

AN ASSESSMENT OF ENVIRONMENTAL IMPACTS OF QUARRYING ACTIVITIES IN  
NDARUGO AREA, KIAMBU COUNTY

By

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**DECLARATION**

This research project report is an original work and has never been submitted in this way or any other to any university for examination or award.

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(N36/2184/2010)

SIGNATURE

DATE

This report has been submitted with my approval as university supervisor

.....

.....

Mr. Wilson Nyaoro

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DATE

## **DEDICATION**

This work is dedicated to Kenyatta University; Department of Environmental Planning and Management and the people of Ndarugu area and the County Government of Kiambu.

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## **ABSTRACT**

Artisanal mining has been for many years disregarded, where large scale mining that involves large scale extraction of minerals such as valuable metals, oil and gas has been documented and given much concentration. Small scale mining however has had a significant role to play in the developing countries, where it takes opportunity of the abundant available labor while only requiring limited amounts of less than abundant capital. Nevertheless, this sector of the economy surrounded by much enthusiasm has a lot of problems, which has plagued it; poor health and safety, wasted mineral resources, and environmental degradation (Noronha, 1998). This sector is not affected by other pollutant problems like those experienced by the mining industry involved in metals and minerals, because the process of extraction is merely physical, and more recently involves the use of some machinery to ease the process. However, this does not mean that stone quarrying does not have its fair share of numerous environmental effects, which are actually serious.

Ndarugu is among the areas in the country where such quarries exist, and they pose a blatant disregard for the environment. The research project aims at looking at these environmental effects, coming up with mitigation measures and recommendations to tackle these issues. The major effects were examined first by looking at relevant literature, and finally collecting data on the ground and providing a comprehensive analysis. Data was analyzed and represented statistically through use of graphs and photographs collected in the field. The findings show that the quarrying activities are a great source of negative environment impacts. The issue is greatly accelerated by the fact that the quarries are abandoned after use and no elaborate rehabilitation plan is available, and furthermore the sector is highly unregulated with no proper legislations and policies.

## **ABBREVIATIONS**

B.C.E - before Christ Era

CSI - Cement Sustainability Initiative

GDP - Gross Domestic Product

IEHM - Integrated Environment and Health Monitoring

ILO - International Labor Organization

IUCN - International Union for Conservation of Nature and Natural Resources

KNBS - Kenya National Bureau of Statistics

NGO - Non-Governmental Organization

WBCSD - World Business Council for Sustainable Development

WHO - World Health Organization

## CHAPTER ONE

### 1.0 INTRODUCTION

#### 1.1 Background to the problem

Mining can be described as the extraction of valuable minerals as well as the removal of other of geological materials from the earth. Mining is an activity that has been carried out since the prehistoric times, where stone and other metals were extracted from the earth. The process of mining has to prove profitable to the miner seeking to gain from the extract, and involves prospecting for the extracts, analyzing the profitability of the mine, the process of extraction and finally but not in all cases the reclamation of the land. For many years, these mining processes have led to adverse negative environmental effects either during the mining process or long after the mines have been closed. Stone as one of the valuable mineral extract has always been used since the beginning of civilization to make early tools and weapons (Hartmann and Howard L, 1992)

Mining techniques are divided into two excavation types, which include surface mining and subsurface mining. In the current times, surface mining is more common. In relation to extraction of rocks, surface mining is employed, and a technique known as open pit mining is used. Surface mining began in the mid sixteen centuries, and has been continually employed throughout the world; although it is majorly employed in the North American continent, where today, surface mining is much more common, and produces, for example, 85% of minerals (excluding petroleum and natural gas) in the United States, including 98% of metallic ores (Hartmann, 2002). This technique is used when the deposits of the useful rock are found near the surface. The open pits that produce building materials and dimension stones are commonly referred to as quarries. Extraction of materials using this method involves the use of heavy

equipment that moves the earth and other huge machines that extract the final product, which in itself results to negative effects to the surrounding environment through noise, dust, and vibrations that are as a result of the activity, where also in some cases additional logging of forests is done in the vicinities of the mines to create room for the storage of debris and soil excavated.

Stone has always been used for building and decorations because of its resistance to weather and for its aesthetic appeal. For example, India's use of stone for construction purposes can be traced back to 3200 B.C. The country's many innumerable temples and ancient palaces have been carved out of locally available stone. One of the most famous buildings, the TajMahal at Agra, portrays a long age tradition of stone architecture in the country (UNESCO World Heritage Centre, n.d.).

Stone being an important component in the construction of homes is often demanded in large quantities, especially in our country Kenya. The demand for quarried aggregates is enormous (George M. Ndegwa, Oguta B, Calvince O, 2003). Developmental activities in Kenya that involves the construction of homes, factories and schools among other developments underpin the necessity of quarrying as an activity in the country. The quarrying and aggregate production industry is therefore a major player in the important role of steering the nation's economy through the provision of essential building materials and providing employment opportunities. Housing demand in Kenya supports the fact that there is an enormous reliance on stone aggregates, and bearing in mind that the population growth is placed at 4.2% per annum, which accelerates urban migration gives a projection of an annual increase of housing units, which currently stands at 206,000 units annually (CAHF, 2012).

Areas like Ngong and Mwiki supply Nairobi's area with building stone and are home to artisanal stone quarrying, however Juja Township is also another location in Kenya that is home to the industry, and has seen exponential growth in the recent years, since the quarries in the area became active in the 1940's and late 1950's. During those early times, there were seven stone quarries that were in operation, however, the number has increased to the present 207 quarries. The quarries are distributed along the Ndarugo river, with the largest quarry covering 20 ha of land and the smallest 0.01 ha (George et al., 2003). The quarries relatively vary in depth ranging from 2- 50 m deep.

The quarries are undeniably of economic significance; however they are also a source of environmental problems throughout their whole phase of operation. Both active and abandoned quarries are a threat to the surrounding environment, and more significantly result to the degradation of land, drainage problems and visual intrusion because many are not rehabilitated after use.

## **1.2 Research questions**

1. What are the environmental issues associated with quarrying activities?
2. What happens to the quarry sites after they have been fully utilized?
3. What rehabilitation measures have been undertaken in the past or in the present for the quarries?
4. What steps are being taken or have been taken in the past to prevent negative environmental effects?
5. What are the socio-economic issues that arise as a result of quarrying in the area?

### **1.3 Objectives**

1. To evaluate the legal frameworks and policies governing quarrying activities
2. To assess the bio-physical and socio-economic effects of quarrying activities in the area
3. To examine the state of the abandoned quarries and what use they are put to
4. To identify and explain mitigation measures that should be adopted to manage and control the negative environmental impacts of quarrying activities

### **1.4 Research premises**

The premises for the study were as follows;

1. The existing policies and legal frameworks governing the quarrying activities are characterized by weaknesses and gaps and are therefore not effective.
2. Abandoned quarry sites in Ndarugu area are not put to any use and there is a reluctance to restore or rehabilitate them.
3. There are numerous negative bio-physical and socio-economic effects of quarrying in the area.
4. There are no proper mitigation measures and sound action plans to curb both negative environmental effects and rehabilitate abandoned quarries.

### **1.5 Justification of the study**

Quarrying is an important part of economic development as it serves as the backbone of an exponentially growing industry in the housing sector. The study focuses on quarries dealing with artisanal stone mining; in an era where stone is the most common type of building material. However quarrying has come with a lot of negative effects where, there is a lot of open-pit, and derelict land that has been left open in the areas where it is being practiced. Ndarugu is one such

area, where this practice has raised a lot of issues both in the environment and to the society around the area. This is an opportunity to exploit especially now that people are looking for serene environments and the fact that ecologically sound environs are diminishing by day; where the land is free from pollution, and a new ecosystem can be created altogether. Furthermore, it being an unexploited opportunity to rehabilitate these lands, new ecosystems that will create diverse flora and fauna like a case example of Bamburi's Haller Park, which will go a long way in boosting the economy of Kiambu County, through establishment of nature trails and agricultural based projects considering Ndarugu's location, which will in turn, create value for land around the area.

### **1.6 Significance of the study**

Quarrying has had an impact both economically and socially, where it contributes to the economy as an industry, and has created many job opportunities for many people. However many people have had to suffer due to the negative effects, especially those people that live around the quarry sites. They are faced with these negative impacts on a daily basis. Juja Township being a home to many people stands to benefit from mitigating these impacts such as arising pollution which causes a lot of problems such as health issues. Further the society that lives around the area will get value for their land, and safety of their houses thus enjoying a serene and conducive environment. The county government is also going to benefit from this study because the study deals with how to manage derelict lands by rehabilitating them. There is a lot of opportunity to be exploited by the county government as there is a lot of land that can be utilized once these lands have been rehabilitated, and also will serve as an opportunity to control pollution in that part of the county. Finally the industry movers of the sector can also refer to the study on how to mitigate the forthcoming negative impacts as they continue their quarrying

activities, and can also learn of the benefits accruing from rehabilitating quarry sites, as is learnt with the positive outcomes of Bamburi success story.

### **1.7 Scope of the study**

The study is going to be carried out in the study area, which is the Ndarugu area in Juja location which covers an area of about 4,000 km<sup>2</sup>, and its effects toward the people of Juja Township where the quarries are located. Since the quarries are located along Ndarugu River, it shall also be included in the study, but the negative effects do not solely revolve around the river system. The study is going to focus on the issues related with negative environmental impacts based on bio-physical effects and socio-economic effects of quarrying, mitigation measures employed to mitigate the adverse effects and finally the policies and legislations governing the quarrying sector. Finally, the necessary recommendations are going to be provided.

## **CHAPTER TWO**

### **2.0 LITERATURE REVIEW**

#### **2.1 Mining and quarrying**

Mining just like agriculture is one development feat by the human race, which marked the start of early civilization. It is one of the basic industries that fueled civilization, and as a fact being second from agriculture as the agrarian revolution commenced in 1500 B.C and it in the 1700 B.C has continually supplied all the basic resources that are in use by modern civilization (Hartmann and Howard L, 1992). According to Madigan, mining has played a chief role in the existence of the human race (Madigan, 1981), whereby the term mining is in its broadest terms to mean the extraction of any naturally occurring minerals, be they in gas, liquid or solid state.

Many important cultural eras are earmarked by the development of mining, and the derivatives of the activities associated with the industry. The eras can be outlined as; Stone Age (prior to 4000 B.C.E), the Bronze Age (4000 to 5000 B.C.E), the Iron Age (1500 B.C.E. to 1780 B.C.E), the Steel Age (1780 to 1945), and the Nuclear Age (1945 to the present). There are many uses of minerals, for different purposes and occurring in different ages by the human race.

Active and abandoned mines and quarries have been a source of negative environmental effects which have led to erosion, formation of sinkholes, and contamination of soil, groundwater, and surface water, and also the loss of biodiversity. All these problems arise from contamination of the chemicals used in mining and the neglect of environmental awareness while operating the mines and quarries. Increasingly, there are abandoned quarries and mines throughout the world because of low running reserves and this leaves so many open pits after the extraction process is finished, where many of the mining companies are reluctant to properly rehabilitate a site after they have exploited it fully. In the United States alone, there are more

than 560,000 abandoned mines on publicly and privately owned land (Kertes, 1996). These open mines are a danger to those that may want to explore them, especially to those people that do not have the proper knowledge and skills on how to approach them safely, and this forms a majority of the population (DOI, 2007).

Minerals have also been a great source of wealth that has enabled many countries with the rich abundance of the natural resources accumulate wealth and form great economies. Those countries that do have them obtain valuable currencies from the countries that do not have. It has also been estimated that only a fraction of 1% of the earth's surface is underlain with mineral deposits that can be exploited for monetary value (National Mining Association, 1998).

In the modern times, the consumption of minerals has been on the rise, as the society is drastically changing because people are relying now more on airplanes, trains and vehicles for transportation; mobile phones, computers and radios for communications; heavy machinery and fertilizers for agricultural output; industrial minerals for home building; and nuclear plants, and coal for electric power. This kind of use for industrial services has led to the over exploitation of minerals.

However, this kind of use has spurred a lot of public reaction, where people have become more aware of the need to conserve energy, minerals and the environment. Countries like the United States have compelled their mining industry to endorse a policy that favors the extraction of minerals in a more sustainable manner (National Mining Association, 1998).

Mining in Kenya is however not that large, and it is dominated by exploitation of non-metallic minerals such as soda ash, diatomite, gypsum, limestone, fluorite, constructional stone

and sand harvesting. The large percentage of mining in the country is done by the artisanal miners, which accounts to about 70-80% (Osumo, 2001).

Majorly the type of activity under quarrying in Kenya is the extraction of stone. This activity is a very significant activity in the country under the informal sector or popularly known as the Jua Kali sector. It involves a number of stakeholders that include land owners, quarry owners, concession holders (who lease land and extract stone for sale) and quarry workers who constitute both the skilled and unskilled. The sector is believed to employ over 40,000 workers nationally, where in Nairobi alone it employs 10,000 people (Asher shadmon, Sam, 1999).

The country has a very great demand for stone because of the ever growing construction industry, and stone from mechanized quarries is in high demand. Many of these quarries are found in Juja, but recently those that that serve Nairobi (the Ngong division of Kajiado district, approximately 13 kilometers southwest of Nairobi) have been surveyed, and according to Asher Shadmon (1999) the results have revealed that the local stone reserves can sufficiently supply stone for the next 50 years.

## **2.2 The bio-physical and socio-economic effects of quarrying activities**

The process of quarrying is greatly related to the negative environmental effects of the activity. There are several processes that are involved in quarrying and they include; clearing of overburden of soil, drilling, blasting, splitting and dressing of stone. The process uses various tools for extraction which are categorized into two, namely, hand tools and machine tools. The hand tools include; jacks, levers, hammers, and chisels for extraction; and hammers, chisels (including pneumatic), drills, saws, grinding stones and polishing powder for stone-working (Shadmon 1989). On the other hand, machine tools include: jack-saws, saws, wire-saws, and

chainsaws, mechanical chisels for extraction; and guillotines, saws, planers or fraisers, grinders and polishers for manufacturing (Shadmon 1989). Every stage in the operation of a mine has its negative consequences, which are:

Clearance of the overburden leads to the destruction of vegetation, destruction of fauna habitats, loss of scenery, enhancement of soil erosion; Drilling leads to the generation of dust, and generation of noise; Blasting causes ground vibrations, fly rock generation of dust, generation of noise, surface land disruption, and explosive fumes (gases); Splitting causes flying stones pieces, while Stone dressing causes the generation of dust (Mines and Geology).

The bio-physical effects are associated with the environmental impacts because the fact that many of the quarry sites are uncontrolled and that insufficient techniques of mining are used, it produces a degradation of both land and stone reserves. In many cases there is lack of resource allocation planning in quarry land, a situation that results to quarry sites being located haphazardly without any proper development and guidance. In the end there is a myriad of mineral surface workings that show a lack of resource and environmental management (Savery, 1997).

Artisanal stone quarries are also known for the high waste to recovery ratio, which is influenced by among other factors, the natural formation of the rocks and the method used to extract the stones. The situation is such that the estimated amount of stone wasted in the country ranges from 50 – 90%. The situation is influenced by use of manual mining techniques, although blasting is also used in areas where the rock is much harder before the stone is split and sized. These wasteful methods of both quarrying and processing of the stones aggravate the situation (Agevi and Ogero, 1990).

There is also aesthetic pollution, which happens if there is no screening of current operations and proper restoration of abandoned mines. Visual aftermath of quarrying is equal to the poor utilization of resources in small-scale artisanal quarrying (Savery, 1997). Introduction of potentially discordant features into the landscape also result to visual intrusion and affect the landscape character e.g. quarry face, plant, lighting and quarry face.

Another effect is that quarries can contribute to air pollution in a number of ways that include; ammonium nitrates form the fuel mix used in blasting and from engines, dust from the quarry or the roads that lead to the quarry site, as well as the dust and fumes from the lorry traffic and dust from the blasting process may cause discharge of pollutants to the atmosphere. Dust is one of the most visible, invasive and potentially irritating impact associated with quarrying. Dust concentrations, potential impacts and deposition rates tend to decrease rapidly away from the source (Howard and Cameron, 1998). However, its visibility tends to raise concerns that are not usually directly proportional to its impacts on human health and the environment (Howard and Cameron, 1998).

Noise is another of the effects which is as a result of the use of explosives, processing equipment and earth moving equipment and the situation is worsened with quarries being at close proximities to each other. The impact of noise on the sound receiver is often from the source which is characterized by the rhythm, pitch of noise, beat and distance (Langer, 2001). The use of explosives may also trigger ground vibration which is also a cause of disturbance.

In cases where rivers are located near river or other drainage systems, they lead to water pollution which is also another effect and can be attributed to the amount of lead in oil, petroleum spills and waste metals on soil without treatment, in the quarry mining and

transportation machinery. Quarries can also be a cause for water table alterations, where the quarries go deep enough to affect ground water aquifers. Formation of dams at quarry sites is also a common feature in abandoned quarry sites (Agevi and Ogero, 1990)

### **2.2.2 The socio-economic effects**

Quarrying is undeniably a valuable source of building materials worldwide, but it raises problems in land use by the communities that are found around areas where such activities take place. A study conducted in the Niagra escarpment on quarrying, revealed that there is a struggle between the industry, the quarry operators who are in charge of producing the construction materials and the local communities that have new uses and value for the same land (Sandra and Andes, 2005).

In Kenya, studies on the socio-economic effects of artisanal quarrying have been conducted. The studies have focused on resource utilization, restoration and respiratory dusts created by lorry traffic, and are aimed at improving productivity and environmental sensitivity of artisanal quarrying (Savery, 1997; Agevi and Agero, 1990; Mjaria, 1997; Ng'ang'a, 1997; Ng'ang'a and Agevi, 1990; Wells, 1996).

In a report tabled by Ng'ang'a (1997) after a workshop of artisanal quarrying stakeholders, quarrying was presented as being a significant economic activity in the construction sector, as well as providing a livelihood for land owners, quarry owners, concession holders, quarry workers, and people in the transport industry. Another report by Kenya Quarry and Mine Workers Union (1996), it indicated that the sector was providing a livelihood for about 200,000 people in the country.

Constraints facing the expansion of the industry, in meeting both the existing and potential demand for dimension stone, have been captured in a report titled socio-economic and institutional survey of stone quarrying in Kenya by Agevi and Agero (1990).

There are potential risks associated with quarrying that cannot be ignored, but have been underplayed in many of the reports, and include health risks. Quarries located near residential areas have been connected to posing health issues especially because of the clouds of dust produced. A certain report in Palestine indicated that the locals living near quarries were suffering from increased levels of asthma and acute bronchial infections (Foundation of Middle East Peace, 1998)

### **2.3 Mitigation measures for the management and control of quarrying activities**

The extraction of materials from the earth's crust inevitably impacts on the surrounding natural and social environment. Particularly, the removal of soil and changes in topography of the area are likely to affect local ecosystems and watersheds. However, throughout the years these impacts have been successfully addressed and mitigated through the development and implementation of effective quarry rehabilitation plans. In many of the cases, effective implementation of a well-designed rehabilitation plan has resulted in significant environmental and social benefits, an example in our country being Bamburi Cement Mines in the coast (CSI, 2011).

The CSI through its published work by the WBCSD indicates that quarrying activity carries with it the obligation to rehabilitate both the site and, wherever necessary, the surrounding area while operating and upon completion of operations. The success of rehabilitation also carries commercial benefits for the operating companies. The license to

operate for both the industry as a whole and for individual companies is dependent on ensuring that land used for quarrying purposes is rehabilitated in an effective and responsible manner, taking into account the needs and expectations of stakeholders, and the influence of regional and local planning requirements. Those that adopt the best practices in this regard have a greater expectation in realization of the significant benefits, which includes long-term sustainability of their operations and competitive advantage, which far outweigh the short-term financial costs that are a result of undertaking a rehabilitation program (CSI, 2011).

CSI ESIA guidelines also points out principles that guide an effective rehabilitation plan are as follows:

- The post-closure land use needs to be clearly assessed when initiating a quarry rehabilitation plan, even if this can evolve over the lifetime of the quarry. A quarry rehabilitation plan needs to be based on a clear set of objectives reflecting the legislative requirements (as the highest priority), and encompassing the local social, economic and environmental (including biodiversity) considerations for the future use of the site. The objectives will be technically and financially sustainable.
- Legal compliance must be the minimum requirement when establishing each quarry rehabilitation plan. The rehabilitation guidelines should never be in conflict with, but should always complement and go beyond legal compliance.
- The rehabilitation plan will ensure the site is left in a safe and stable condition. The safety of the rehabilitated quarry includes the stability of slopes, roads and raw materials piles. Safety should always be considered as paramount for the rehabilitation plan.

- Stakeholders should be listened to, and relevant stakeholders need to be involved at all stages. The quarry rehabilitation plan must address stakeholder expectations, and be aligned with, or leverage from, the stakeholder view, experience, culture and customs.
- An assessment of the baseline conditions enables identification of the impacts and measurement of the changes that may arise as a result of quarrying activity. The assessment of baseline conditions includes air and water, flora and fauna, site safety, landscape integration, human activities and cultural heritage.
- The rehabilitation plan shall be developed prior to the commencement of mining for new sites, but should also be developed for operating quarries, where such a plan does not already exist. It should be aligned with the mining plan. Depending on the objectives and priorities set, the development and monitoring of management plans for biodiversity should, at a minimum, be considered as a supplement to the quarry rehabilitation plan, and in other cases, as core parts of the plan.
- A monitoring plan and appropriate corrective measures (if necessary) should be included in the rehabilitation plan, thereby ensuring the documentation and measurement of performance against the objectives.

Other mitigation measures have been explored by many scholars and organizations and are as outlined below:

Classification of protected areas is an effective mitigation measure and if there is a need to designate such areas, then the classification of the protected areas by the International Union for Conservation of Nature and Natural Resources (IUCN) is one of the prominent systems that exist for such purpose. There was a resolution that was passed on October 2000 by the world

Congress in Amman, Jordan, that recommended the member states to prohibit by law, all explorations and extraction of mineral resources in protected areas that corresponded to the IUCN protected area management categories.

EIA's and ESIA's are another mitigation measure where there are internationally accepted tools that have enabled mining companies to adequately factor in environmental and social considerations in investment decisions. For many of the companies internationally they have become an integral part of investment assessment methodologies that had previously been focused largely on financial criteria. There has been a re-emphasis on the use of impact assessment instruments that came as recommendations of the UN conference on Environment and development in 1992, which as a result reinforced the aspirations of the Berlin guidelines of 1991 on environmental stewardship. The impacts of assessments cover the effects on flora and fauna and on human health, as well as broad socio-economic impacts of mining both directly and indirectly.

Public participation is another very important part of regulating the environmental and social impacts of mining activities and an effective mitigation measure, which ensures sustainability by ensuring overall management of exploiting mineral resources, is held to accountability. There are key benefits that do arise from public participation, where the decision on whether a project has a significant impact on the environment as well as social effects and should be allowed to proceed is based on the local knowledge that is often valuable information often missed by the experts and it also legitimizes the project that would otherwise prove to be a problem because of social tensions when the project is externally imposed.

It is also now law that whenever anyone is carrying out an environmental and social impact assessment, that they include a public participation component. This is supported by the fact that many of the African countries provide for the right to a clean environment in their constitutions. This kind of provisions can actually found claims of a right of a member of the public to be heard before any decisions are made on projects that could have significant adverse effects on them.

Last but not least is access to information as outlined in Principle 10 of the Rio declaration that states that “each individual shall have the appropriate access to information concerning the environment that is held by public authorities, including information on hazardous material and activities in their communities and the opportunity to participate in decision making processes. States shall facilitate and encourage public awareness and participation by making information widely available”, expresses the relationship between access to information and participation in decision making. This is also further expressed in the UN Economic Commission for Europe “convention on access to information, public participation in decision making and access to justice in environmental matters (the Aarhus Convention), which is widely regarded as a model of public participation regime (UNECE, 1998).

In South Africa, their promotion of access to information act (2000) and its regulations establish a scheme to facilitate access to information held by public and public institutions. To monitor and enhance the implantation of the act, the South African human rights commission is assigned that responsibility.

## **2.4 Policy and legal framework governing mining in Kenya**

### **2.4.1 National Environment Policy, 2012: Revised Draft 5 of July 2012**

The policy aims to provide a holistic framework to guide the management of the environment and natural resources in Kenya. Its core goal is to advance better quality of life for present and future generations through sustainable management of the environment and natural resources.

### **2.4.2 The National Minerals and Mining Policy: Revised Final Draft 2010**

The objectives of this draft policy that is awaiting parliament's enactment covers several facets of mining in Kenya such as the regulatory framework, stimulation of investment in the mining sector in Kenya, ensure harnessing of minerals contributes optimally to vision 2030 and national development. Additionally, the policy also recognizes the need to bring into the mainstream the small scale artisanal mining sector.

### **2.4.3 Draft National Education for Sustainable Development Policy, 2011**

This is a policy document prepared by the ministry of environment and mineral resources on November 2011 (Ministry of Environment and Mineral Resources, 2011, p. 14). Education of the general public around the mineral rich areas is critical for them to understand the benefits, opportunities and effects of the mining activities. This policy is crucial in preparing the people for a resettlement exercise and in order to receive less resistance.

### **2.4.4 Mineral Development Policy**

This policy covers the National Development Plan of 1994-1996, titled Resource Mobilization for Sustainable Development. The National Environment Action Plan Committee (NEAP) is established under Section 37 of EMCA. This cross-sectoral committee is responsible

inter alia, for the development of a five year national environment action plan. The national environment action plan shall contain among other aspects analysis of the natural resources of Kenya and their distribution, quantity and various uses. It shall also recommend legal and fiscal incentives for business that incorporate environmental requirements into their planning and operational processes as well set out

#### **2.4.5 Legal framework Governing Mining Activities**

The Mining Act Cap 306 of 1940 is outdated and does not apply to standard mining regulation procedures. The industry wants to see a new law that aims to remedy the problems by stating the timeframes and procedures to be followed when access to land is unreasonably denied. The current Mining Act, which dates back to the 1940s, has been termed as a major block in the development of the mining industry.

#### **2.4.6 Environmental Management and Co-ordination Act no. 8 of 1999**

The policy process culminated into the Draft Sessional Paper No. 6 of 1999 entitled “*Environment and Development.*” The legislative process gave forth the Environment Management and Coordination Act (EMCA) (Act No. 8 of 1999) as Kenya’s first framework environmental law. Both the Draft Policy and Act added to a large number of existing sectoral laws and policies dealing with various facets of the environment, such as water, forests, minerals and many others (Government of Kenya, 2012, p. 7).

#### **2.4.7 National Land Policy Of 2007**

To address this problem, the Government has come up with a National Land Policy 2007 whose vision is to guide the country towards efficient, sustainable and equitable use of land for prosperity and posterity. This policy will ensure that all land is put into sustainable and

productive use. The policy has so far received Cabinet's approval and is currently waiting for enactment by the legislature.

#### **2.4.8 The Kenya National Environment Action Plan (NEAP) report of June, 1994**

This policy is covered in the Draft Sessional Paper on Environment and Development of 1996, Sessional Paper No.1 of 1994 on Recovery and Sustainable Development to the Year 2010, and the Report of the East African Cooperation Meeting of National Environment Institutions of November, 1997. This policy was updated in 2009 by the National Environment Management Authority (NEMA) in a document titled the "The National Environment Action Plan Framework 2009 to 2013.

#### **2.4.9 Trade Policies**

Although most of the minerals are exported in their raw form, the government policy is to encourage value addition within the country for higher returns, support of industrialization and employment creation.

#### **2.4.10 Resettlement/Land Acquisition Policy Framework of the Government of Kenya**

The objective of the policy is to outline the manner in which the people in areas where minerals have been found to be relocated to other areas.

#### **2.4.11 Land Reclamation Policy**

This policy was not drafted by the ministry concerned with mining and minerals in Kenya rather it is a product of the Ministry of Water and Irrigation. Nevertheless, it has been included here since it affects the mining sector especially on the aftermath of mining activities and not on the onset of mining. For instance, in mining from limestone and even sand, huge holes are left behind that become hazardous to the environment.

#### **2.4.12 National Occupational Safety and Health Policy (June 2010)**

This policy aims at promoting safe and healthy environment in places of work especially mining sector which not only uses dangerous chemicals in extraction of minerals but also exposes the workers to health hazards like dust.

#### **2.5 Gaps from the existing literature**

Health and safety issues in and around the quarry sites have not been explored as well as there are no proper policies and legislative frameworks to govern the sector in the country.

### **2.6 Theoretical and Conceptual Framework**

#### **2.6.1 Theoretical framework**

The theory guiding this study is the systems theory. This section reviews the theory with a view to bringing out the salient attributes that would enable this study to fit in. Similarly, the concept of land degradation is also incorporated to further buttress the effect of mining within the system. The general systems theory developed by Bertalanfy (1951), argue that the natural geology consist of mutually related subsystems and the destruction of one of the subsystem lead to the modification of the entire system. The environment is the sum total of all the external factors that influences the life of an organism, here the physical environment which comprise the land is considered. Consequently in the strive for economic growth, the physical and social environments are subjected to pressure that affect the entire system. He emphasized that real systems are open to, and interact with, their environments, and that they can acquire qualitatively new properties through emergence resulting in continual evolution. Thus rather than reducing an entity e.g. (environment) to the properties of its parts or element e.g. (land, social and economic setup), system theory focuses on the arrangement of and relations between the parts which connect them into a whole.

The systems theory conceptualizes land degradation and negative social and economic effects as the response of the mining to the demand of the environment. The theory sees land degradation as well as negative social and economic effects as an output of the mining. Land degradation such as loss in vegetation cover, changes on the landscape and negative social effects such as health related issues is seen as the reaction of the mining to environmental demands and pressures. The theory shows that the relationships that unite the part to form a whole have a lot of influence on the behavior of the whole.

Man affects his environment as he responds to the changing condition set by the environment and the environment responds to human manipulation, thereby creating a state of dynamic equilibrium that continues to adjust and readjust in space with time (Olofin, 1989). The systems theory was chosen against other theories because, the world is made up of components and the components are interrelated. Nothing is independent on its own. A change in one will have repercussions on the other parts. With respect to this study therefore, because man depend on the mining and the mining is being done on the land, the environment is in turn affected by such activity and land degradation sets in. The relationship between the two is that the mining as an input was converted into land degradation as the output in this case. The three interrelated components resulted into land degradation. Land is one of the major resources in both developed and developing countries, and forms the basis of economic sustenance. Degradation is therefore the diminution of the biological productivity expected of a given tract of land (Ayuba, 2005). Land degradation which includes degradation of vegetation and soil has been identified as a major problem in Africa (FAO, 1980). From the foregoing therefore, the systems theory sees land degradation as the output of the mining.

### **2.6.2 Conceptual framework**

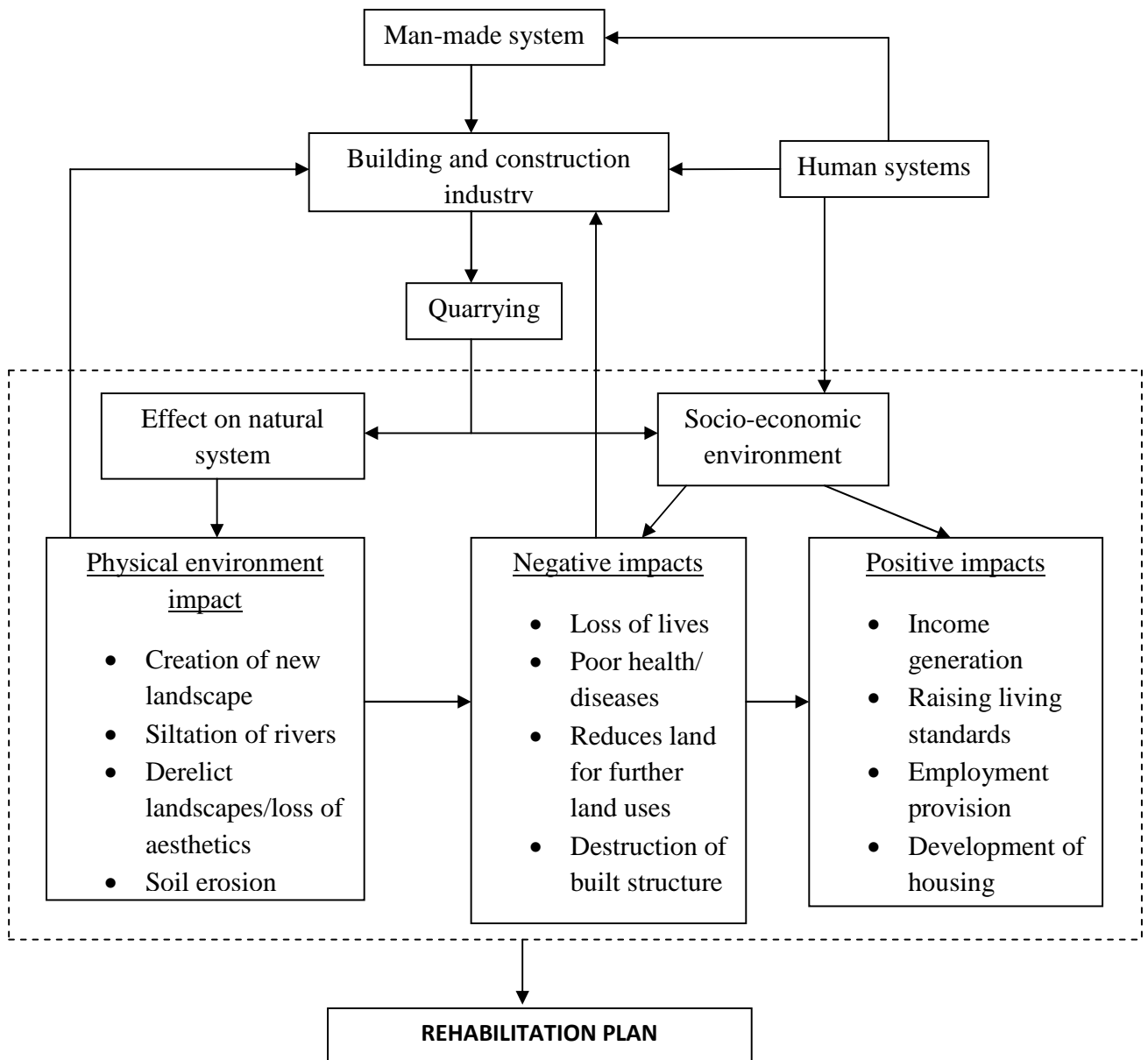
Human beings are part of the biosphere or its ecological component and play a central role in modifying and interfering with the physical environment through their activities. Human systems tend to influence these activities, whereby socio-economic aspects that include demography, knowledge, economic development and lifestyle among others, directly or indirectly influence what we do. These in turn lead to the development of man-made systems that are strongly influenced by human beings, and includes the development of physical structures, public infrastructure, parks, man-made lakes, mines and rock quarries, so as to satisfy the needs and wants in society. Quarrying as one of the developments interacts with the aspects of the physical environment or otherwise the natural systems that includes physical phenomena that do not originate from human activities; including water, air and climate. The ecosystem as part of the natural system is also affected. Human beings as the sole generator of these effects are also affected, where the effects on the physical environment can also impact on the socio-economic aspects of quarrying, including loss of lives, poor health and diseases, accidents, reduction of land for other land uses, and destruction of built structures.

Quarrying as an activity that involves the extraction of earth materials for economic value, takes place within the physical environment and therefore has impacts both on the physical and socio-economic environment, however there are also positive aspects of mining which determine whether quarrying will continue.

The conceptual framework is a synthesis of components from a developed conceptual framework for integrated monitoring, namely Integrated Environment and Health Monitoring (IEHM) framework developed by WHO (world health organization), 2010 with that of a theoretical framework by Law and Smith on the principal components of the environment. The

synthesis has modifications in line with the researcher's conceptualization of quarrying as an activity that has both socio-economic and environmental impacts (see figure 1-2).

Figure 1-2: Conceptual model



Source: Adapted and modified from WHO Integrated Health and Monitoring Framework (2010)

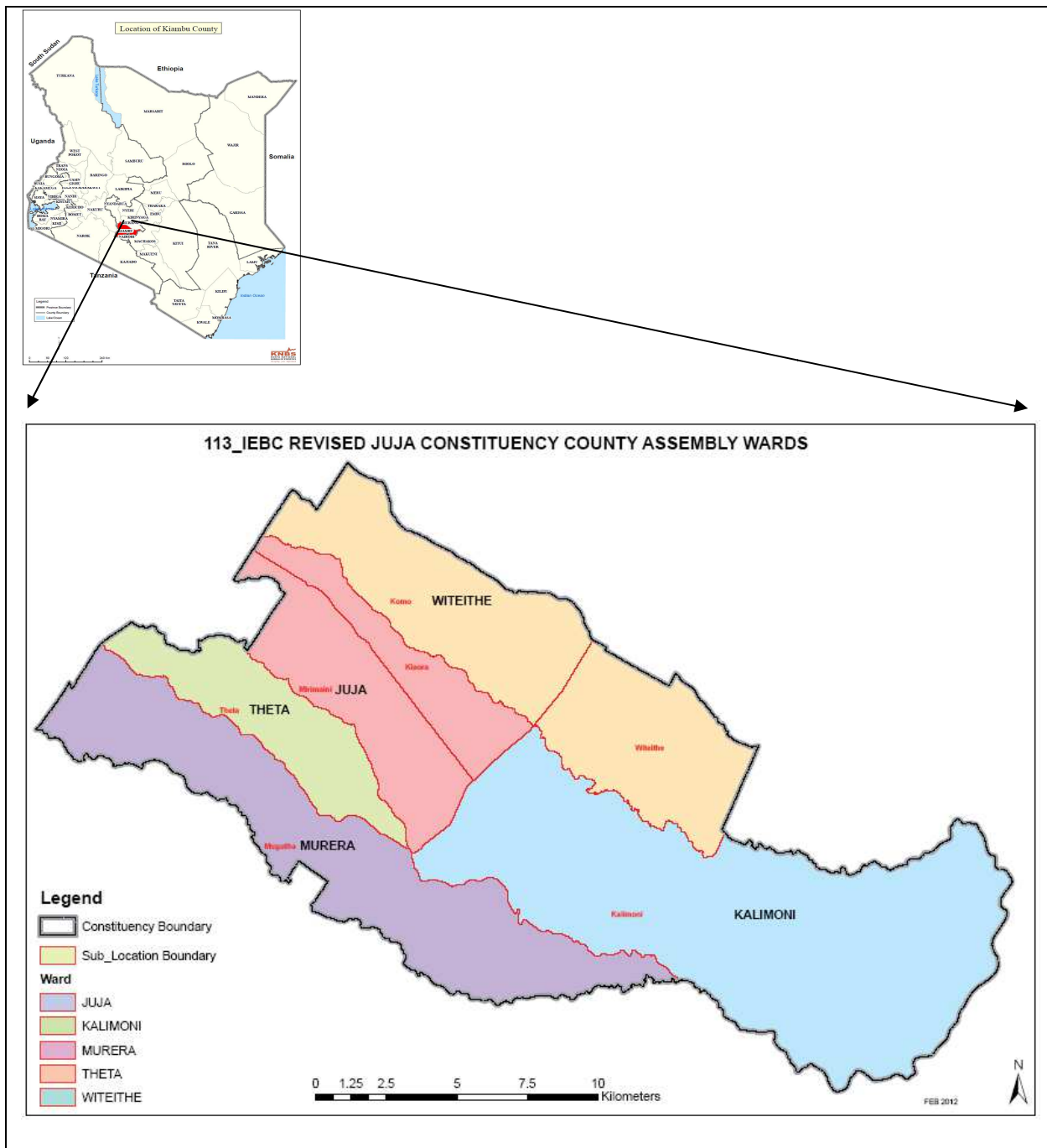
## **CHAPTER THREE**

### **3.0 AREA OF STUDY**

#### **3.1 Location and extent**

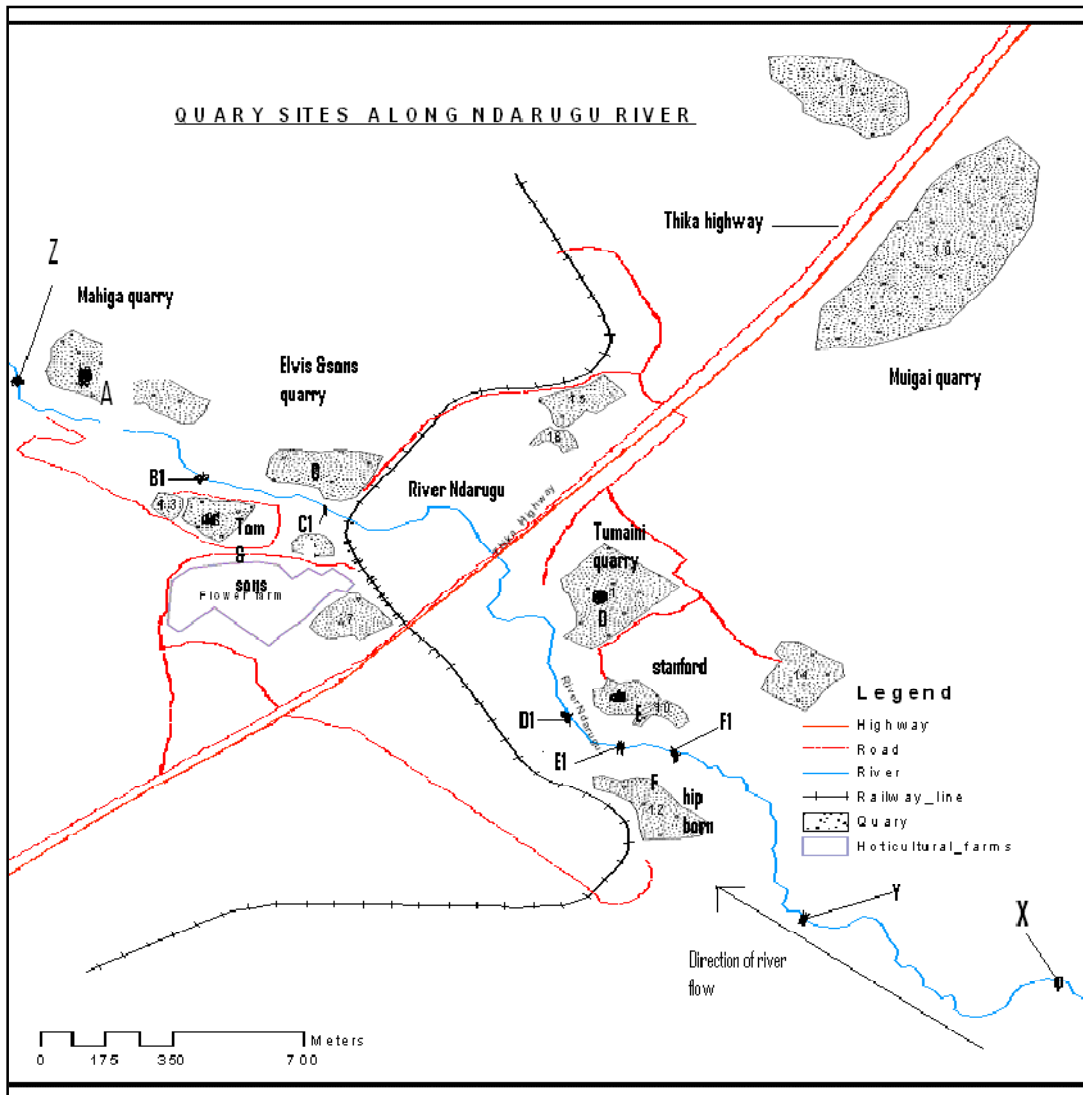
Ndarugo area is found in Kalimoni sub-location, Juja location of Thika district, Kiambu County, in central Kenya and is located at about 30 km north of Nairobi city. Juja location is divided into three sub-locations namely Kiaora, Kalimoni and Komo. The location covers an area of about 4,000 km<sup>2</sup> and is home to a population of about 200,000 people (KNBS, 2009). It lies within 1 11' 0'' South, 37 7' 0'' East, and is placed at an altitude of 1560 m above sea level (see figure 2-3). Kalimoni is home to most of the hand operated quarries, while most of the machine operated quarries are found along Ndarugo River (figure 3-3).

Figure 2-3: Juja constituency wards in context from Kiambu County



Source: KNBS, 2009

Figure 3-3: Quarry sites along Ndarugu River



Source: George, Oguta and Calvince, 2007.

### 3.2 Topography

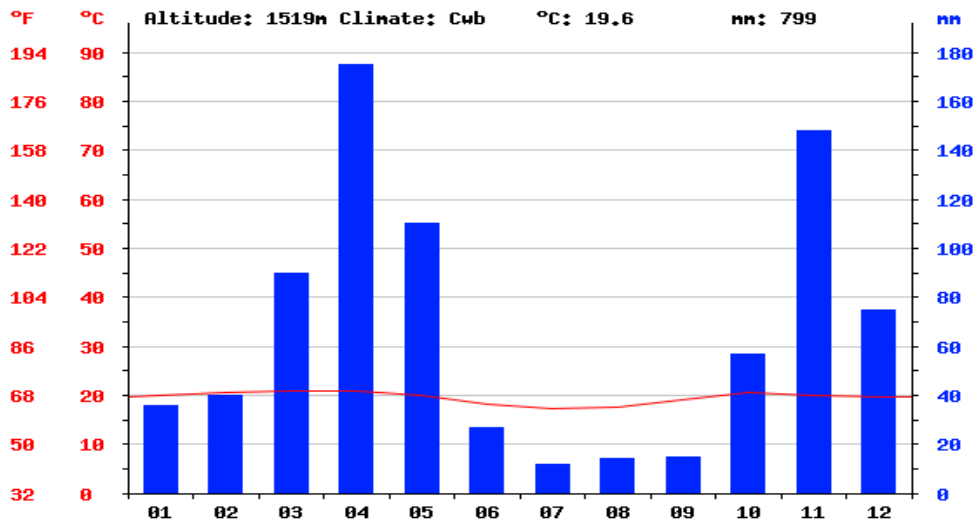
The slope of the area is oriented to the northeast- southwest direction and its physiographic consists of scarps that are formed by the extensive quarry activities going on in the area. The underlying bedrock in Ndarugu area is formed of granite, which is suitable for building stones.

There are two small rivers that can be located in the area, and they join the Nairobi River at the lower boundary of the wider Juja. The quarry sites are located along river Ndarugo, which is recognized for its diverse flora and fauna, and also offers a mild climate and natural beauty to the area. It is a freshwater river that is both ecologically and economically beneficial to the residents of the area. The river provides water for both domestic and agricultural use.

### 3.3 Climate

The area receives an annual rainfall of 856 mm and experiences two rainy seasons; that is the long-rains that occur between March and May, while short-rains occur between October and December. The mean annual temperature of the area is 19.6°C, with the hottest month which is March with 21.3°C, and the coldest month which is July with 18.4°C (see figure 4-3).

Figure 4-3: Climatic data for Juja area



Source: World weather, 2013

### **3.4 Land use**

The quarries are placed under a lease tenure system, where the developers lease the land from the owners at an agreed fee until the quarry work is finished.

The main land uses in the area can be categorized into two; that is quarrying and agriculture. As mentioned earlier, the granite deposit that underlies the area are suitable for building stone exploration, therefore suitable for commercial quarrying of stone as well as quarry dust. Apart from the quarries there are also agricultural activities around the area, with mostly subsistence and cash crop farming. The cash crops planted in the area are coffee and horticultural flowers and products. Penta flower is the major flower grower and has a farm by the name Ndarugu farm, whereas horticultural products are grown by one farm known as Benvar Limited, which also owns several quarry sites.

### **3.5 Geology**

The Proterozoic Mozambique Belt that is most extensive in Kenya Central, North to South in which metamorphic minerals such as Kyanite, Corundum, Graphite, Wollastonite, Marble, kaolin and a variety of gemstones are found together with minerals associated with basic and granitic rocks, such as mica and iron ore. The general rock formation in Juja is tertiary basic igneous rock that consists of olivine basalts, phenelites, granite and other older basic turf. The presence of such rock formation provides an abundance of suitable stone that can be used as building material. The igneous rocks are used in the production of coarse aggregates, which are used in making of concrete. As for other rocks that are relatively soft compared to the igneous rocks, they are used as building stones sourced from the quarries, and are exploited either through hand or machine methods. The soils in the area are moderately well drained, shallow, and friable, as dictated by the presence of gravely clay or petrophithenite with pockets of

murrumwith lithesol. There are also pockets of poor drained deep to very deep petrophithite, vestrols, undifferentiated and verticgleyosols. This type of geological formation provides a rich background of building materials in the area.

## **CHAPTER FOUR**

### **4.0 RESEARCH DESIGN AND METHODOLOGY**

This chapter concerns itself with the methodology used in this study. The information includes the sampling frame and design, and then covers data collection, processing and analysis. The instruments of data collection are also outlined as well as the limitation of the study.

#### **4.1 Sampling frame and design**

The respondents for this study were drawn from quarries in Ndarugo and its environs. The sampling frame is inclusive of all quarries in Ndarugo area. Since most of the quarries are closely located to each other, the systematic random sampling was employed. Most of the quarries assume similar characteristics and the same quality of stones are mined. According to the mines and geology department of Kenya, the quarries in the area can be termed as large scale quarries, based on the kind of technology and scale of operation. The stones are extracted through machines such as crushers, bulldozers and run in a 24 hour cycle, thus assuming the term large scale quarries. The socio economic considerations for all the quarries are assumed to be similar.

The socio economic data was collected from quarry workers, quarry owners and those people living within the quarries. The choice of the number of respondents was through simple random sampling, and a total of 30 Workers from the quarry sites were interviewed. The availability and willingness to respond was determined by who the respondents were. The work done in the quarries is tedious and it demands a lot of commitment to the extent that by the end of the day most of the workers are too tired to respond to an interview or even fill in a questionnaire. The researcher had to take advantage of the short sessions of rest during the day collect data.

Another sample of 5 respondents was taken from the quarry owners. This is because most of the owners of the quarries have their offices outside the area of study, which presented difficulty in accessing them as their locations are not well defined. This reduced the number of the intended respondents from 10 to 5. Lack of cooperation also posed a great challenge, just as in the case of the quarry workers. Most were very negative and suspicious of the researcher. There have been a lot of complaints in the recent past about the problems caused by quarrying activities, and these complaints are a threat to the activity. The researcher was viewed as a spy with a motive of getting information from the public so as to take it to the government. Many of the respondents had to be convinced so as to cooperate.

Another 30 respondents were interviewed for people living within 3 kilometers of the quarry sites. The quarries are located on individuals' land which is leased. Purposive random sampling was used in selecting these respondents as the data was to be used to determine the effects of quarrying on people living within quarry environs. The presence of respondents, which was determined by availability of settlement structures close to the quarries, was significant. Most of the people were living in their own plots of land, which were found just adjacent to the quarry sites.

## **4.2 Nature and sources of data**

### **4.2.1 Nature of data**

The data collected for the study is qualitative data because it is descriptive in nature, where the data collected was focused on individual people rather than the use of numbers and figures to answer the study research questions. The study aims to evaluate the descriptions and responses given by the respondents and this place the respondents' responses as paramount in the research approach.

## **4.2.2 Sources of data**

The data collected in the study was based on both primary and secondary data. The primary data collected was gathered from the use of instruments such as; questionnaires, interview schedule, photography, and direct observation. The secondary sources of information used were books, peer reviewed journals and the internet.

### **4.2.2.1 Primary and secondary sources of data**

The primary sources of data included;

- **Questionnaire**

Three questionnaire schedules appendices I, II, and III were administered to various respondents. Questionnaire A was administered to quarry workers, B to the quarry owners, and C to people living within 3 km of the quarry sites. 30 questionnaires were administered to quarry workers, 5 to quarry owners, and 30 to people living within 3 km of the quarry sites. The questionnaires were used to elicit primary data on both socio economic aspects such as sex, age, level of education, direct employment generation, income and wealth generation, welfare of those involved, welfare of those living nearby, support of quarrying to other social aspects and conditions of work. It also provided information on extent of quarry rehabilitation.

The respondents were randomly selected depending on their availability and willingness to respond. The researcher conducted the research wholly on his own.

- **Interview schedule**

The interview schedule was used alongside the questionnaires. It was used on all respondents whenever the researcher felt it was necessary in the process of filling the

questionnaires. It proved to be a vital tool in eliciting information that could not be obtained through the use of questionnaires. Moreover the level of education of most of the respondents commanded the use of this tool. Most of the respondents could not afford time to fill the questionnaires by themselves as payment of their work is pegged on the amount of work done.

- **Photography**

This method of data collection was an effective tool and was used to capture some of the information relevant to the study such as dust in the quarry sites, the abandoned quarries, as well as the pit floods.

- **Direct observation**

This was also employed and as one of the most important tool, it was aided by the use of an observation record sheet, where information seen was recorded.

Secondary sources of data included;

Secondary data was used to cover the dimensions of the study was also used. This included data from academic journals, NGO reports, government policy documents, the meteorological department of Kenya, newspaper reports and the internet. The data used was that obtained from studies on socio-economic aspects of quarrying, policy documents, and quarry rehabilitation practices in general from any part of the world, and one case study in Kenya which was mentioned.

### **4.3 Data processing and analysis**

Data from the various sources was edited and then coded for analysis using the SPSS analysis tool. This was done in order to find answers to the research questions and then draw the conclusions from the objectives of the study. Data collected using questionnaires was first used in computation of statistics as frequencies, totals, percentages, tabulations and cross tabulations. Secondary sources and observation provided data on bio-physical characteristics of the site as well as the quarrying process.

## **CHAPTER FIVE**

### **5.0 DATA ANALYSIS AND DISCUSSION**

#### **5.1 Policy and legal framework governing quarrying activities in Kenya**

The respondents both the quarry owners and people living within the quarry environs were asked whether they knew of any policies or legislations that govern the quarrying sector in the country during the interviews, the quarry owners said that they had the knowledge of some laws that state the fact that the quarries have to be reclaimed after use. They also pointed out that laws governing quarrying are not properly developed and that the national environmental management authority (NEMA) usually makes random visits to the sites to ensure that they are not doing any harm to the environment. The owners also pointed out to the fact that it is a recommendation that they develop an EIA and clearly set out mitigation measures.

Many of the people living within the quarry environs said that they had not heard of any laws or policies that govern quarrying. They said that the quarry owners did not regard any environmental regulations as they blatantly disregard the safety of the surrounding environment as there are no authorities that control them other than the fact that the local county council collects levies from the quarries.

Those that work in the quarries are not safeguarded in any case of accidents occurring in the quarries as the quarry owners ignore the fact that health and safety laws exist, whereby the workers operate in the quarries without any protective gear, and as a result of this they are exposed to potential health and risk hazards.

Mining activities in the country have not been well coordinated as there are many artisanal mining groups that do not adhere to environmental policies and guidelines. There has

been a major setback in the policy implementation, which is caused by having fragmented stakeholders and oversight authorities. Many of these policies have been faced with the challenge of lack of adequate up to date regulations addressing the rights of key stakeholders such as communities in rich mineral areas, and in addition the present laws are outdated and full of loopholes that have provided easy ways for fragmented mining activities that are hazardous especially to the inexperienced miners. Some of the key policies that could be directly linked with quarrying activities are as outlined below, and the gaps in the policies discussed.

### **National land policy of 2007**

The law is supposed to ensure that land is put into sustainable and productive use, but it is inconsistent with mining and minerals bill of 2009 that states “a mineral right shall not be granted under this Act on, under or over private land without the consent of the owner.” Whereas the land policy states that all private land harboring mineral resources shall be repossessed by Government upon offering sufficient compensation to land owners. In addition, the commissioner of department of mines and geology grants both exploration and mining licenses to companies and individuals who want to explore minerals in Kenya in areas that are agricultural lands, gazetted forests, urban areas, areas set aside for commercial activities, ranches, private lands, trust lands and so on. The laws are in contradiction, and the policy does not provide for a clear framework where all stakeholders are supposed to communicate and execute the processes smoothly.

### **Resettlement/land acquisition policy framework of the government of Kenya, 2007**

The policy outlines resettlement measures undertaken in areas where minerals have been found, and though this is the case, there has not been a clear way forward for resettling people

found in such areas. The problem is aggravated by the lack of adequate awareness by the people though it is the responsibility of the government in conjunction with the ministry of lands. Many of the people found living in the quarry environs are surrounded by quarries in very close distances, a situation which puts the people in huge risks. Because the land owners have operating licenses, they disregard the people living near the quarries, where they explore for stones near residential areas and many of the people that are found too close are forced to move without any compensation.

### **Land reclamation policy, 2005**

The policy is not drafted by the ministry concerned with mining and minerals in Kenya but rather the former ministry of water and irrigation. Therefore, there is a very big issue as it does not provide a conceptual framework on how the ministry concerned with minerals and mines can be involved. The lack of this networking framework means that the policy is only as good as it is on paper. The quarry owners do not reclaim the quarried land at all, and because this issue is disregarded by the concerned ministry, the owners do not bear any responsibility for their actions.

### **National occupational safety and health policy, 2010**

The policy aims at promoting a safe and healthy environment in the places of work. In relation to quarrying, it would ensure that workers are not exposed to health hazards such as dust, but due to the lack of a clear framework governing mining in Kenya, there lies a gap in the implementation strategy of the policy as it is conclusive and concrete. Many accidents do occur in the mining sector and especially in the quarrying sector as the owners disregard the provision of safety equipment and gear for their workers. When the quarry workers were asked through the

questionnaires what they would like to be improved in the quarries, 98% of the workers stated that they wanted the owners to provide them with safety gear and equipment to prevent them from the hazards in the place of work.

### **Quarrying legislations**

Though no specific mention or reference to quarrying has been made in any mining legislations, some laws however point indirectly to some legislations that ensure proper governance of quarries and efficient extraction of stone and rock. Some of these laws are as follows;

### **Environmental Management and Co-ordination Act, no. 8 of 1999**

The policy process culminated into the Draft Sessional Paper No. 6 of 1999 entitled “*Environment and Development.*” The legislative process gave forth the Environment Management and Coordination Act (EMCA) (Act No. 8 of 1999) as Kenya’s first framework environmental law. Its most important contribution to the governance of environmental regulations is the creation of the National Environmental Management Authority (NEMA) (EMCA, 1999 part II & 7). NEMA is charged with enforcing EMCA’s provisions as well as the subsidiary legislation that has been passed over the last decade. The subsidiary legislation includes water quality, waste management, controlled substances, biodiversity, wetland, river and seashore, and environmental impact assessment (EIA) regulations. Most of the provisions contained in EMCA, as well as the subsidiary legislation, are intended to provide regulations for the usage and type of allowable activity in the different ecosystems and habitats of Kenya. Thus, NEMA’s main task is to review and grant licenses to proponents that plan to change land-use.

Under EMCA, 1999 and the subsidiary 2003 regulations, NEMA is required to review the EIA report and solicit comments from the relevant lead agencies and the public. Nonetheless, NEMA's review process faces many challenges that could allow proponents of ill-prepared reports to get EIA licenses. Some of the quarry owners do have these licenses and they do not have proper reports, while some do not even have these reports.

### **Mining Act, 1940**

The Mining Act 1940 (chapter 306 of the Laws of Kenya) (the "Mining Act") regulates all mining activities in Kenya. The Commissioner of Mines and Geology (the "Commissioner"), heads the Department of Mines and Geology and is responsible for overseeing mining research and policy as well as implementing the Mining Act.

The law does not include stone and rock. Consequently, artisanal stone quarrying has operated outside this legislation with no governing body, no overall framework governing land use planning, and no environmental control. The absolute bereft of quarrying control is illustrated by the fact that stone quarrying can commence on private land without reference to any authority. Such operations are unrecorded, unregulated and have no environmental obligations. It should be noted however that quarries operating on government of Kenya forestry land do require a license and are required to restore the land at closure.

## **5.2 The bio-physical and socio-economic effects of quarrying activities**

### **5.2.1 Bio physical effects**

#### **5.2.1.1 Pit flooding**

The analysis was based on the responses of those people that lived within the quarry sites as they were deemed to understand the surrounded environment better, therefore all the responses are based on appendix 1. There was evidence of flooded pits near the quarry sites that are found just opposite the Thika super highway, where water had filled the abandoned quarries after the companies exploiting the stone resources had vacated as shown in plate 1-5.

Plate 1-5: Flooded quarry pits

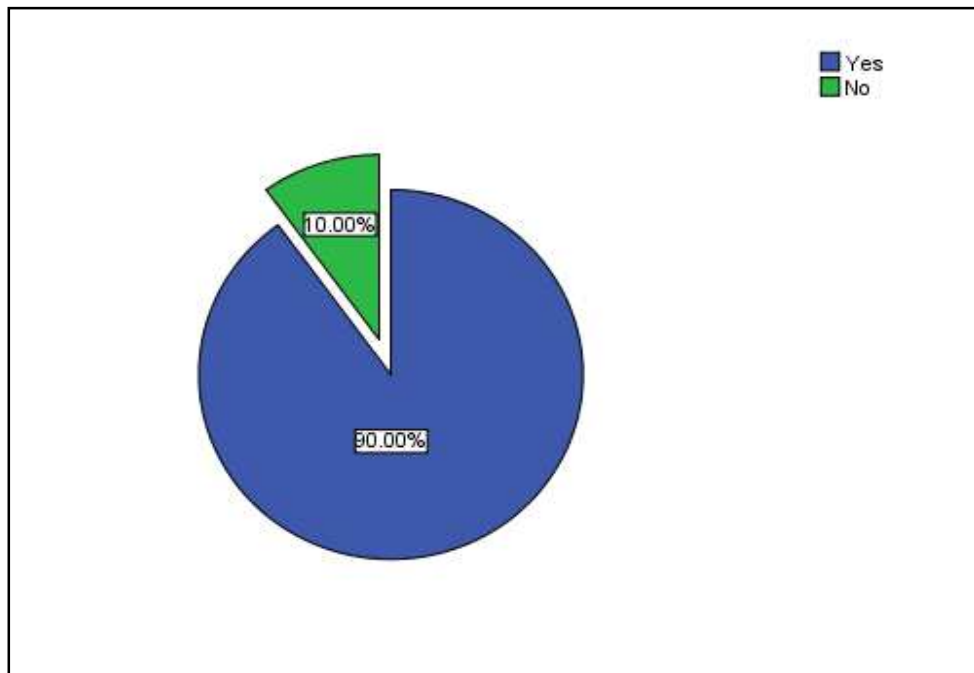


Source: Field survey, 2014

People living around the quarry environment were asked whether the abandoned quarries experienced pit flooding. 90% of the respondents said that the abandoned pits experienced flooding after rains, and since the floor of the quarry is covered by stone, the water takes time before it percolates, and that it takes a long time for the water to subside especially for the

abandoned quarries, and as a result pits flooded with water are seen even through the dry period. 10% of the respondents said that they had not seen the pits flooding because they had moved recently in the vicinity and had not explored the area (figure 5-5).

Figure 5-5: Percentage response on pit flooding



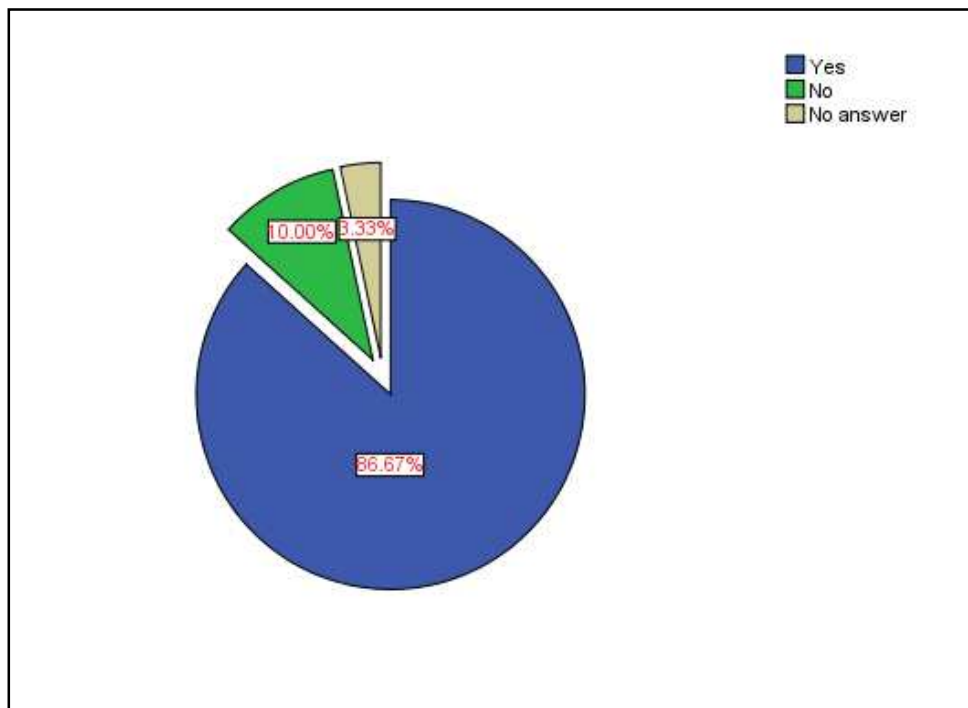
Source: Field data, 2014

### 5.2.1.2 Property damage (Effects of dust, noise and vibration)

The respondents living in the quarry environs were asked whether there was any property that had been affected either by noise, dust or vibration and that had caused damage, and 86.7% of the respondents reported that indeed some of their properties had been damaged, majorly by the appearance of cracks on their houses as well as accumulation of dust inside their houses. The respondents who responded in this manner had been living in the area for a significant number of years, and were living in close proximity to the quarry sites, with those living within a 500m to

1km radius being the most affected. 10% of those questioned said that they had not seen any damages on their property because they were not in close proximity to the quarries and most had moved into the area less than a year ago. 3.33% of the respondents did not give any answer as shown in figure 6-5.

Figure 6-5: Percentage response on property damage



Source: Field data, 2014

Many of the houses in the area had to be closed, that is the doors and windows, for the better part of the day because dust was an issue as the roads are not made of tarmac and when trucks ferrying the stones pass on these roads they leave huge clouds of dust and as the winds blow they carry the dust in the houses, especially for those that are found in close proximity to the road. Houses that had been in the area for a long time were being affected by the fact that new quarries that were being developed near the residential, were producing a lot of vibrations and cracks had started to develop on both the floors and walls of the houses (plate 2-5). Noise

from the heavy machinery was also a big nuisance for the residents living around the quarry sites, especially those that were found in close proximity of within 500m to the quarries.

Plate 2-5: Developing cracks on the floor of a newly built house

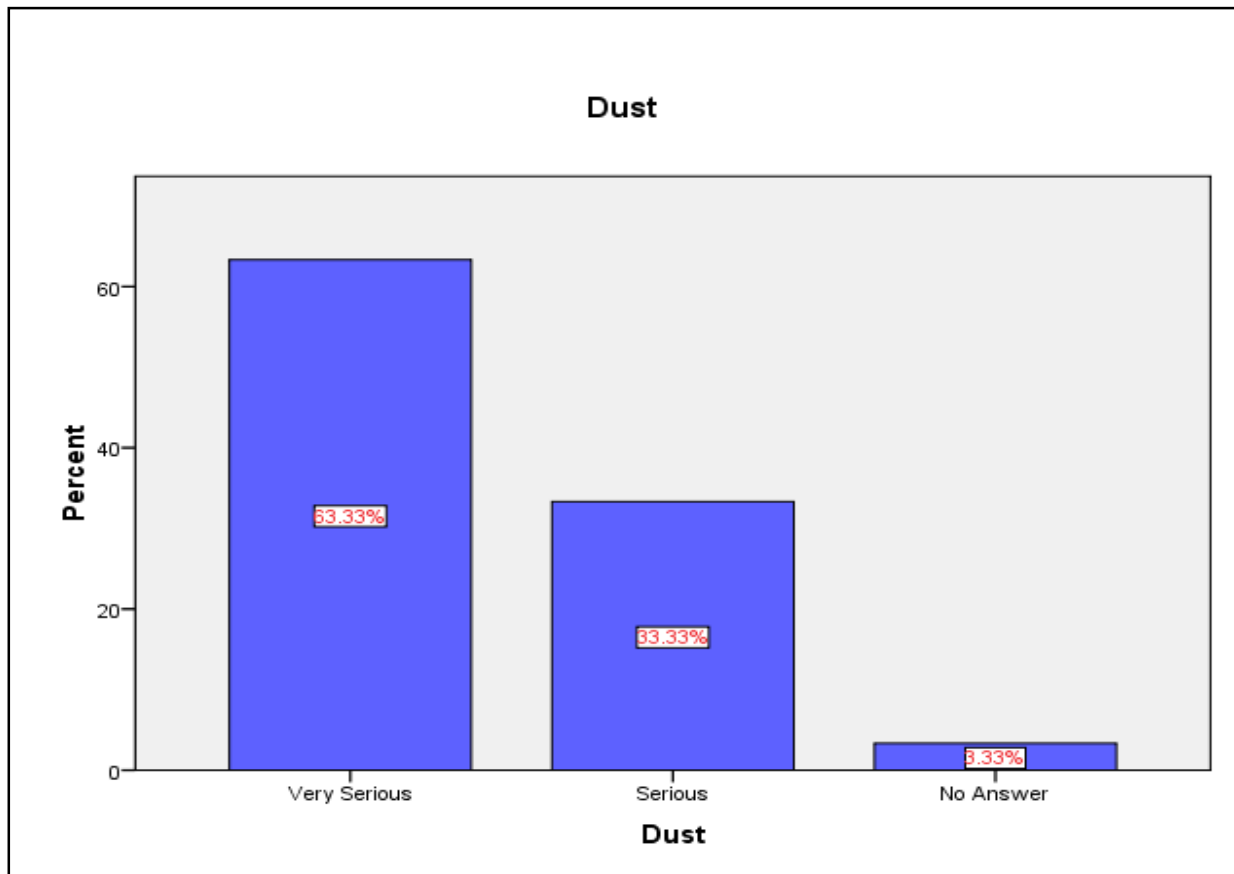


Source: Field survey, 2014

### **5.2.1.3 Air pollution (dust)**

The respondents, that is people living around the quarry environs were asked about the seriousness of dust as a cause of pollution around the environs as a result of the quarrying activities and 63.33% of the respondents stated that the issue of dust was very serious, and was a great source of air pollution in the area while 33.33% stated that it was a serious issue and 3.33% gave no answer. The level of seriousness decreased based on the distance of the residents home from the quarries, where those that were within a radius of 500m said the issue was very serious, and those that were within a radius of 1km and 3km said that it was a serious issue (figure 7-5).

Figure 7-5: Seriousness of dust as a cause of pollution



Source: Field data, 2014

The issues was aggravated because of the fact that the roads in the area were plain earth and are very dusty and because of the constant passage of the heavy trucks, the earth becomes loose and dust particles are always seen suspended in the air especially when there is a lot of wind blowing. Quarry dust produced after cutting stones was also another serious cause of air pollution in the area as a lot of dust is produced in the quarry process, and it is not moved where it is just scattered on the quarry floors. When strong winds blow over the quarry sites, a lot of dust is lifted in the air and it causes a lot of nuisance around the area (plate 3-5).

Plate 3-5: Dust lifted into air

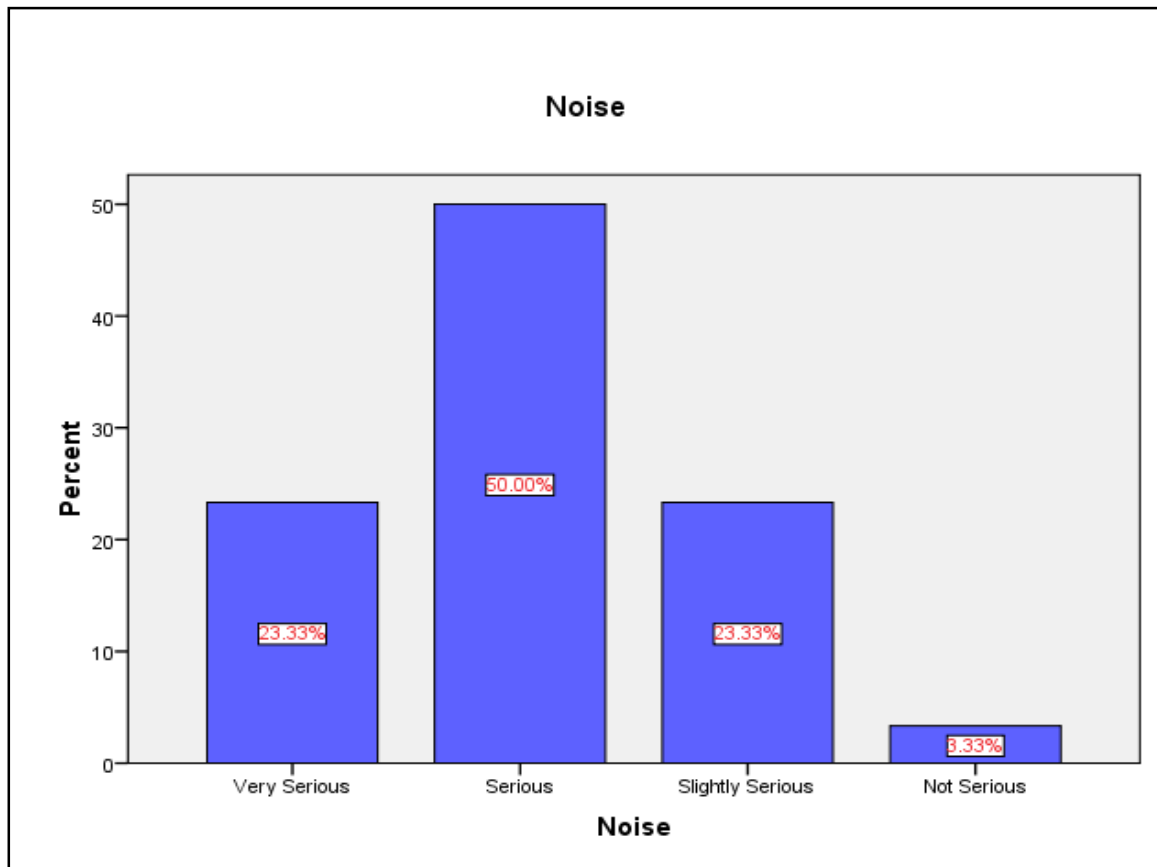


Source: Field survey, 2014

#### **5.2.1.4 Noise pollution**

Respondents who were the people living around the quarry environs were asked on the seriousness of noise in their environment, and 23.33% stated that the issue of noise pollution was very serious, while 50% of the respondents said that the issue was serious, whereas 23.33% said it was slightly serious, and 3.33% said that it was not serious, as shown in figure 8-5. Those that attested to the issue being very serious were those that were close to the quarry sites within a radius of 500m, and as the distance increased the issue decreased in seriousness with those residents living within a 1km radius not being subjected to much noise, which is a result of the working of some heavy machinery and blasting of stone, with the later occurring rarely.

Figure 8-5: Seriousness of noise as a cause of pollution



Source: Field data, 2014

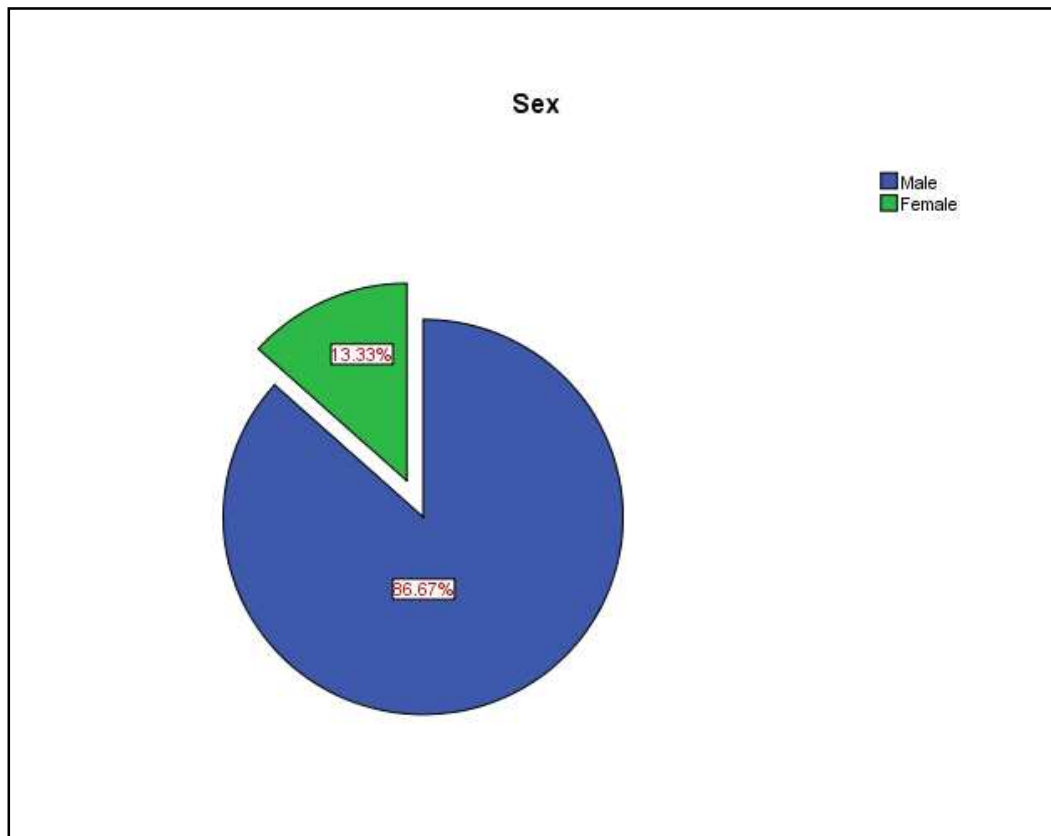
### 5.2.2 The socio-economic effects

These are the effects that are related to the functional society and their livelihoods, and the information gathered was derived from the quarry workers, and therefore the responses are based on both appendix I and II.

### 5.2.2.1 Sex

Overall, 86.67% of the respondents were male, while 13.33% were female. Much of the work in the quarry is physical, where digging of soil, loading of stones and blasting of rocks, are the day to day activities, activities which are more preferable to men than women (figure 9-5).

Figure 9-5: Percentage male and female respondents



Source: Field data, 2014

### **5.2.2.2 Pit flooding versus drowning incidents**

In order to understand the occurrence of drowning incidents based on the fact that there was pit flooding that occurred in the quarry pits, a cross tabulation was derived indicating the relationship between pit flooding and drowning incidents. From the tabulation, 83.3% of those respondents that had agreed to pits flooding stated that that indeed there were drowning incidents in the flooded pits, whereas 6.7% of the respondents said that they had not heard of any drowning incidents. This was because some of the respondents had just moved into the area. 10% of the respondents said that they had not seen any flooded pits and thus had not heard of any drowning incidents. This was majorly because those respondents had just moved into the area and had not had a chance to explore their environs. Many of the respondents also revealed that children were more prone to drowning because they are found playing near these abandoned quarries, and the situation is aggravated further by the fact that most of these abandoned quarries are not fenced and if they are it is done poorly, and as a result increases the risk not only for the children but also the rest of the population especially at night when the ability to see clearly is low.

### **5.2.2.3 Marital status versus income sufficiency**

In order to better understand whether the income earned by respondents, that is those who were working in the quarries, was sufficient to support their livelihoods based on their marital status, a cross tabulation between these variables was derived. The results showed that, 60% of those workers that were single and earning an income between ksh.10,001 – ksh.20,000 said that they had a sufficient income, while 40% in the same income range and assuming the same marital status said that the income was not sufficient to cater for their needs. 60% of the respondents was majorly comprised of those respondents that were below 25 years as they did

not have that much responsibility, while 40% were those respondents were those aged above 25 years as they had an increased pressure of being more responsible towards different areas of their life such as owning some property and wanting to settle down into marriage life.

Results on workers that were married and were earning an income of between ksh.10,001 – ksh.20,000 indicated that 50% of the respondents said that they did not have sufficient income, which was because of the increased responsibilities that they had as they were supporting their families, where most of them were the sole bread winners. 14.3% of those workers that were married and earning an income of more than ksh.20,000 stated that the income was sufficient, whereas 28.6% of the same category of respondents stated that the income was insufficient, whereas 7.1% gave no answer. This shows that many of the respondents do not have a sufficient income to take care of their needs and the work they do is tedious and demands a lot from them.

One of the respondents was a widower and stated that the income earned was insufficient.

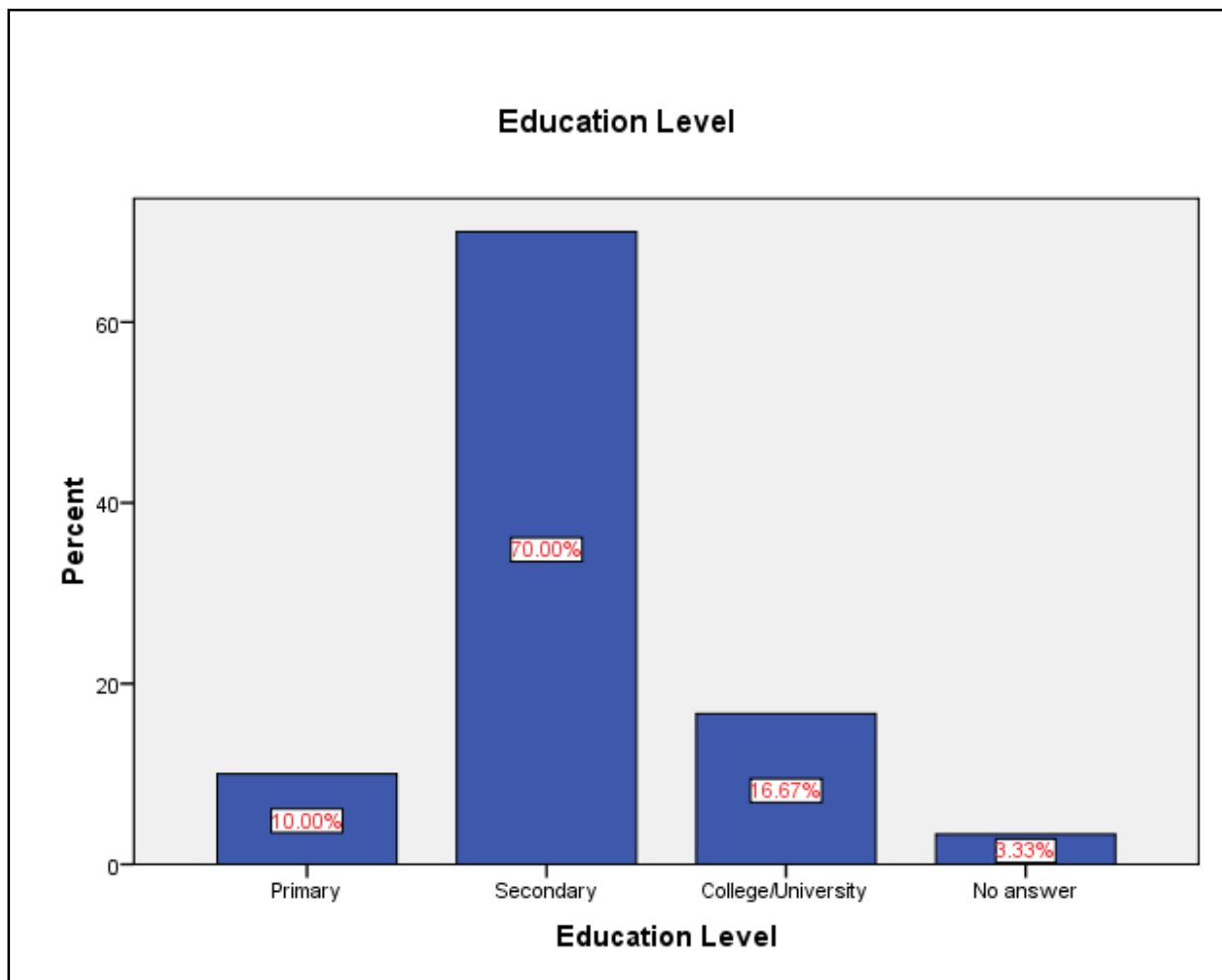
#### **5.2.2.4 Income sufficiency based on the number of dependants**

Information on whether the income earned was sufficient enough to support those respondents that had dependants was sought, and the results indicated that out of those respondents that said that the income earned was sufficient 30% had no dependants at all, while 3.3% had one dependant and the other 3.3% had three dependants. Of the respondents that said that the income earned was not sufficient, 10% had no dependants, 16.7% had one dependant, 13.3% had two dependants, 20% had three dependants, and 3.3% had four dependants. This shows that the more the number of dependants that the workers have, the more they feel that the income they earn is not sufficient, which is because of the burden they have to bear in taking care of their dependants.

#### **5.2.2.5 Education level**

To understand the education level of those workers in the quarries, respondents were asked what is the highest education level that they attained and 10% said they had reached primary school level, 70% had completed secondary school, 16.67% had got to college or university level, and 3.33% gave no answer to the question asked (figure 10-5). When asked why most of them had only had a primary education and secondary education as the highest level of education, they said that they did not have funds or their families could not facilitate a further education for them, and as a result they decided to go work at the quarries. This is because most of the work that they were employed to do was informal and did not require specialized skills.

Figure 10-5: Total percentage of respondents' level of education

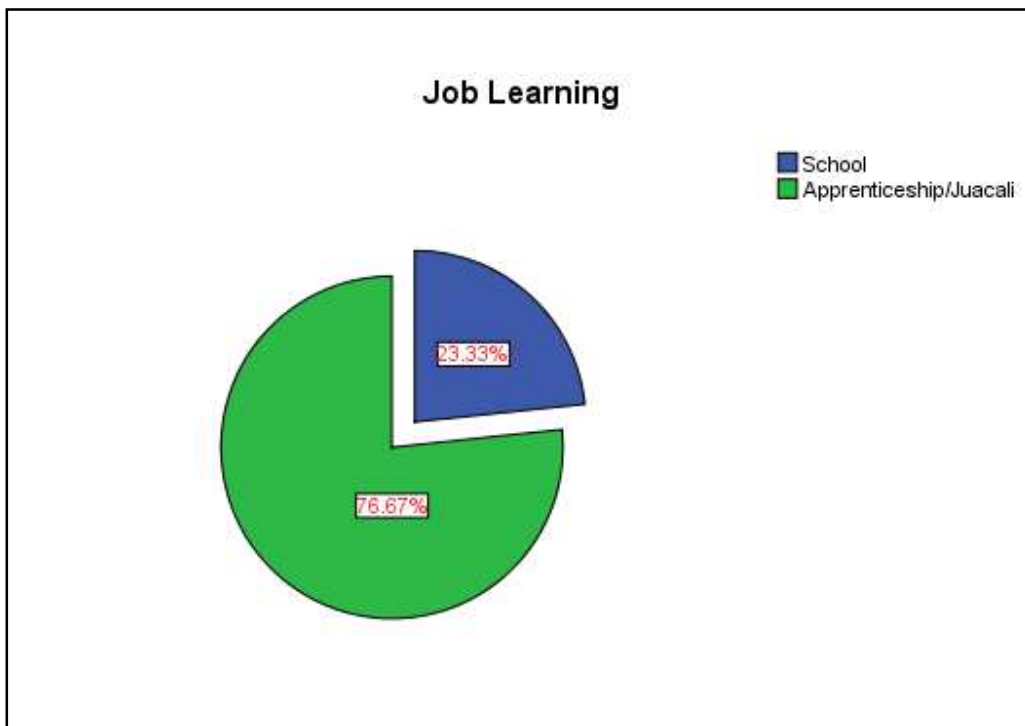


Source: Field data, 2014

In order to understand the level of skills required to do the different kind of works in the quarries because many of the workers had pointed out the fact that they had only attained a secondary education and some of them a primary education as the highest level of education, the respondents were asked how they learned of their job and the results showed that 76.67% of the respondents, that is the quarry workers, had learned to do their job by watching others, or what is known as apprenticeship or Jua Kali which is the informal sector, where it included stone blasters, soil diggers, and stone cutters. 23.33% of the respondents went to school to learn

whatever they were doing and it included those in the administration of the quarries, machine operators and quarry supervisors. Much of the work that is done in the quarries is largely informal, and skilled labor is only required when operating the heavy machinery and general administration of the quarries (figure 11-5).

Figure 11-5: Percentage on job learning



Source: Field data, 2014

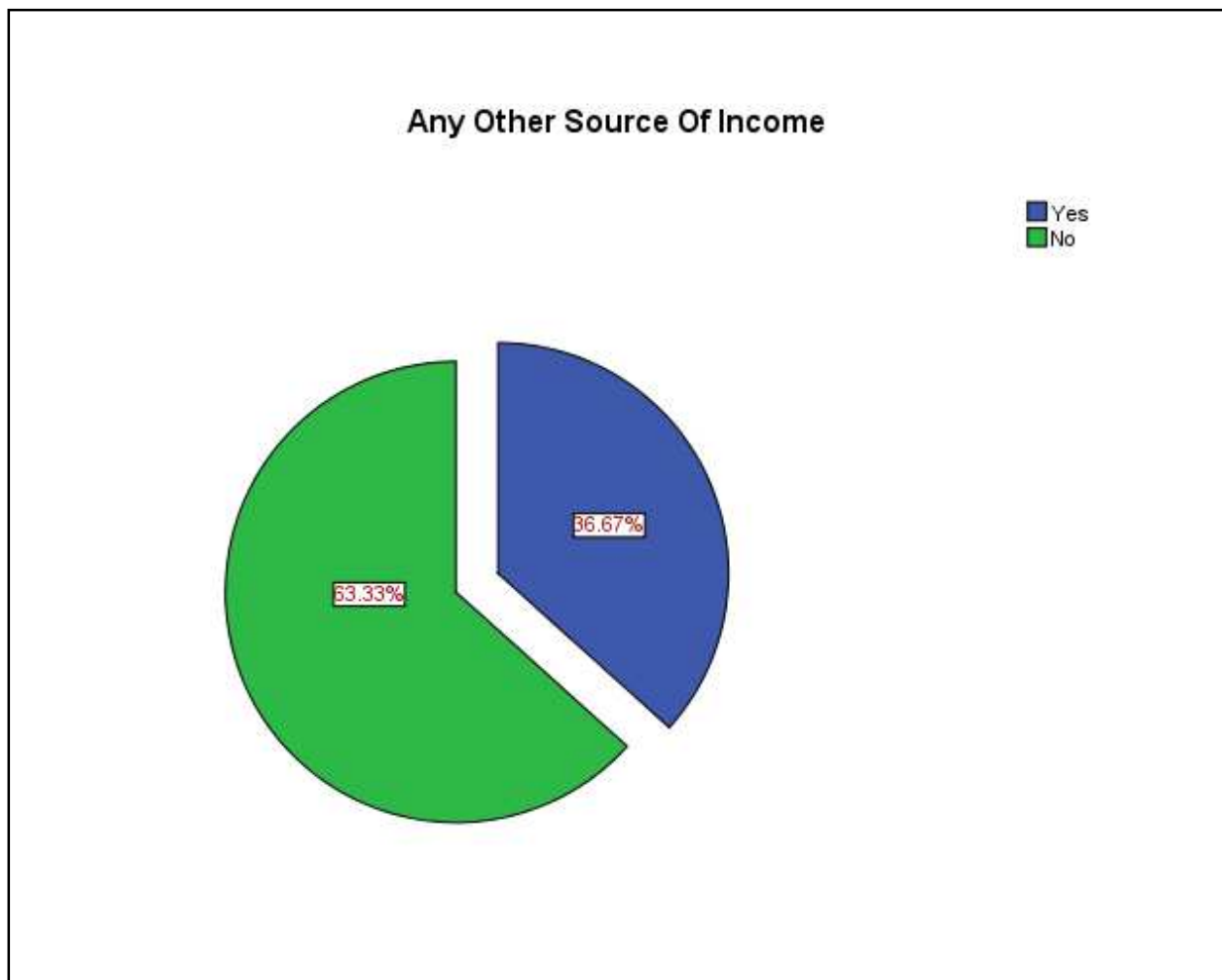
#### 5.2.2.5 Education level versus the type of job employed to do

According to the survey results, a comparison on the type of job the workers were employed to do based on their level of education, revealed that 10% of the workers were employed to carry out soil digging in the quarries, and they had only attained a primary school education. Those that had attained a secondary school education were employed to do various

works such as blasting, stonecutting, soil digging and small administrative duties, and they comprised of 70% of the respondents. Respondents who had attained a college/university education were employed to do administrative jobs and office accounting, and they comprised of 16.7% of the respondents. 3.3% of the respondents gave no answer. Much of the work in the quarries requires hard labor, and for the greater part it is unskilled labor which only requires physical strength to carry out the jobs that mainly involve digging soil, loading trucks with stone, and blasting the hard rock, and is a choice of many dropouts and those who do not have access to further education after they are through with high school.

In order to further understand whether the respondents had any other source of income to support them, because of the fact that much of the work is on casual and informal basis and is mostly unpredictable especially for those that are unskilled, it was important to gather the information and the results showed that, 63.33% said no, while 36.67% said yes. Many of the people working in the quarries are not married and do not have many dependents, as they are people who have left school at primary level and secondary school level and are relatively young (figure 12-5).

Figure 12-5: Percentage response on other sources of income



Source: Field data, 2014

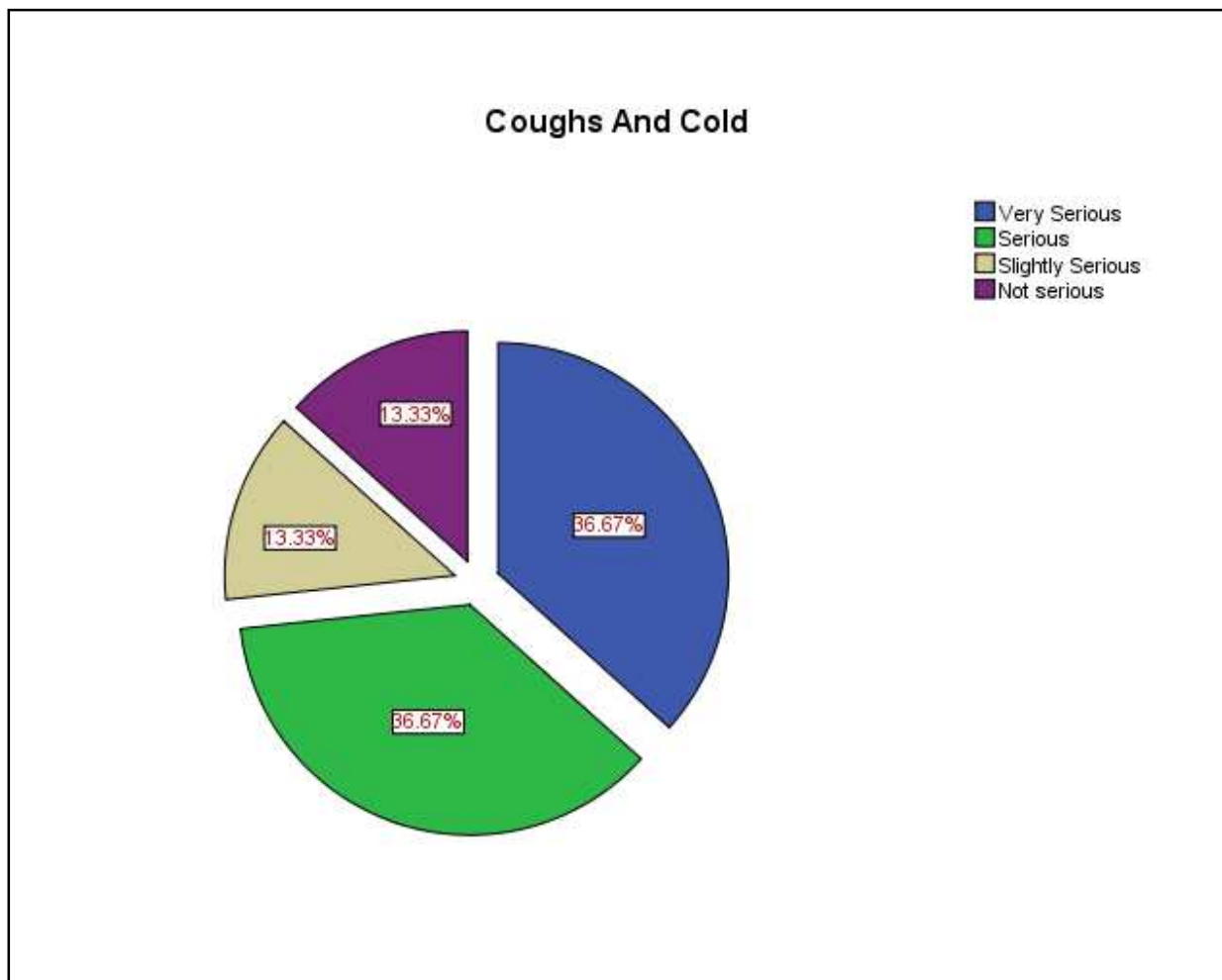
#### 5.2.2.6 Health related issues

Respondents in the study were asked about health related issues and the major health issues were coughs and colds, chest aches, throat infections, and stress. Each of the mentioned problems was analyzed, and the results were as follows:

#### **5.2.2.6.1 Coughs and colds**

According to the results, the highest percentage of the respondents declared the health issue to be very serious and serious, which translated to 36.67% for the former and a similar 36.67% for the later (figure 13-5). The quarry is filled with dust which is left behind during the quarrying process, and there is a lot of dust in the air within those quarries, which accelerates the issue. The workers in the quarries are prone to inhaling the dust throughout the day as they work because they do not have any protective equipment like dust masks to cover themselves as they work. Those loading the stones to the Lorries are most affected as they have to follow the stone cutter machine as it cuts the stones, and blows a lot of dust as it moves on the rails.

Figure 13-5: Seriousness of coughs and colds

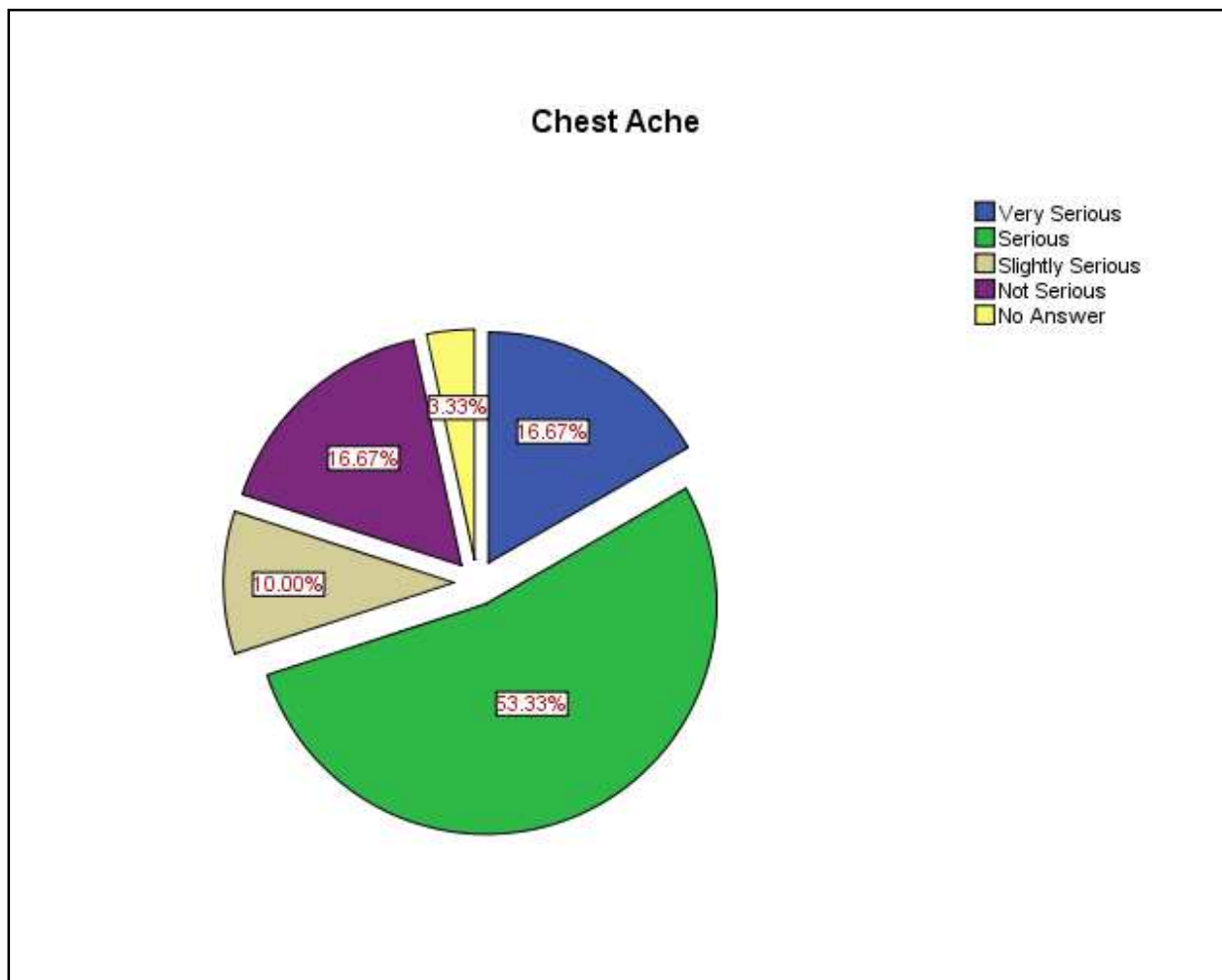


Source: Field data, 2014

#### 5.2.2.6.2 Chest aches

Majority of the respondents having been asked on the issue concerning chest aches, the highest percentage replied that the issue was serious, which was at 53.33% (figure 14-5). The issue is accelerated with the presence of dust and the fact that most of the workers do tedious work without any protection gear.

Figure 14-5: Seriousness of chest aches

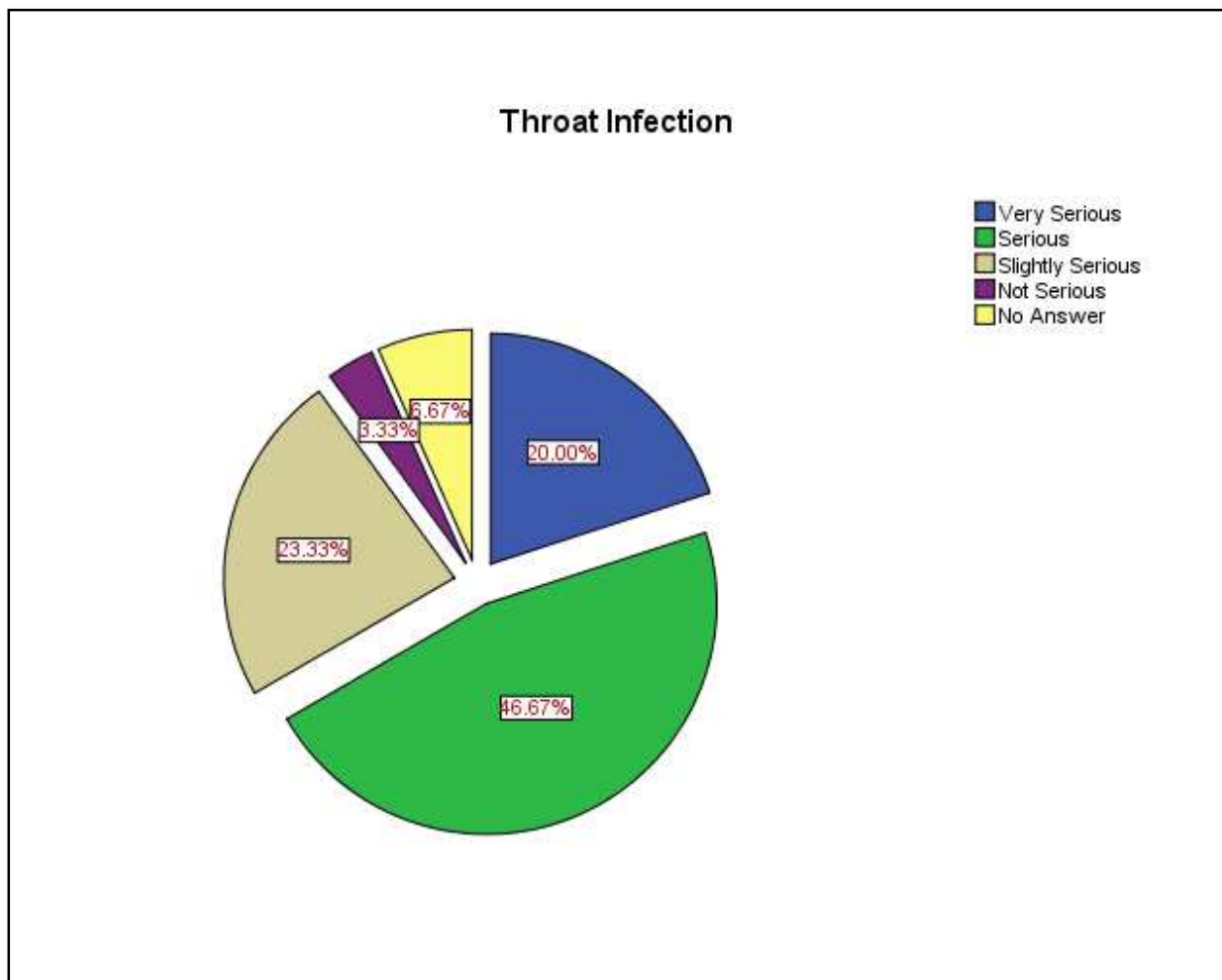


Source: Field data, 2014

### 5.2.2.6.3 Throat infections

The highest percentage of the respondents that replied on the issue of throat infection indicated that the issue was serious, which was at 46.67% (figure 15-5). Just like the other cases, dust is the major cause of the problem, where during the whole process of quarrying a lot of dust is produced and the workers breathe in a lot of dust.

Figure 15-5: Seriousness of throat infections

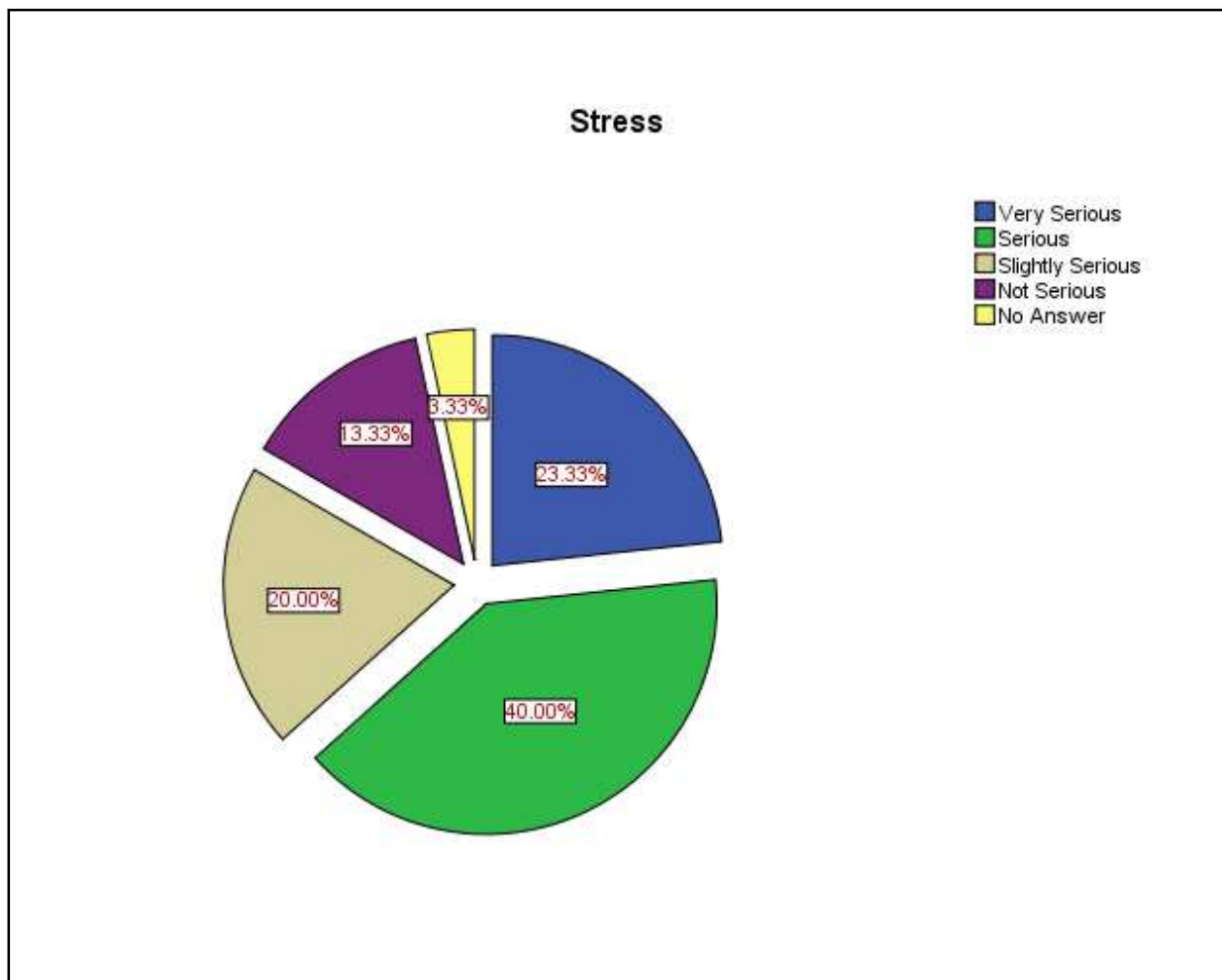


Source: Field data, 2014

#### 5.2.2.6.4 Stress

The respondents having been asked on the issue of stress, the highest majority said that the issue was serious, which translated to 40% of the total respondents (figure 16-5). Stress related issues occurred due to the kind of tedious work that the workers are subjected to because the amount they earn is dependent on the amount of work done. The levels of noise, vibrations, and dust also contribute highly to the issue of stress.

Figure 16-5: Seriousness of stress related problems



Source: Field data, 2014

### 5.3 The state of abandoned quarries and their use

According to the survey results, all the respondents asked about the issue of the state of quarries after their lifecycle, said that the owners left them as open pits which translated to 100% of all the respondents, as shown in figure 17-5. The owners leave the quarry pits open and most of the abandoned ones have been filled with a very small layer of stone rubble and dust where no further rehabilitation takes place, as shown in plate 4-5. The quarry owners said that filling up of the quarries after use is an expensive exercise which would not translate to good profits, as the

depth of the quarries is large, where some quarries are more than 50m in depth and 100m wide. Also the fact that the land is majorly leased to the quarry owners, and the lessors are after gaining financially from the lease, they do not provide that the land be rehabilitated once the lease period expires.

Plate 4-5: Abandoned quarry pit with small layer of stone rubble

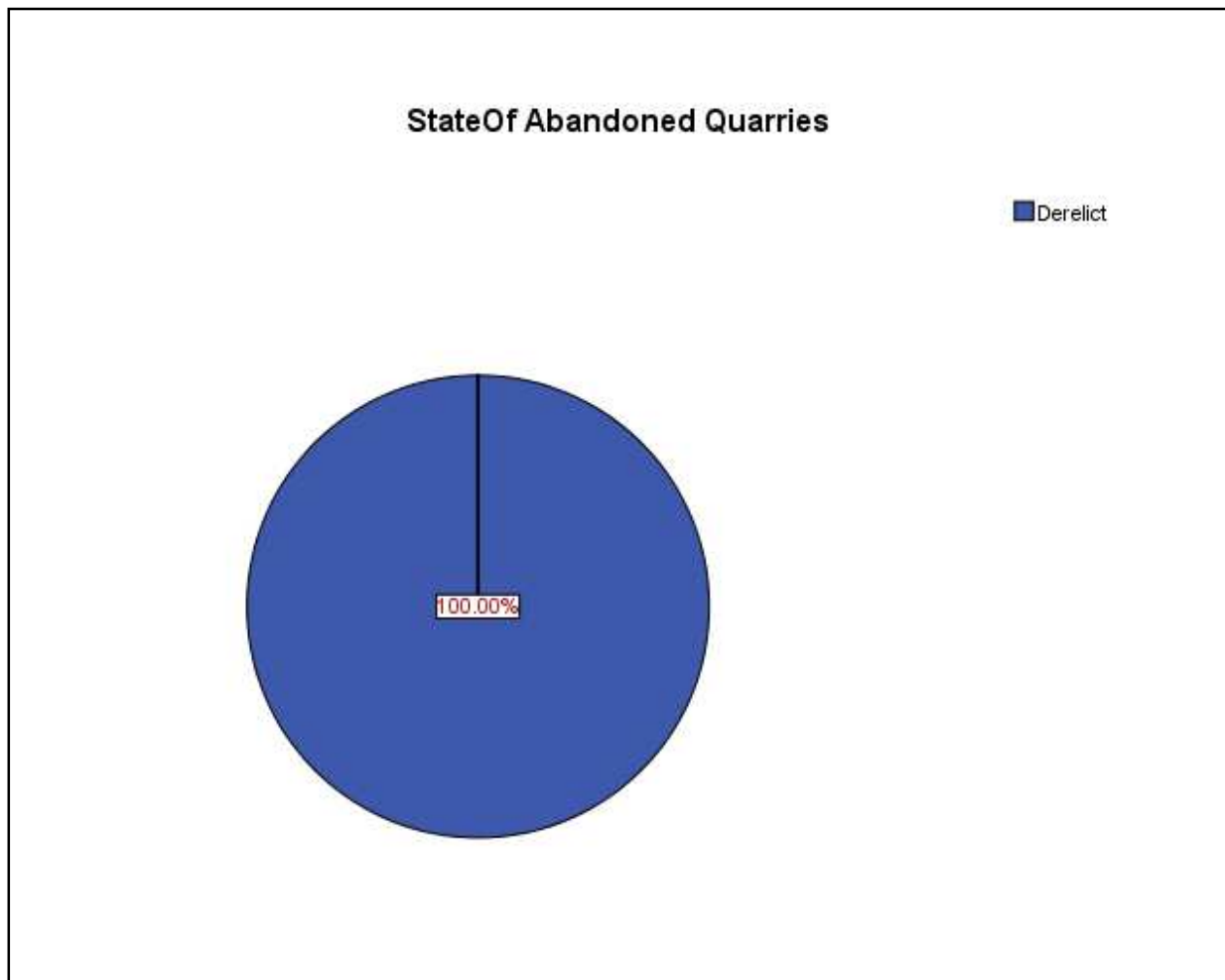


Source: Field survey, 2014

The whole quarrying process is expensive as explained by the owners and causes a lot of pollution, and it involves land preparation where the land is leveled using bulldozers, shovels and tippers. After this is done, the stone cutting machine is guided through rails where actual stone cutting starts. Noise and vibrations are produced throughout the process and the major product is quarry dust, which is often left behind. This whole process is filled with a lot of negative implications to the environment, as the land that is being turned into a quarry site does not blend in with the rest of the environment because of the huge rubbles and quarry dust that is left

behind, often creating aesthetic intrusion around the areas where they exist. The noise, dust and vibrations that are produced during the process, leave behind a huge trail of both environmental pollution and socio effects in terms of diseases; such as air pollution caused by the heavy presence of dust for the former and coughs and chest aches for the later. After the exploitation is complete, the quarries are left open because as explained by one of the quarry owners, the filling up of the pit is more expensive than the actual exploitation because there would be need of a lot of metric tons of soil and gravel to fill it up. Because this does not make economic sense to the owners, which if they did actually fill the pits up would mean more expenses than income, they result to leaving them in that state.

Figure 17-5: State of abandoned quarries



Source: Field data, 2014

#### 5.4 Mitigation measures for the management and control of quarrying activities

All of the quarry owners attested to having elaborate rehabilitation plans after they are done exploiting the quarries, where they said that the quarries are to be filled with loam soils for the purposes of farming but no quarry has done this. The quarries are partially filled with the quarry dust and stone debris left behind after the quarrying process. The major hindrance to this is the fact that the policies and legislations governing the sector have so many loop holes as

discussed and a large part of mitigation measures for the management and control of quarrying activities lies with the proper formulation of these policies.

This means that there is need for harmonization of sectoral policy instruments with EMCA and the Constitution: There are several sectoral policies and laws relating to the environment which are not harmonized with both the EMCA and the Constitution. These include policies concerning agriculture, water, forests, trade and industry, which have significant implications for the environment. It is imperative that policy instrument in these sectors are harmonized with the EMCA and the Constitution and requirements made that they be subjected to strategic environmental assessment in order to promote sustainable development.

Implementation of Land Policy: Striking the right balance between land tenure and environmental imperatives is critical for sustainable development. The National Land Policy and the Constitution provide a critical basis for addressing the long-standing tensions around land tenure and use in Kenya. However, they need effective legislation to ensure implementation.

Valuation of environmental and natural resources: The value of environmental resources is hardly reflected in pricing of marketed goods and services. Environmental and natural resources are largely considered as public goods. This is symptomatic of market failure. Integrating environmental considerations into the behavior of enterprises and consumers would reflect a change in consumption and production patterns. Prioritization of environment and natural resources remains low among policy makers partly due to inadequate appreciation of the total economic value of the sector. Thus there is less public investment in the sector. Rehabilitation and restoration of environmentally degraded areas: There are several degraded areas in Kenya which require rehabilitation and restoration. These include wetlands, riverbanks, deforested

areas, eroded shoreline, hilltops, and disused quarries and mines. An example is a case scenario in Ndarugo area where there are many abandoned quarries.

Loss of biodiversity: Biodiversity plays a fundamental role in underpinning ecosystems and the services they provide. The most important causes of loss of biodiversity include habitat destruction, overgrazing, deforestation, pollution, unsustainable harvesting of natural resources, bio-piracy and introduction of invasive and alien species. Public participation, environmental education and awareness: Broad public participation in decision making processes is one of the fundamental preconditions for sustainable development. This presupposes access to timely and accurate information on the environment. Sound environmental management has to be based on openness and participation at all levels.

## **CHAPTER SIX**

### **6.0 SUMMARY OF THE FINDINGS, CONCLUSION AND RECOMMENDATIONS**

#### **6.1 Summary of the findings**

From the information collected and analyzed, it is evident that the quarrying process in the area causes both negative environmental and socio-economic effects, as a result of the quarrying process which uses some heavy machinery and leaves behind a lot of debris and quarry dust which is an environmental nuisance. Issues to with open pit flooding, property damage, air pollution and noise pollution are some of the bio-physical effects that are evident, and have been a nuisance to the surrounding community. Socio-economic effects on issues to with the quarry workers as discussed reveal that the workers are highly affected by the presence of dust as many of them complain about various infections such as coughs and chest aches. Casual workers in this sector are also not well compensated and many of them have only attained a secondary school level education and learn the work through apprenticeship, showing that the sector is highly informal, and a situation that makes it prone to exploitation by those controlling the sector. Those that live around the quarry are also directly affected by the negative effects arising from quarrying, as they suffer directly the consequences of pollution and property damage, because of the fact that the quarries are in close proximity with the residential areas, where there is a huge concentration of residential within a 3km radius.

The results from the discussions also show that the quarry owners are in total disregard of the environment evidenced by the fact that the quarries are left as open pits without being rehabilitated. The quarries are also in close proximity to the area residential areas and safety issues are ignored by the owners, creating a huge risk to the community residents.

It is also evident that the quarrying sector is highly unregulated, where the county council only collects levies from the trucks leaving the sites as they transport materials, and there is also a lack of policies and legislations to govern the activity, as only mining regulations for other minerals exist. Because of this, the quarry owners ignore the responsibility of rehabilitating quarries after their use as well as disregard of safety measures and regulations for the workers, and lack of the general respect of the environment as well the surrounding community.

## **6.2 Conclusion**

In assessing the environmental impacts of quarrying activities in reference to Ndarugu area, Kiambu county, it can be deduced that; in an effort by quarry owners who seek to exploit minerals through quarrying activities, for the highly demanded stone commodity, there are numerous abandoned quarries that have been put to no use. This is because there is a general reluctance by the owners to restore or to rehabilitate the abandoned quarries. For the active quarry sites, there are numerous negative environmental impacts both bio-physical and socio-economic which affect both the people living in close proximity to the mining sites and the workers who work in the sites. This has led to the development of many risks both health wise and exposure to risky sites that leaves the community highly affected. However this is not only limited to active sites but also abandoned quarries have hugely contributed to the degradation of the environment as well as posing numerous risks associated with open pits.

Several mitigation measures have been laid out to mitigate mining activities at worldwide level and also locally in the country with Agenda 21, The National Environmental Action Plan, National Environmental Policy and also rehabilitation plans that have been successful, but the issues to do with artisanal or small scale quarrying have not been properly addressed and the

policies and legislative frameworks go silent when it comes to issues of concern to quarrying. This has resulted to a blatant disregard of the environment in a highly unregulated industry, where those that assume the role of controlling the sector, who being the local authority have no capacity in terms of skills and manpower to affect control in the sector.

## **6.3 Recommendations**

### **6.3.1 Short term recommendations**

- The quarry owners should adopt methods that are less wasteful
- There should be use of technologies that are user and environmental friendly
- Rehabilitation of quarries should be emphasized after use
- Adoption and emphasis of use of safety equipment to reduce accidents and health risks around the worksites
- Community members, landowners and concession holders be involved in finding viable solutions to the problems posed by quarrying
- Promotion of environmental awareness campaigns and technical training programs to add value to how the locals respond to the quarrying process and negative environmental impacts

### **6.3.2 Long term recommendations**

- Quarrying activities should be under one government department under the newly established Ministry of Environment, Water and Natural resources. The quarrying activities in the country are currently licensed by the local authority that do not have the capacity to do so. They operate from revenue collection and land allocation only without any regard of the actual activities carried out. They are unable to assess the quantity and

production capacity and hence duration of quarrying to go hand in hand with development plans. They are unable to assess the environmental degradation and rehabilitation program thereof required after the quarrying.

- The government should re-establish mining cooperative societies for the small scale and artisanal mining. This is because individuals may not be able to handle the environmental issues and the mines rehabilitation.

#### **6.4 Areas for further studies**

- Safety and health regulations in the quarrying sector
- Policy and legislative framework gaps in the governing of quarrying in the country
- Rehabilitation process for quarries in the country
- Planning regulations and zoning of lands with quarrying potential
- Quarrying contribution to the country's GDP

## REFERENCES

- Agevi and Ogero B.B. (1990).***Stone quarrying in Kenya: a socio-economic and institutional survey.* Nairobi, Kenya: Intermediate Technology and Development Group Mining Program.
- Asher Shadmon, Sam G. (1999).** *Training and policy guidelines for artisanal quarrying.* ITDG.
- Ashurst, J. and Dimes, G. (1977).***Stone in building: its use and potential today.* London: The Architectural Press.
- Ayuba, H.K. (2005).***Environmental science.* An introductory text. Apani publisher.
- Bertalanfy, L. (1951).** *An outline of general systems theory.* British Journal of Philosophy of Science theory, 1: 143.
- CAHF. (2012).** *Housing Finance in Africa - a review of some of African's housing finance markets.* Finmark Trust.
- CSI. (2011).***Guidelines on quarrying rehabilitation: biodiversity and land stewardship.* Switzerland: RotoPresse SA.
- FAO.(1980).** *Natural resources and the human environment for food and agriculture.* Environment Paper No. I. Rome. File:///A:\Population and Land degradation (Text).htm.
- George M. Ndegwa, Oguta B, Calvince O. (2003).***Impacts of quarrying on water quality along Ndarugu river of Thika District.* Kenya: JKUAT.

- Government of Kenya.(2012).***ACT NO. 8 of 1999 - Environmental Management and Coordination Act.* Nairobi: Government Printers.
- Government of Kenya.(2010).***The National Minerals and Mines Policy.*Nairobi: Government Printers.
- Hartmann Hl. (2002).***Introductory to Mining Engineering.*
- Hartmann, Howard L. (1992).***SME EGINEERING Handbook, Society for Mining, Metallurgy, and Exploration Inc.*
- Hornbostel C. (1991).***Construction Materials: Types, Uses and Applications (Second Edition.).* New York: John Wiley and Sons Inc.
- Howard Bob and Cameron Ian.(n.d.).** Dust Control: Best Practice Environmental Mngement in Mining.
- ILO.(1999).***Social and labour issues in small-scale mines. Report for discussion at the Tripartite Meeting on Social and Labour Issues in Small-scale Mines Geneva.* International Labour Office.
- Kertes N. (2007).***U.S abandoned mine count still a mystery-General Accounting Office Report.* American Metal Market.
- Logging of forests and debris dumping.(n.d.).** Retrieved from Ngm.nationalgeographic.com
- Ministry of Environment and Mineral Resources.(2010).***draft national education for sustainable development policy.*nairobi: ministry of environment and mineral resources.

**Ministry of Environment and Mineral Resources.(2012).***National environment policy, 2012.*

Nairobi: ministry of environment and mineral resources.

**Mjaria J. (1997).***The artisanal stone quarry workers in Nairobi region: Baseline survey report.*

Nairobi, Kenya: Intermediate Technology and Development Group.

**National Environment Management Authority (2009).***NATIONAL ENVIRONMENT ACTION PLAN FRAMEWORK 2009-2013.* Nairobi: National Environment Management Authority.

**Noranha I. (1998).***The smallscale Indian laterite stone quarry and working sector: A case study of Goa.* New Delhi: Tata Energy Research Institute.

**Olofin, E.A.(1989).***Human response to the natural environment in the kano region. Kano and Some of Her Neighbours.* ABU Press.

**Saevry S.P.A. (1997).***Training and policy guidelines for artisanal quarrying: Report on field study research in the Nairobi region of Kenya (Working paper).* ITDG/University of Bath/ODA.

**Savery S. (1997).***Report on field research in the Nairobi region of Kenya (Unpublished report).*ITDG/University of Bath/ODA.

**Shadmon A. (1989).***Stone: An Introduction.* New York: The Bootstrap Press.

**Shadmon A. (1993).** Dimension Stone-its impacts on environment and constructional applications-the role of engineering geology.

**UNECE. (1998).** *Convention On Access To Information, Public Participation In Decision Making and Access to Justice in Environmental Matters.* Aarhus.

**UNESCO World Heritage Centre.(n.d.).** Taj-Mahal - UNESCO World Heritage Centre.

Retrieved from Whc.unesco.org

**Wells J. (1996).***Artisanal stone quarrying in Kenya: a market study.*

## APPENDICES

### Appendix I: People living in quarry environs questionnaire

The aim of the questionnaire is to collect data on socio-economic and environmental aspects of quarrying in Ndarugo area and its environs. The data collected is solely for academic purpose with an aim of linking it to policy making and rehabilitation plans. Information provided will be treated as confidential and will be used for academic purpose. Tick or fill in spaces provided.

The questionnaire is to be administered in English or Kiswahili.

**Answer in the spaces provided and tick the appropriate boxes**

Name of location \_\_\_\_\_

**The questionnaire will be administered to people living within 3km diameter of the sampled quarries**

Respondent Name \_\_\_\_\_

1. Age

2. Sex

1. Male

2. Female

3. Distance from the quarry

1 0 – 500m

2 501m – 1km

3 1km – 2km

4 3km >

4. How long have lived in this particular locality?

1 0 – 5 year

2 6 – 10 years

3 11-20 years

4 20years >

5. Did you find quarrying going on?

1 Yes

2 No

6. If 'No' when did quarrying start in this locality?

\_\_\_\_\_

7. To what degrees do the following problems associated with quarrying affects you?

PROBLEM	SEVERITY			
	1 Very serious	2 Serious	3 Slightly serious	4 Not serious
coughs and colds				
chest ache				
backache				
throat infections				
breathing problems				
Stress				
Malaria				
Cholera				
dysentery				
Typhoid				
Noise				
dust				
accidents				
vibrations				
other problems				

8. Is there any property that is affected by noise or dust or vibration?

1 Yes  2 No

9. Do quarry pits in this location become flooded during the rains?

1 Yes  2 No

10. Any incidences of drowning in flooded quarry pits in this locality?

1 Yes  2 No

11. What benefits do you enjoy as a result of this activity in this area?

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12. What uses are abandoned quarries put to?

1 Derelict  2 rehabilitated

13. Are you aware of any policies or legal frameworks governing quarrying activities?

1 Yes  2 No

If yes, which ones .....

## Appendix II: Quarry workers questionnaire

The aim of the questionnaire is to collect data on socio-economic and environmental aspects of quarrying in Ndarugo area and its environs. The data collected is solely for academic purpose with an aim of

2 Female

1. Residence

2. Marital status

1 Single  2 Married  3 Widow/er  4 Divorced  5 Separated

3. How many dependants do you have? \_\_\_\_\_

4. Highest education level

1 Primary

2 Secondary

3 College/university

4 None

5. What type of job are you employed to do?

1 Blaster

2 Stonecutter

3 Soil digger

4 Assistant

5 Other (specify)

6. How did you learn this job? 1 School  2 Apprenticeship

7. How are you paid?

1 Daily  2 weekly  3 monthly  4 other

8. How much are you paid?

1 0 – 2000  2 2001 – 5000  3 5001 – 10000  4 10001 – 20000  5 20001 >

9. Is the amount of money you are paid sufficient to cater for your needs?

1 Yes  2 No

10. Any other source of income for the family?

1 Yes  2 No

11. Is there any other job you would choose instead of quarrying?

1 Yes  2 No

12. To what degree do the following problems related to quarrying affect you

PROBLEM	SEVERITY			
	Very serious	Serious	Slightly serious	Not serious
Coughs and colds				
Chest ache				
Backache				
Throat infections				
Breathing problems				
Stress				
Malaria				
Cholera				
Dysentery				
Typhoid				

Noise				
Dust				
Accidents				
Vibrations				
Other problems				

13. When you get an accident or fall sick, what happens?

1 I get myself treated

2 My workmates help me get treated

3 The quarry owner arranges for me to get treated

14. What do you do in the event of an accident before one gets to hospital?

1 Nothing

2 First aid

15. How do you spend your evening after you leave the quarry?

---

16. In your opinion what should be done to improve quarrying?

---

17. Are you aware of any policies or legal frameworks governing quarrying activities?

1 Yes

2 No

If yes, which ones .....

### Appendix III: Quarry owners questionnaire

The aim of the questionnaire is to collect data on socio-economic and environmental aspects of quarrying in Ndarugo area and its environs. The data collected is solely for academic purpose with an aim of linking it to policy making and rehabilitation plans. Information provided will be treated as confidential and will be used for academic purpose. Tick or fill in spaces provided.

Name of quarry \_\_\_\_\_

The questionnaire is to be administered in English or Kiswahili.

#### Answer in the spaces provided and tick the appropriate boxes

Respondent Name \_\_\_\_\_

1. Age

2. Sex

1 Male

2 Female

3. Residence

4. Marital status

1 Single

2 Married

3 Widow/er

4 Divorced

5 Separated

5. How many dependants do you have? \_\_\_\_\_

6. Highest education level

1 Primary

2 Secondary

3 College/university

4 None

7. How do you own this quarry? (Type of ownership)

1 It is part of my land

- 2 I have rented it form a private landowner
- 3 I have hired it from the government
- 4 Other (specify)

8. If rented/hired, how much does this cost? \_\_\_\_\_

9. For how long have you rented/hired?

- 1 0 – 10 years
- 2 11 – 20 years
- 3 21 – 30 years
- 4 30years>

10. Have you had other quarries besides this one in the past? 1 Yes  2 No

If yes, how many \_\_\_\_\_

11. What was the type of ownership?

- 1 It was part of my land
- 2 I had rented it form a private landowner
- 3 I had hired it from the government
- 4 Other (specify)

12. How many people do you employ? \_\_\_\_\_

13. Explain how the rock is broken in the quarrying process:

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14. What quarry materials do you produce?

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15. How many Lorries of quarried materials do you produce per day?

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16. How many Lorries do you sell per day?

---

17. What is the price of the material per lorry?

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18. Where do the buyers come from?

---

19. How do you attract buyers to your quarry since there are many quarries?

---

---

20. Where do you operate from?

---

21. Does the noise and dust disturb you? 1 Yes  2 No

22. Do you experience any health problems which you think are connected to quarrying?

1 Yes  2 No

If yes which problems?

---

23. Do accidents occur in quarries? 1 Yes  2 No

24. If yes what is done to get the quarry workers treated?

1 I get myself treated

2 My workmates help me get treated

3 The quarry owner arranges for me to get treated

25. Are there any rehabilitation plans put in place once the quarry productive life is over?

1 Yes  2 No

If yes, which are they?

---

---

26. Are you aware of any policies or legal frameworks governing quarrying activities?

1 Yes  2 No

If yes, which ones .....

**Appendix IV: List of tables for data analysis and discussion**

Table 1-4: Pit Flooding

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Yes	27	90.0	90.0	90.0
No	3	10.0	10.0	100.0
Total	30	100.0	100.0	

Table 2-5: Property Damage

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Yes	26	86.7	86.7	86.7
No	3	10.0	10.0	96.7
No answer	1	3.3	3.3	100.0
Total	30	100.0	100.0	

Table 3-5: Noise

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Very Serious	7	23.3	23.3	23.3
Serious	15	50.0	50.0	73.3
Slightly Serious	7	23.3	23.3	96.7
Not Serious	1	3.3	3.3	100.0
Total	30	100.0	100.0	

Table 4-5: Pit Flooding versus Drowning Incidents Cross tabulation

			Drowning Incidents		Total
			Yes	No	
Pit Flooding	Yes	Count	25	2	27
		% of Total	83.3%	6.7%	90.0%

	No	Count	0	3	3
		% of Total	.0%	10.0%	10.0%
Total	Count		25	5	30
	% of Total		83.3%	16.7%	100.0%

Table 5-5: Income \* Sufficiency Of Income \* Marital Status Cross tabulation

Marital Status		Sufficiency Of Income		Total	
		Yes	No		
Single	Income 10001 - 20000 Count	9	6	15	
	% of Total	60.0%	40.0%	100.0%	
Total		Count	9	6	15
		% of Total	60.0%	40.0%	100.0%
Married	Income 10001 - 20000 Count	0	7	7	

	% of Total	0%	50.0%	50.0%
20001 >	Count	2	4	6
	% of Total	14.3%	28.6%	42.9%
No answer	Count	0	1	1
	% of Total	0%	7.1%	7.1%
Total	Count	2	12	14
	% of Total	14.3%	85.7%	100.0%
Widow/er Income 20001 >	Count		1	1
	% of Total		100.0%	100.0%
Total	Count		1	1
	% of Total		100.0%	100.0%

Table 6-5: Sufficiency Of Income versus Number Of Dependants Cross tabulation

			Number Of Dependants					Total
			0	1	2	3	4	
Sufficiency Of Income	Yes	Count	9	1	0	1	0	11
		% of Total	30.0%	3.3%	.0%	3.3%	.0%	36.7%
	No	Count	3	5	4	6	1	19
		% of Total	10.0%	16.7%	13.3%	20.0%	3.3%	63.3%
Total		Count	12	6	4	7	1	30
		% of Total	40.0%	20.0%	13.3%	23.3%	3.3%	100.0%

Table 7-5: Education Level

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Primary	3	10.0	10.0	10.0
Secondary	21	70.0	70.0	80.0

College/University	5	16.7	16.7	96.7
No answer	1	3.3	3.3	100.0
Total	30	100.0	100.0	

Table 8-5: Education Level versus Job Type Cross tabulation

		Job Type						
			Blaster	Stonecutter	Soil Digger	Assistant	Other	Total
Education Level	Primary	Count	0	0	3	0	0	3
		% of Total	.0%	.0%	10.0%	.0%	.0%	10.0%
	Secondary	Count	5	7	7	0	2	21
		% of Total	16.7%	23.3%	23.3%	.0%	6.7%	70.0%
	College/	Count	0	0	0	1	4	5

	University	% of Total	.0%	.0%	.0%	3.3%	13.3%	16.7%
	No answer	Count	0	0	1	0	0	1
		% of Total	.0%	.0%	3.3%	.0%	.0%	3.3%
Total	Count	5	7	11	1	6	30	
	% of Total	16.7%	23.3%	36.7%	3.3%	20.0%	100.0%	