elements and minerals. Trace elements (cadmium, cobalt, lead and others), when leached from mining wastes and concentrated in water, soil or plants, may be toxic or may cause diseases in people and other animals who drink the water, eat the plants, or the soil.

2.2.3.3 Impacts on the Atmosphere

Atmospheric emissions attributable the extraction stage of mining come mainly from the action of wind on disturbed land and stockpiles of ore and waste material. Other sources include underground ventilation systems, machinery movement and exhaust, and reactions such as oxidation or radioactive decay of ores. The extraction stage primarily produces larger particles with limited dispersion, which have major effects on mine workers and occasionally on local residents.

2.2.3.4 Impacts on Bio-environment

Environment protection can form part of the planning and design of contemporary mines with benefits to both the company and the community (Environment Protection Agency, 1995). Community standards have evolved to the point where principles of ecologically sustainable development, such as protecting endangered wildlife and minimizing air pollution and air-borne dust, must underpin acceptable mining practice.

2.2.3.5 Social impacts

Social impacts associated with mining results from a rapid influx of workers into areas unprepared for growth. Stress is placed on local services, water supplies, sewage and solid waste disposal systems, schools, rental housing.

Land use shifts from open range, forest, and agriculture to urban patterns. More people also increase the stress on near recreation and wilderness areas, some of which may be in a fragile ecological balance.

Construction activity and urbanization affect local streams through sediment pollution, reduced water quality, and increased runoff. Air quality is reduced as a result of more vehicles, dust from construction, and generation of power (Keller , 1988).

Table 2.0: Other studies on quarrying

AUTHOR /YEAR	TITLE	OBJECTIVES	FINDINGS
Nkhuwa (1992)	Karst problems in marble areas of Lusaka.	To study the cause of failure of engineering structures in Lusaka.	Difficult drainage problems leading to flooding, groundwater pollution, accelerated solution of marble due to percolation of acidic waste.
Mkandla (1990)	Production of Aggregate by breaking limestone rock.	To establish the pull factor in quarrying, extent to which earnings meet basic needs, to locate the situation of women in the informal sector.	Over 40% aged over 40 yrs, started about 1986, poverty main pull factor, over 70% of sample had only primary school level of education. Recommended ways of making 'stone breaking' by providing basic tools, marketing arrangement through

			cooperatives rota system of selling.
	REGIONAL CASE		
Milne et al (1996)	Small Scale Gold Panning in Zimbabwe	To complete a cost benefits analysis and make policy recommendations.	Alluvial and riverbed gold panning as presently practiced although resulting in substantial benefits to miners is uneconomic to society.

2.5.0 Environmental Control and Mitigation.

Worldwide, mining activities always have been associated with direct negative impacts to the environment. Research conducted by the university of Dar es salaam has shown that implementation of existing legislation in that country before, during and after mining will help the environment to regenerate itself to its original form. In practice, most of the existing national legislation is not implemented, partly due to informal practices like small scale mining activities or lack of educational knowledge.

Most of the miners are not aware of the legislation that protects the environment. Field demonstrations, workshops and seminars on environmental impacts caused by mining activities, conducted with the participation of the miners, indicated clearly that miners were anxious to learn methods that can protect the environment during mining activities. Mitigation and control actions include mobilization of the mining community on the following:

- Technical training on environmental protection procedures;
- Reduction of health risks by promoting dust proof masks, gloves, proper clothing, boots, and goggles during mining activities. All quarries should be equipped with

first aid kits, good sanitary facilities and clean water have to be given priority prior to the opening of a quarry;

- Since very little can done to restore quarries to original landscape due to removal of large volume of materials during quarrying, miners should fence and revegetate the quarry slopes in order to reduce erosion;
- Waste disposal in quarries can be conducted after detailed examination of the type of rocks, groundwater pattern and geotechnical data and Industrial waste disposal in quarries should be prohibited; and
- Water harvesting should be promoted, especially during planning stages of quarrying activities.

Research conducted by Zambia Consolidated Copper Mines in Kitwe, on the Copperbelt Province of Zambia has clearly shown that cooperatives or individuals involved in mining and / or quarrying can have environmental restoration carried out successfully. Therefore, some of the most severe environmental implications brought about by human intervention can be cushioned significantly, if the following mitigation measures are put in place:

- Reclamation, backfilling and slope engineering;
- Vegetative stabilization; and
- Physical stabilization; covering with inert material such as slug, soil concrete.

However, nowadays particular attention is given to the following approaches;-

- Increased use of waste material for mine backfilling, roads, construction;
- Increased use of non-entry methods of mining and alternative methods of disposal;
- Appropriate waste-dump siting; and
- Gaseous pollutants are controlled by removing them from their gaseous environment to either liquid or solid surface, where they are preferentially retained or where they react to form a non-polluted species or a species that is more readily removed than the original contaminant.

Ecosystem restoration is a relatively new science even though humans have been disturbing the land for many centuries. Many organisations are developing the expertise to re-

assemble species into communities that have a chance to grow, develop and rebuild local diversity.

This is particularly important where they may be impacts on rare or endangered species of plants or animals.

Areas that require rehabilitation or re-vegetation in mining areas on the Copperbelt have been identified as the overburden dumps, tailings dams, waste rock dumps, stockpiles areas, open pit areas and plant areas.

Other studies conducted in Zambia concerning the state of the environment have also given rise to recommendations that implore government to embrace economic status of the people involved in small scale mining and quarrying.

According to Environmental Council of Zambia, the following are the key problems affecting environmental management in Zambia;-

- Absence of an umbrella policy on environmental and natural resources management;
- Fragmentation of environmental legislation;
- Inadequate co-ordination between and among environmental institutions;
- Inadequate provisions for local community and public participation in the formulation and implementation of policies for management of the environment and natural resources; and
- Inadequate provisions of incentives to local communities and to private sector investors participating in environmental management (ECZ, 2000).

2.6.0 SUMMARY OF RECOMMENDATIONS FROM PAST STUDIES ON MINING AND QUARRYING

With regard to the environment, the research conducted by Dar-es salaam University had shown that small scale mining activities, particularly quarrying of building and construction materials, cause considerable environmental degradation over the years by leaving unattended wastelands.

According to the research, socio, technical, and financial aspects that can improve small scale mining activities include:

- Provision of improved technology which is two-fold; it will lead to less mining of non-renewable mineral resources, and secondly, miners use the scientific knowledge to reduce environmental impacts;
- Development of human resources through technical training in mining sites, field demonstrations etc;
- Government providing essential services to the miners. Miners need better health services due to increased health risks and accidents as a result of continuous change of working environment; and
- Improved information systems that can warn miners in case of heavy rains, floods, land slides, overcrowding, outbreak of infectious diseases, etc.

The legal aspects include the enforcement of the national legislation that protects the environment. The mining act of that country (Tanzania) requires possession of licences in order to participate in different activities of mining. Miners require specifying how they will protect the environment in undertaking their operations. But, in practice, mining activities have done little to protect the environment. Some of the measures that can be practiced by miners include:

- Conducting environmental impact assessment, prior to issuing prospecting rights to the small scale miners.
- Making sure mining permits include conditions for environmental protection, specific to that type of mining activity.
- Programmes have to be established to reclaim former or abandoned mine sites. Special care should be given to quarrying activities, whereby site selection is an important factor for future reclamation of the hollow space. (S.S.M.A.C, 1998)

With regard to research conducted on the socio-economic and environmental impacts of river mining in Jamaica. It was recommended that;

- To develop a memorandum of understanding between departments regarding monitoring and enforcement responsibilities.
- The agencies charged with monitoring should have the enforcement authority;
- The agencies involved should be adequately funded; and

- To ensure that post-closure commitments are met. This refers to the depositing of a sum of money with a consent authority by the mining company before operations begin. This deposit is intended to guarantee the reclamation and rehabilitation of the area mined.

CHAPTER THREE

DESCRIPTION OF THE STUDY AREA

3.0 Introduction

This chapter highlights the characteristic features and basic facts about the study area. Principally, this ensures enhanced comprehension of the socio-economic status of the people while, at the same time, outlining the geographic setting of the study area. A more focused approach was employed in order to investigate the effects of mining and quarrying activities along Nansenga stream. Thus, the description of the study area offers a sound basis for realistically undertaking the above mentioned study.

3.1 Location

Nansenga stream is in southern province of Zambia, it cuts across the Livingstone road and is approximately 8 km from the Lusaka-Chirundu and Livingstone road junction.(figure below shows the location of the area).

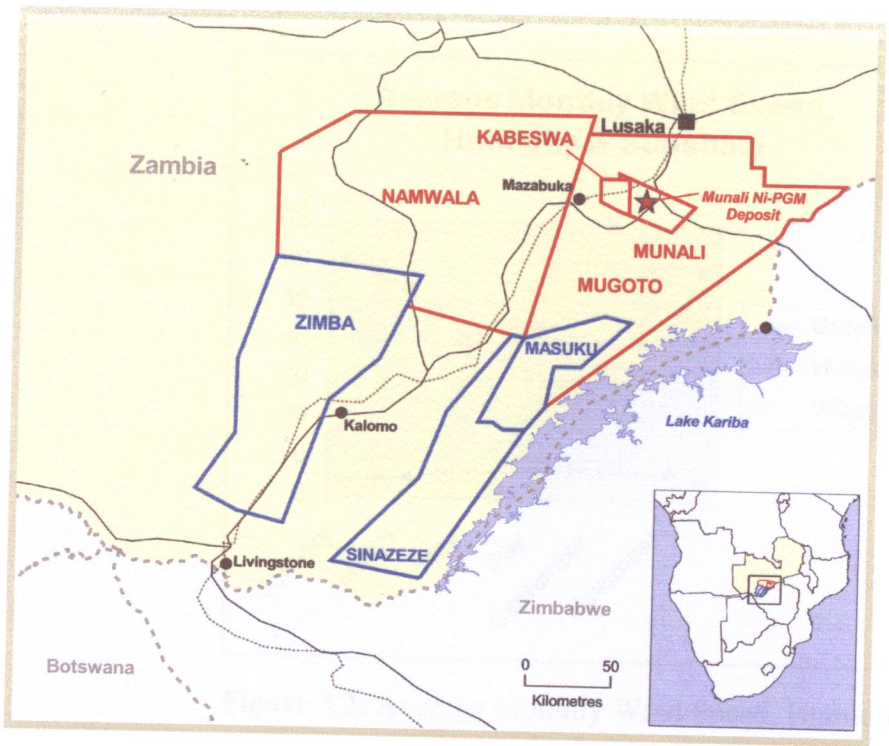

Figure 3.1Location Map of the Project area

3.2 Climate

3.2.1 Regional Rainfall, Temperature, Humidity, Wind Speed, Evaporation and Sunshine Data

The Southern Province of Zambia lies in a low rainfall zone of the country. Rainfall mainly occurs in heavy thunderstorms producing typical precipitation events of 10 to 40 mm. The region has distinct dry (May to October) and wet (November to April) seasons. Temperatures range from 9.5^0 to 32^0.

Department of Meteorology 30-year climatic data (1974 - 2004) for Southern Province town of Kafue indicates mean annual rainfall to vary between 502.6 and 1159.2 mm per annum. The average rainfall, maximum and minimum temperatures, Wind speed, Humidity and sunshine data for Kafue, 1974 - 2004 are presented in Figures 3.2 and 3.3. Thirty year meteorological data sets covering rainfall, temperature (minimum and maximum), wind speed, humidity, sunshine and evaporation were collected from the Zambian meteorological department and are summarised in the figure below.

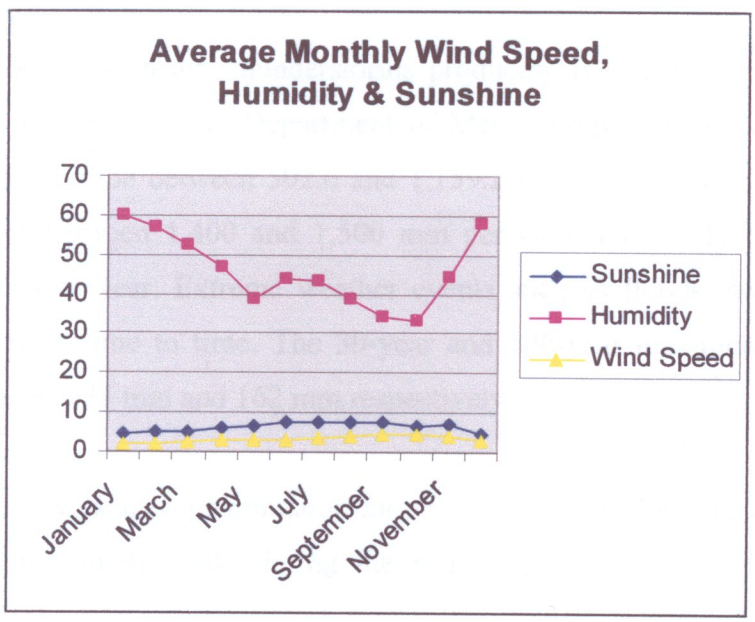

Figure 3.2: Average Monthly Wind Speed, Humidity & Sunshine.

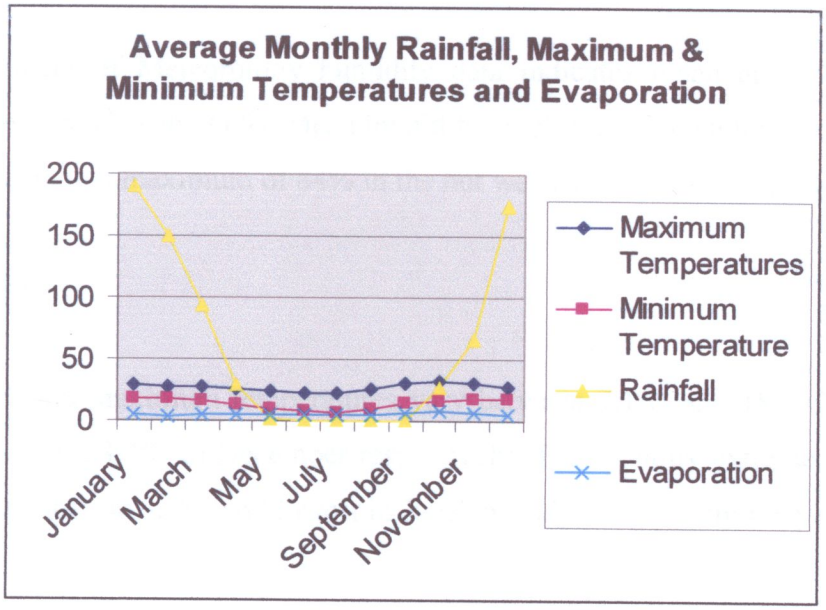

Figure 3.3 Average Monthly Rainfall, Maximum & Minimum Temperatures and Evaporation.

3.2.1.1 Rainfall and Evaporation

Rainfall mainly occurs in heavy thunderstorms producing typical precipitation events of between 10 and 40 mm. Zambia Department of Meteorology rainfall data indicates the mean annual rainfall to be between 502.6 and 1,159.2 mm per annum in the Kafue area. Annual rainfall of between 1,400 and 1,500 mm per annum is likely to be reached or exceeded once in five year. Extreme weather events such as floods, droughts and high winds do occur from time to time. The 30-year and 100-year maximum 24-hour storm event is calculated as 135 mm and 162 mm respectively.

Evaporation generally exceeds precipitation for most of the year. Potential evaporation is highest in the driest months and during the beginning of the summer (September to November).

3.2.1.2 Humidity

Zambia Department of Meteorology humidity data indicates mean annual humidity at Kafue to be between 33% and 60%. Mean humidity levels vary from a minimum of 27% in the cool dry season to a maximum of 84% in the hot wet season.

3.2.1.3 Temperature

Mean minimum and maximum temperatures vary between 7.1°C and 18.4°C in June and between 22.9°C and 28.2°C in December respectively. The monthly extreme temperatures are highest in October, at 32°C, and lowest in June and July, at approximately 6.4°C.

3.2.1.4 Sunshine

Mean annual sunshine in Kafue is about 4.4 to 7.8 hours. There is more sunshine during the dry season than during the wet season. In the rainy season the sunshine hours decrease from December to March and then start to increase in April and May.

3.2.1.6 Wind Speed

The predominant dry season wind direction is from the east-southeast. Mean monthly wind speeds vary from a low of 2.2 m/sec in February to a high of 4.6 m/sec in September. Thunderstorms during the summer are generally associated with west-northwesterly winds.

3.3.0 Soils

The soils of the area are classified as follows;

(a) Red clays forming the extensive farming soils of the area;
(b) Sandy soils that are mainly used for pasture and have a low nutrient content;
(c) Marginal flat soils used for sugar cane production and,
(d) The hydromorphic clays of the Kafue flats.

3.4.0 Socio-Economic Activities

The understanding of the socio-economic activities of the study area is so vital to make rational inferences about the study area. Under this sub-section, occupation and land use will be described.

3.4.1 Land Use

The commonest land use activities in Nansenga area are rain fed subsistence farming, quarrying. In the recent years, there has been an escalating increase in the number of adult males and children involved in the mining and quarrying business. The materials from the study area are used for construction of houses and other structures in Lusaka and other surrounding areas. Most of the users of river sand are non residents of Nansenga. Most of the customers come from as far as Lusaka. Economic policies of the MMD government in the last fifteen years have to a great extent influenced quarrying activities along Nansenga stream. The undesirable impacts of the neo liberal policies have had a bearing on the intensity of land use by the poor. However, the single contributing challenge triggered by the MMD policies of privatisation of most companies since 1990 has been the rapid reduction of the labour force in the formal sector. This has had a consequential effect of pushing more people- evidently much poorer into the informal sector thereby increasing the pressure on the environmental resource base.

CHAPTER FOUR

METHODOLOGY

4.1.0 Introduction

This chapter indicates the ultimate sources of data, methods used in the collection of data, sample sizes and sampling methods used. It also clearly shows the presentation and analysis of data adopted. Finally, the chapter ends by unfolding the constraints faced during data collection in the field.

4.1.1 Sources of Data

There are two sources of data that were used. These are the primary and secondary sources. Both sources of data collection were of valuable assistance as they complemented each other, and in effect, aided in shaping the success of this study.

4.1.2 Primary Data Sources

Two different kinds of scheduled-structured questionnaires were used to obtain data from two different categories of respondents. In the study area, where levels of literacy are relatively low, the researcher was involved in recording virtually all the respondent's answers.

Direct observations in the field during data collection played a significant role as the subtle, yet previously unknown, attitudes and beliefs about the respondents were uncovered. Those observations were subsequently compared with the responses recorded on the questionnaires to gauge if there was compatibility

4.1.3 Secondary Data Sources

Secondary sources of data collection involved the extensive review and research from literature at various resource centre and libraries. However, most of the literature used is

from the ECZ documentation centre and from the school of mines. Other useful sources of secondary data included Newspapers, magazines and maps of the study area obtained from the survey department.

4.2.0 Data Collection Methods and Techniques

Scheduled-structured questionnaires were used to collect data from respondents in the study area. Secondary data were collected from literature and other sources already mentioned above.

4.2.1 Sampling Methods

Accidental sampling method was used to obtain data from the respondents because the total population of people in the study area could not be ascertained without any reasonable doubts. The accidental sampling method has several shortcomings; it is not scientifically robust as systematic sampling and other scientifically-based sampling methods. In accidental sampling, the members of a population do not have an equal chance of being selected. Consequently, some biasness may be inherently introduced. Accidental sampling tends to be influenced by the subjectivity of the researcher. This makes it to be less scientific although it remains a reliable means of sampling if subjectivity is reduced or in cases where total populations where samples are drawn from are unknown, as in this study.

The total sample size of the respondents was 79 and the breakdown is as follows;

(i) Forty questionnaires for the small scale miners; and

(ii) Thirty nine questionnaires for the members of the community.

CHAPTER FIVE

RESULTS.

5.0 Introduction

The results presented in this chapter, are the findings that were obtained to help in the achievement of the aim and objectives of the research. Results from respondents in the study area are given. The physical observations carried out during the site surveys have also been presented.

Table 5.1: People interviewed in Nansenga area

Interviewee	Number
Small scale miners	
Men (resident)	40
Men (non resident)	0
Women	0
Community Members	
Villagers	
Men	19
Women	15
Teachers	5
Agricultural officer	1
Total	79

5.1 Profile of the Small Scale miners

The information set constituted 40 individuals involved in small scale quarrying. Of these 100% were men and 0% women respectively. The average age of the miners was 20-30 yrs with the youngest being 14 yrs and the oldest 40 yrs. The table below shows the characteristics of the small scale miners sampled.

5.1.1 Alternative Employment in Nansenga

Table 5.2; Alternative employment in Nansenga.

Gender	Alternative employment	Alternative employment	Alternative employment
	Yes	No	No response
Male	10	87.5	2.5
Female	0	0	0
Total	10	87.5	2.5

Evidence suggests that over three quarters (87.5%) of the miners were full time in river sand mining and did not have alternative forms of employment elsewhere. About 88% of these miners rely i.e on river sand quarrying for their subsistence. This indicates that river sand mining is a major source of livelihood for most of the miners. This finding has crucial implications for choice of regulatory mechanism(s), which would secure livelihoods for these people and of the same time ensure environmentally sustainable river sand quarrying.

5.1.2 Family sizes of the miners

Family size of the miners ranges from 1 individuals to over 10 individuals per household but most households had 1-5 individuals (42.5%), 5-10 individuals (30%), and above 10 individuals (27.5%).

Table 5.3 Family sizes of the community members

Number of individuals	Percentage
1-5	42.5
5-10	30
>10	27.5
Total	100

5.1.3 Educational attainment of the miners

The educational attainment of the individuals in the informal sector activity is low with only 7.5% have tertiary level education, 52.5% with secondary level education and 40% with primary school level education respectively. In addition only 7.5% had previous semi skilled employment prior to entering the quarrying venture while the rest were either engaged in other informal activities like petty trading, small scale farming. This clearly shows that small scale quarrying is a low skill intensity occupation.

Table 5.4 Educational attainment of the miners

Educational level	Percentage
Primary	40
Secondary	52.5
Tertiary	7.5
Total	100

5.1.4 Knowledge of miners regarding need to obtain license.

One interesting issue investigated was the knowledge of the miners regarding the need to obtain a license. Data collected indicates that only 30% of the total number of the miners had licenses and indicated the knowledge regarding licensing requirements, furthermore the rest of the respondents indicated willingness to obtain mining licenses from the ministry of mines but all of the mining area have been taken up already.

All the respondents revealed that they did not take any safety measures to safeguard themselves from the dangers of quarrying activities and indicated that they experience accidents once in a while. They also indicated that the work area has no toilets, so they used near the quarries to discharge human waste.

On the knowledge of the consequences of quarrying activities on the environment 76% of the respondents indicated that they were aware.

5.2 Profile of the community members

A total 39 individuals were interviewed, 51.3% males and 48.7% females. The age range of those interviewed was between 16-72 yrs of which 89.7% were residents.

Table 5.5 Community members interviewed.

Sex	Number	Percentage
Males	20	51.3
Females	19	48.7
Total	39	100

5.2.1 Family sizes of the respondents

Family size of the community members interviewed were 1-5 individuals (41.1%), 6-10 individuals (33.3%) and over 10 individuals (25.6%) respectively.

Table 5.6 Family sizes of the community members in Nansenga.

Number of individuals	Number	percentage
1-5	16	41.1
6-10	13	33.3
>10	10	25.6
Total	39	100

5.2.2 Educational attainment of the respondents

The educational attainment of the respondents in the community is low with 23% tertiary education, 46% secondary level education, 20.5% primary education and 10.3% with no education at all.

Table 5.7 Educational levels of the community members.

Level of education	Number	percentage
No education	5	10.3
Primary	8	20.5
Secondary	18	46.2
Tertiary	9	23
Total	39	100

5.2.3 Residents knowledge on environmental degradation

Nearly all the respondents expressed knowledge that quarrying activities have led to environmental degradation like loss of vegetation, loss of aquatic life, change of landscape but 90% of the respondents expressed ignorance on air pollution caused by quarrying activities.

Over 90% of the respondents expressed their view that miners should not be encouraged to continue with the quarrying activities because of the adverse effects they have on the environment unless a solution was found to combat the negative effects.

5.3 PHYSICAL OBSERVATIONS IN NANSENGA STREAM

River sand quarrying has both negative and positive impacts to the socio community and the environment. Most of the positive impacts are linked with socio-economic, while the negative impacts mainly are related to the environment, the study was aimed at establishing the socio-economic and environmental impacts of river sand quarrying along the Nansenga stream.

In order to establish the socio-economic and environmental impacts of river sand quarrying in Nansenga stream, field observations were undertaken to supplement other activities done in the research to help achieve the objectives of the project and presented below are some of the observations made during site visits to the study area.

5.3.1 Increased Risk of Human Injury from Natural Disasters

Mining and quarrying activities have potential to increase risks of human injury for people living on degraded land, if subsidence occurs.

Plate 5.1: increased risk of injury for pupils and teachers at Nansenga Basic School on degraded land if subsidence occurs.

5.3.2 Air Pollution and Dust Emission

River sand quarrying activities can impact the atmosphere through generation of excessive atmospheric particulates or dust. Generation of excessive dust is of particular concern at open cast quarrying ventures where activities such as soil stripping, dumping and haulage all act as particulate generators. During the dry season, the dust produced coats leaves of plants, buildings and the land surface. The dust is carried as fine sediments by surface runoff.

Plate5.2: Air pollution, fumes from haulage truck.

5.3.3: Destruction of community Roads.

Extraction of river sand may take place on flood plains and adjoining terraces. in this case, pits normally shallow and wide, exposing large areas of the subsurface occurs. Successive pits develop due to high demand for river sand. However, due to indiscriminate extraction of river sand community roads have been destroyed and the community roads in the study area have not been spared as seen in plate 5.3.

Plate 5.3: Destruction of community roads.

5.3.4 Alcohol and Drug Abuse

Potential cumulative impacts of river sand quarrying activities are characterised by increased levels of crime, violence, drug and alcohol abuse, family stress, community, instability, depression, school drop outs.

Alcoholism is one of the most serious social impacts to be created by incremental effects of quarrying activities. Although excessive drinking rarely impacts whole communities, the minority involved can disproportionately affect the rest of the community.

Plate 5.4: Alcohol abuse

5.3.5 Destruction of roads

Truck damage to roads, including removal of wearing course, removal or slumping of tarmac cover on road due to overloading or inadequate sheeting.

Plate 5.5; Destruction of road

5.3.6 Unsafe mining Practices

Miners were not practicing safe mining practices as seen from plate 5.6 and plate 5.7. A number of cases concerning small scale miners were reported by the members of the community. Cases of subsidence of the ground arising from the collapse of the overlying ground into the mined area are common.

Plate 5.6; Unsafe mining practices.

5.3.7 Poor Health and Sanitation

The working environment for the miners is very poor. A majority of the miners work without protective gears such as goggles, dust masks, ear plugs, helmets, hand gloves or mine boots. Other health hazards include drinking of silted water resulting from quarrying activities.

Plate 5.7; Miners work without protective gears.

5.3.8 Destruction of the Bridge

Sand quarrying especially in urban areas has resulted in several socio-economic problems. Sand mining in urban river banks has accelerated erosion that disturb bridges and roads near such rivers. In the study area, the Nansenga bridge has not been spared from destruction as can be seen in plate 5.8.

Plate 5.8; Destruction of Nansenga bridge.

5.3.9 Children Involved in Quarrying Activities

It was discovered that a very significant number of children is involved in mining activities. Most of the children involved in mining activities dropped out of school due to financial difficulties.

Plate 5.9; Children involved in quarrying activities.

5.3.10 Deforestation and Soil Erosion

Deforestation and soil erosion in Nansenga stream area are caused by the indiscriminate cutting of trees by the miners and the local inhabitants. The miners cut trees to create more land to extract sand. This poses the danger of deforestation and possible desertification not only in the river sand mining areas of Nansenga but in the nearby and distant forested areas.

Plate 5.10; Trees cut to clear land for quarrying.

5.3.11 Destruction of the aesthetic value of land

Though not extensively discussed, river sand quarrying activities causes disturbance of the surface and always has negative impacts on vegetation, wildlife, e.t.c. The loss of land may be accompanied by degradation of local flora and fauna, a loss of livelihood and the loss of land for agricultural or forestry land use alternatives/ purposes.

Plate 5.11; Abandoned quarries are a common feature of the Nansenga area.

5.3.12 Destruction of Arable land for Agriculture

River sand quarrying activities have taken up much needed agricultural land and the resulting land formation is not conducive for proper farming due to soil erosion.

Plate 5.12; Destruction of arable land for agriculture.

5.3.13 Blocked Stream

Surface waters such as rivers and streams may need to be blocked or diverted to allow extraction of river sand to occur, potentially causing direct ecosystem impacts (e.g on invertebrate communities living in the river sediments) and indirect impacts from rechannelling of water, including changes in flood risk and location. As can be from the study area, Nansenga stream has not been spared see plate 5.13.

Plate 5.13: Blockage of stream.

5.3.14 Change of landscape

Large and small quarries that are left unattended after mining activities have ceased are a major cause of the landscape destruction. Some of the quarries have given rise to severe gully erosion that leaves vast areas of waste land.

Plate 5.14; Change of landscape

5.3.14 Reduced Access to Water Resources

Related to the livelihood issue is resource availability. The resource availability impacts include loss of access to clean water for drinking, bathing, cleaning and irrigation. In the study area, Nansenga stream has not been spared as can be seen from plate 5.15 quarrying activities along the stream thereby reducing access to water for various purposes.

Plate 5.15; Reduced access to water resources.

5.3.16 Destruction of fauna and flora habitat.

The natural habit of plants and animals has been destroyed. Actually, few species of animals was seen in the study area.

CHAPTER SIX

ASSESSMENT OF ENVIRONMENTAL IMPACTS

6.0 Introduction

Environmental impacts are evaluated according to the following 9 criteria:-

1. Is the impact associated with the quarrying activities?
2. Is the impact negative or positive?
3. What is the source of the impact?
4. What is the impact target e.g. surface water, ground water, flora, fauna?
5. What is the duration of the impact?
6. What are the likely cumulative effects of the impact?
7. What is the likely speed of recovery to baseline conditions?
8. How significant is the impact?
9. What is the likely extent of the impact?

Table 6.1 Environmental Impact matrix for Nansenga river sand quarrying.

Aspect/ Issue	Impact Target	Nature of Impact	Duration of Impact	Cumulative Impact	Recovery to Baseline	Significance of Impact	Extent of Impact
Noise	Nansenga	Negative	Long term	No	Immediate	Minimal	Local
Dust Generation	Nansenga	Negative	Long term	No	Rapid	Minimal	Local
Clearing of Vegetation	Nansenga	Negative	Permanent	No	Immediate	Significant	Local

Table 6.1 Environmental impact matrix for Nansenga river sand quarrying (cont)

Aspect/ Issue	Impact Source	Impact Target	Nature of Impact	Duration of Impact	Cumulative Impact	Recovery to Baseline	Significance of Impact	Extent of Impact
Destruction of road and bridge	Quarrying activities and haulage trucks	Nansenga bridge and road	Negative	Long term	Yes	Immediate	Significant	Local
Fauna and Habitat disturbance	Quarrying and haulage trucks	Local population	Negative	Long term	Yes	Immediate	Significant	Local
Erosion	Quarrying activities	Soil Surface Water	Negative	Years	Yes	Immediate	Significant	Local
Employment	Quarrying activities	Local Population and Lusaka	Positive	Years	No	Immediate	Minimal	Local
Commerce	Quarrying activities	Population	Positive	Entire Project	Yes	Immediate	Minimal	Local

HIV/AIDS	Quarrying Activities	Population	Negative	Years	Yes	Permanent	Significant	Local area and surrounding areas
Water Quality	Quarrying activities	Nansenga	negative	Long term	Yes	permanent	significant	Local
Alcohol and Drug abuse	Quarrying activities	Nansenga	negative	Long term	yes	permanent	significant	Local
Poor Health and Sanitation	Quarrying activities	Nansenga	negative	Long term	yes	Immediate	moderate	Local
Change of landscape	Quarrying activities	Nansenga	negative	Long term	yes	permanent	significant	Local
Aesthetic value of land	Quarrying activities	Nansenga	negative	Long term	yes	permanent	significant	Local
Blockage of Stream	Quarrying activities	Nansenga	negative	Long term	yes	permanent	moderate	Local
Land Degradation	Quarrying activities	Nansenga	negative	Long term	yes	permanent	Significant	Local

CHAPTER SEVEN

MITIGATION MEASURES

7.0 Introduction

This section proposes mitigation measures for identified potential impacts as discussed in earlier chapters. Mitigation measures are actions that are intended to avoid, alleviate or reduce environmental impacts on the environment. The mitigation measures are set forth to maximise positive impacts and minimise negative impacts as a result of quarrying activities.

Table 7.1: Mitigation Measures

Impact	**Mitigation Measures**
Destruction of bridge and road	Regular maintenance of the bridge and road No quarrying activities near the bridge and road.
Deforestation	Less vegetated areas to be selected Implementation of Environmental impact Assessment and Environmental Management Plan mitigation measures
Disturbance of Fauna and Habitat	Quarrying activities to be carried out in areas designated for that purpose
Air Pollution and dust emission	Regular maintenance of Haulage trucks Periodical watering of the access roads Waste should be carefully managed to prevent unpleasant odours
Poor Health and Sanitation	Enforcement of public health and safety regulations

AIDS and STD's	Provision of education both to the miners and the community on HIV and STD's
Alcohol and drug abuse	Provision of education to the miners and the community on the dangers of drug abuse
Children involved in quarrying activities	Provision of education on child labour and enforcement of labour laws
Accidents during quarrying	Development of safety procedures
Erosion	Quarry slopes should be fenced and revegetated
Airborne diseases	Promoting dust proof masks, gloves, proper clothing, boots , and goggles.

CHAPTER EIGHT

DISCUSSION

8.0 Introduction

Small scale quarrying is an important informal sector activity, providing employment and means of subsistence to a number of residents in many developing countries like Zambia.

It has been demonstrated that quarrying is a demand driven activity with strong linkages with the construction industry. Its profitability has attracted a lot of entrants (largely unemployed low skilled individuals) into the sector seeking to secure employment and income.

Throughout the developing world, river sand and gravel is widely exploited as aggregates for construction. Aggregate is often mined directly from the river channel as well as from flood plain and adjacent terrace deposits. Depending on the geological setting, in Stream River mining can create serious environmental impacts, particularly if the river being mined is erosional.

The impacts of such mining on farmland, river stability, flood risk, road and bridge structures and ecology are typically severe. The environmental degradation may make it difficult to provide for basic needs (water, food, fuel-wood, communication) of communities naturally located in the river valleys.

Environmental and Social Impacts may be positive or negative in nature. For example projects that enhance the quality of life and that make people feel better about themselves and where they live have a positive impact. In contrast, projects that debilitate the vitality of a community or make people feel worse about themselves and where they live, have a negative impact.

8.1 Environmental impacts of river sand quarrying along Nansenga stream.

Although income and employment enhancement may improve environmental quality in many aspects, there are a number of environmental degradation aspects of small scale mining in the study area that are evident. The major environmental impacts of quarrying can be categorised in three; Land and Landscape destruction; poor waste management; and health effects from air pollution and noise.

8.1.1 Land degradation

Perhaps the most visible and crucial impact of quarrying relates to Land degradation and Landscape denudation. Quarrying as earlier indicated involves the excavation of sand which is a constitute of building materials. Once the sand has been excavated, what remains is sometimes a big pit or the river/stream channel is increased.

As can be seen from the extent of land degradation in plate 11, the opportunity cost of the land is reduced bringing down its value and subsequently the revenue for the government from land rates. This is basically so because the use of the land for commercial, industrial or agricultural purposes needs to take into account the cost of land rehabilitation, which in most cases out weighs the present value of land.

In this regard, the opportunity cost of the land declines and concurrently government revenue through rates. Secondly, landscape denudation spoils the scenic value of the real estate on site and in the neighbourhood.

8.1.2 Occupational health

Without getting into great details about the environment and tools used in the extraction of river sand have serious effects on the miners. In the first instance miners use manual tools to extract river sand and suffer blisters, back ache e.t.c, because they do not use safety clothing like helmets, goggles, boots, gloves and dust masks.

In addition transportation of extracted materials emits a lot of dust that again causes respiratory infections and silicosis to miners and the neighbourhood population.

8.1.3 Contamination of Surface and Groundwater

Blockage of the stream course is a common problem in the area (as seen in plate 13). Groundwater and Surface water in this area is used for the community around. During the rainy season, the abandoned quarries are flooded with rain water and surface water runoff. Water ponds in the abandoned quarries are breeding grounds for mosquitoes and other parasites, which cause diseases such as malaria, cholera, dysentery and other water borne diseases.

One of the most common water issues associated with extraction is the erosion of fine particulates and the transfer of suspended solids into surface waters during periods of rainfall. This typically increases proportionally with increasing area of disturbance and it is therefore very important that total disturbed area be minimised.

8.1.4 Destruction of Nansenga Bridge and Road

The study revealed that river sand quarrying near the Nansenga Bridge caused the undermining of bridge piers which has resulted in the destruction of the bridge and the road causeway has been undermined.

8.1.5 Increased Risk of Human Injury from Natural Disasters

The study revealed the, abandonment of river sand quarrying workings was almost invariably done with out refilling or making safe excavations and the nature of river sand quarrying was such that the miners were not compelled to undertake reclamation and protection of the mined area, which has potential to increased risks of human injury for people living on degraded land.

CHAPTER NINE

CONCLUSION AND RECOMMENDATIONS

9.0 Conclusion

River sand quarrying is a sector that is on the increase around Nansenga area. Despite its increase, the activities are associated with both negative and positive impacts. The most significant positive aspect of river sand quarrying along Nansenga stream is the employment effect. Being a highly labour intensive activity, it has provided employment for a substantial number of people of Nansenga because alternative job opportunities are scarce and low paying. Predominantly, the labour in river sand quarrying consists of unskilled labourers with little or no formal education. Despite the typically low level of skill, average incomes earned in this activity are usually well above minimum wages.

In view of the large number of people involved, substantial purchasing power has become available in Nansenga. Much of the income generated is immediately spent on consumption, thereby stimulating economic activities and employment in other sectors of the local economy and significantly contributing to rural development.

Apart from the beneficial effects of the sub sector discussed, uncontrolled quarrying activities along Nansenga stream have resulted in serious environmental impacts. Of particular concern is poor health and safety record of the sub sector and the widespread use of environmentally hazardous mining practices.

A major health issue in Nansenga is lack of sanitary facilities and of safe drinking water. Another potential health hazard in river sand quarrying is the absence of precautions against airborne dust which can cause respiratory diseases in cases of extended exposure to dust and lack of boots, gloves, helmets e.t.c.

The field study revealed that miners were not practicing safe mining methods . Cases of subsidence of the ground arising from collapse of the overlying ground into mined out areas are common. The miners expressed great need for security and safe mining techniques.

River sand quarrying activities moreover cause the destruction of vegetation and degradation of large areas of land as mined out prospects are usually abandoned without post-mining land reclamation. Much of the land over which the miners have worked is left with unsecured pits and trenches, which pose a grave safety hazard to people and livestock, potentially resulting in injury from accidental falls. Effectively addressing both health and safety issues and the environmental impact of the sub sector through education of the miners and the progressive enforcement of adequate regulations, is a great urgency in many countries,

Quarrying activities, presence of people and haulage trucks cause noise, which has threatened wildlife and have caused them to migrate from the area near the Nansenga stream into distant places not very suitable for them. Indigenous species of plants, once destroyed, may end up with extinction, through clearing of areas for mining activities thereby disturbing habitat for wild animals and birds.

Quarrying activities have had an effect on the quality of water and access to the water for drinking, washing, e.t.c. Considerable amount of dust from extracted sand and unsurfaced roads have contaminated surface water.

9.1 Recommendations

On account of the findings of this study and the proposed mitigation measures, the following recommendations have been made that;

- . All stakeholders and particularly government commit themselves to good governance, so that the HIV/AIDS pandemic can be effectively managed and the people are protected from the escalation of the disease.
- GRZ design pro-poor development projects to alleviating poverty and place special emphasis on education and vulnerable children be involved.
- Small scale miners and quarriers recognise their role in the economy of the country and commit themselves to cooperation with other stake holders in the sector to align small scale mining with principles of sustainable development.

- Development of human resources through technical training in mining sites, field demonstrations e.t.c.
- Environmental impact assessment should be conducted prior to issuing prospecting rights to the small scale miners.
- Mining permits should include conditions for environmental protection, specific to that type of mining activity.
- Programmes have to be established to reclaim former or abandoned mine sites. Special care should be given to quarrying activities, whereby site selection is an important factor for future reclamation of the hollow space.
- Government should provide essential services to miners, miners need better health services due to increased health risks and accidents as a result of continuous change of working environment.
- The government should put in place a comprehensive land use programme backed by effective legislation that will ensure secure property rights to land ownership for different purposes including quarrying. This would, restrict quarrying to such areas designated for that purpose.
- There is need to harmonise and strengthen regulations and legislation relating to land use, mineral exploitation, and environmental protection by all line ministries (MLG, MOL, MENR, MMMR, LCC, and the ECZ) and stakeholders. This will ensure cost-effective monitoring and enforcement of properly coordinated policies and programmes.

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APPENDICES

APPENDIX 1

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

QUESTIONNAIRE ADMINSTERED AT NANSENGA (RIVER SAND QUARRYING AND ITS SOCIO-ECONOMIC AND ITS ENVIRONMENTAL IMPACTS)

Dear Respondent,

You have been selected in a sample of respondents in the study of socio-economic and environmental impacts of river sand quarrying along Nansenga stream. The information you give is solely for academic purposes and will be regarded in the strictest confidence. Answer all the appropriate questions by ticking the answer or write brief sentences where necessary.

(a) Sex (1) Female (2) Male

(b) Age (1) 16-30 yrs (2) 31-45 yrs (3) above 45 yrs

(c) Family size (1) 1-5 (2) 6-10 (3) above 10

(d) Educational level:

(1) Primary level (2) secondary level (3) tertiary level

(e) How long have you lived in Nansenga?.....

.....

(f) What do you do for your living?

(1) Farming (2) Government institution etc. (3) Quarrying

.....

.....

(g) Are you aware of the environmental impacts of river sand quarrying like?

(a) Change of landscape (1) Yes (2) No

(b) Change of air quality (1) Yes (2) No

(c) Land degradation (1) Yes (2) No

(d) Destruction of Roads, Bridges and Houses (1) Yes (2) No

(e) Poor Health and Sanitation (1) Yes (2) No

(h) Over the years you've been living in this area what changes have seen as a result of quarrying in terms of

(a) Landscape.....

(b) Air quality.....

(c) Land degradation.....

(d) Destruction of roads, bridges and houses.....

.....

(e) Vegetation.....

.....

(f)With the changes you've seen as a result of river sand quarrying should the small scale miners be encouraged to continue?.....

.....

(g) Are you affected by quarrying activities?

(1) Yes (2) No

APPENDIX 2

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

QUESTIONNAIRE ADMINSTERED IN NANSENGA AREA TO THE SMALL SCALE MINERS (EVALUATION OF SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACTS OF RIVER SAND QUARRYING)

Dear Respondent,

You have been randomly selected in a sample of respondents in the study of socio-economic and environmental impacts of river sand quarrying along the Nansenga stream. The information you give is solely for academic purposes and will be regarded in the strictest confidence.

Answer all questions appropriately by ticking where necessary or write brief sentences where possible.

SECTION A: PERSONAL INFORMATION

a) Sex (1) Female (2) Male

b) Age (1) 12-15 yrs (2) 15-20 yrs (3) 20-30 yrs (4) over 30 yrs

c) Family size (1) 1-5 (2) 5-10 (3) Above 10

d) Educational level:

(1) Primary level (2) Secondary level (3) Tertiary level

e) Why did start you quarrying?

.....

.....

.....

f) How long have been involved in river sand quarrying?

(1) 1-5 yrs (2) 6-10 yrs (3) above 10 yrs

SECTION B: GENERAL INFORMATION

g) Are you from Nansenga?

(!) Yes (2) No

(h) How much do you earn per day?

(1) Less than K45, 000 (2) K45, 000- K90, 000 (3) above K90, 000

(i) How many loads of river sand do you sell per day?

(1) 1 (2) 2 (3) 3 (4) over 3

(j) Do you have toilets in your work area?

(1) Yes (2) No

(k) Who are your customers?

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.....

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(l) Are you aware of the environmental impacts of quarrying activities?

(1) Yes (2) No

(m) What type of equipment do you use to carry out quarrying activities?

.....

.....

(n) Do you practice safety precautions like:-

(1) Using dust masks (2) Wearing safety boots (3) Wearing helmets

(o) Do you have a license?

(1) Yes (2) No

(p)If your answer to (o) is no give a reason

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(q)Who gives you permission to conduct quarrying activities?.....

(r) Over the years you've been in business, what changes have you noticed in terms of

(a) Landscape -.....

(b) Fish and other aquatic animals

.....

(c) Vegetation

.....

(d) Air quality

.....

(e) Road, bridge and houses

.....

(f) Noise

.....