RESTORATION STRATEGIES AND COMMUNITY ATTITUDES TOWARDS MINE PIT HAZARDS IN KAKAMEGA COUNTY, KENYA

Rael Ramkat

A research thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Disaster Management and Sustainable Development of Masinde Muliro University of Science and Technology

November, 2017

DECLARATION AND CERTIFICATION

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This Thesis is my original work prepared with no other than the indicated sources and support and has not been presented elsewhere for a degree or any other award.

Signature -- **Date** 23/11/17 --

Rael Ramkat

Reg No. CDS/G/06/11

CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance of Masinde Muliro University of Science and Technology, a thesis entitled "**Restoration Strategies and Community Attitudes Towards Mine Pit Hazards in Kakamega County**".

Signature -- **Date** 23/11/2017 --

Prof. John O. Obiri

Department of Disaster Management and Sustainable Development.

Masinde Muliro University of Science and Technology.

Signature -- **Date** 23/11/2017 --

Prof.Samwel S. China

Department of Disaster Management and Sustainable Development

Masinde Muliro University of Science and Technology.

DEDICATION

This thesis is dedicated to all disaster managers in Kenya who are involved in disaster risk reduction.

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ABSTRACT

Mining is an economic activity that has been practiced for time immemorial. Land degradation from old mines operations is known in almost all the countries but they have been few systematic surveys to quantify the nature of associated problems so as to prioritize remediation action. There is knowledge in the techniques of rehabilitating both operational and abandoned sites yet there is still delay in remediation action. The enforcement of the Environmental Management and Co-ordination Act (EMCA) of 1999 was envisaged to go a long way in managing negative impacts of mining, quarrying and sand harvesting. The National Environment Management Field Dataity on the other hand, controls the restoration fund meant for the mitigation of environmental degradation. There is however very little rehabilitation works that have been done on old mines and quarries in the country. The study was conducted in Kakamega County and the study population drawn from 18 mine pits in Kakamega County. The respondents were drawn from the Sub-County Environment Committees, Mine Geologist Experts, Miners, Constituency Roads Committees, Association of mining companies, Construction Companies, County Government Environment Committees, local Administration, land owners of mine pits and residents neighboring the pits. The researcher employed evaluation research design, purposive sampling and systematic random sampling techniques. Data collected was summarized in tables and bar charts. The data was analyzed using descriptive statistical analysis, analysis of variance (ANOVA) and chi-square the results indicated that there were many abandoned mined pits in the County, whose restoration strategies are not effective. The findings showed that there were several mining activities in Kakamega County including; Gold mining 26% (38), sand harvesting 22% (37), quarry mine 17% (28), murrum 15% (25) and soil mining 20% (14). Mining activities had environmental degradation effects indicated by loss of vegetation 45% (75), soil erosion 20% (33), low farm yields 15% (25), contamination of water bodies and root exposure at 10% (17). Open mine pits were areas for mosquito breeding thus increasing prevalence of malaria in the community. These effects created different attitudes in the community basing on social class and education. The strategies in place for restoration of mine pits are not implemented due to lack of enforcement. This has finally made abandoned mine pits a hazard to the community. It was recommended that the County Government of Kakamega should revisit its laws on the restoration of mined lands. The community should be made aware of other benefits of mine pits and change their attitude towards them.

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LIST OF ABBREVIATIONS AND ACRONYMS

ANOVA	-	Analysis of variance
CEC	-	County Environment Committee
COCHILCO	-	Chilean Copper Commission New work
CRC	-	Constituency Roads Committee
CREEK	-	Center for Research in Environment Kenya
DEC	-	Department of Environment Conservation
E.I.A	-	Environmental Impact Assessment
EMCA	-	Environment Management and Coordination Act
FGD	-	Focus Group Discussions
FRA	-	Forest Reclamation Approach
HRM	-	Human Resource Management
IIED	-	International Institute for Environmental Development
KERRA	-	Kenya Rural Roads Authority
KNBS	-	Kenya National Bureau of Statistics
MEMR	-	Ministry of Environment and Mineral Resources
NACOSTIC	-	National Commission for Science and Technology and Innovation.
NEAP	-	National Environment Action Plan

NEC	-	National Environmental Council
NEMA	-	National Environment Management Authority
N.W ENCYC	-	New Work Encyclopedia
SCEC	-	Sub-County Environmental Committees
SER	-	Society for Ecological Restoration
SSM	-	Small Scale Mining
UN	-	United Nations
UNEP	-	United Nations Environmental Programme

OPERATIONAL DEFINITION OF TERMS

Community Refer to all Owners of mines, residents neighboring the pits, Local leaders in areas with mine pits and miners.

Mine pits Refer to all manner of excavation pits resulting from the mining of precious and non-precious minerals that include gold, gravel, murram, sand, quarry, brick making soil etc.

Mine pits neighboring areas Refer to communities living near mining activities

Mine pits restoration strategies Refers to the process of reclamation of mining lands

CHAPTER ONE

INTRODUCTION

1.1 Background

Mining is an economic activity that has been practiced for hundreds and in some cases, thousands of years (UNEP, 2001). According to some estimates, there are between 700,000 and 800,000 abandoned mines in the United States. Many of them are in the vicinity of abandoned towns, often referred to as “ghost towns” (N.W. Encycl, 2008). In June 2001 the United Nations Environmental Programme (UNEP) and the Chilean Copper Commission (COCHILCO) co-sponsored the first Pan-American workshop on abandoned mines in Santiago, Chile. Remediation of abandoned mine sites was noted to be one of the most outstanding environmental, social and economic problems related to mining (UNEP, 2001). Land degradation from old mines operations occurs in almost all countries but they have been few systematic surveys to quantify how many sites need attention. It is actually hard to quantify the nature of associated problems so as to prioritize remediation action (UNEP, 2001).

Africa has also experienced environmental problems with mining. Abandoned pits shafts are found in West Africa and Zambia and they pose safety risk to local populations and animals. In Johannesburg, we have tailing dumps from past mining activities which are a source of dust affecting health of neighbouring populations and cleanup cost are likely to be very high (Boocock, 2002). South Africa initiated a programme to develop a national strategic framework to guide the mining and minerals sector to sustainable development.

Among the key objectives it aimed to achieve was to identify and rehabilitate ownerless mines (Swart, 2003).

Several studies have reported community health, related to living close to asbestos mines (Munan, Thouez *et al.* 1981). One review article (Koike 1992) on the health effects of non-occupational exposure to minerals found that the health impacts on communities varied. Mesothelioma was observed among non-occupationally exposed persons living in the north-western region of Cape State of South Africa, where Crocidolite is mined and transported. However, the long-term residents of Thetford Mines in Quebec Province, Canada, who have never engaged in mining and milling of chrysolite have not shown an excess mortality of respiratory disease or impairment (Koike 1992). Although the results of these studies are conflicting, it is important to note that many of the adverse effects on community health result from the use of asbestos, and that this part of the mining and minerals cycle has not been covered in this review.

Most of the studies in risks related to mining relate to artisanal or small-scale mining (SSM). Although there are risks associated with the extraction of gold, in the context of SSM the predominant concern is in relation to exposure to the mercury that is used in winning the gold from the extracted ore. In the 1980's a modern "gold rush" began in developing countries and millions of people have become artisanal miners, despite these risks. In the interim at least 2000 tons of mercury have been released into the environment (Malm, 1998), and this new "gold rush" is reflected in the world-wide demand for gold, which is currently 44% above the total annual production of the world's gold mines.

Mining in Kenya is regulated by the Mining Act of 2014. The National Environment Management Field Dataity (NEMA) is responsible for ensuring that the impacts from extraction of resources are minimized and that the affected lands are reclaimed and usable after extraction (NEMA, 2009). In Kakamega County, Kakamega, Butere and Mumias districts are famous for a number of economic minerals that have been mined from early 1920s. Sand harvesting quarrying, murram and gravel extraction for building materials also takes place in the county. Part of the rehabilitation funds under the Ministry of Environment and Mineral Resources, has been used to rehabilitate the Rosterman disused mines by fencing off the affected grounds and planting of fast growing vegetation (NEMA, 2007). Major gold mining by Rosterman Gold Miners in Ikolomani Constituency closed operations in 1952.

1.2 Statement of the Problem

After mining, the primary goal should be to return mined areas to productive post-mine uses and achieve full reclamation in a timely manner (Mcquire, 1998). When abandoned, mine pits make the landscape rugged and interfere with the aesthetics of the area as well as the economic value for use of land. They also pose danger to livestock, children and hold stagnant water which breeds vectors such as mosquitoes. Pits may be used for waste dumping and may contain contaminated water thus becoming a source of ground water pollution (NEMA 2004).

Abandoned pits originally established through uncontrolled blasting could lead to failure of engineering structures such as buildings, roads, bridges and dams. in their vicinity. Active and abandoned mine pits therefore, require perimeter fencing and restoration to reduce hazards (Lameed and Ayodole 2010). In Kenya, the enforcement of Environment Management and Coordination Act 1999 (EMCA) and the creation of a restoration fund was envisaged to go a long way in managing negative impacts of mining, quarrying and sand harvesting in the country (NEMA, 2004).There is however very little rehabilitation works that have been done on old mines and quarries in the country (NEMA, 2004). According to Western Provincial mines and Geology officer, miners in the Rosterman Gold Mines have been directed to fill all holes which are not in use however, artisanal miners have undermined rehabilitation efforts by excavating fill materials (NEMA, 2007). Sand harvesting along rivers such as Yala, Isiukhu, Shatsala, has caused river bank erosion and siltation. Furthermore, murram extraction in various parts of Kakamega County has resulted in land degradation, mass wasting, soil removal, air and water pollution (NEMA, 2007).

From the above literature, there has been no attempt to establish why restoration of mines are minimal yet according to UNEP(2001) there is knowledge in the techniques of rehabilitating both operational and abandoned sites. Moreover, in places where rehabilitation has commenced, artisanal miners have undermined the same.

Conflict in mining communities is a major problem that confronts many resource rich countries that requires special attention. There are several issues that result in conflicts in mining areas which have the propensity to impact on the attitude of mining communities to mining sector policies and interventions. Twerefou (2007) elaborates on the different sources of conflicts in most African countries to include conflicts on royalties, land use conflicts, resettlement, and survival of small scale mining, among others.

Thus, this research sought to addresses this gaping question of unsuccessful restoration initiatives by evaluating restoration strategies of mine pits in Kakamega County. It seeks to identify why rehabilitation is minimal and suggest ways to enhance remediation activities. The study determined community attitudes on restoration of mine pits which is critical in achieving full rehabilitation and sustainability.

1.3 Research Objectives

The overall objective of this study was to examine restoration strategies and community attitude with a view of recommending remedial measures that enhance sustainable restoration of mined land in Kakamega County.

The specific objectives were;

i) To establish the various types of abandoned mines and their contribution to degradation of surrounding environment.

ii) To determine community attitudes towards mine pits, hazards, risks and disasters and their restoration.

iii) To evaluate the current restoration strategies on mine pits.

1.4 Research Questions

This study used the following research questions to validate the outlined objectives;

i) What are the existing mine types and their degradation levels?

ii) What are the communities' attitudes towards mine pit, hazards, risks and disasters and their restoration initiatives?

iii) Are the current restoration strategies on mine pits in Kakamega County effective?

1.5 Justification

This research was undertaken in Kakamega County because a variety of mining activities are undertaken in the county, and especially gold mining which started in early 1930s, which was fueled by reports of the geologist Albert Ernest Kitson, and still taking place today with unbearable hazards on the community and the environment, Shilaro, (2000). In the County, Kakamega South, Butere and Mumias sub-counties are famous for mining activities which started in the early 1930s. Sand harvesting, quarrying, murram and gravel extraction activities are increasing as construction undertakings accelerate in Kakamega (NEMA, 2007). According to NEMA, there is great demand of materials for construction in Kakamega and the natural environment is highly interfered with (NEMA, 2007). Pottery and brick making take place in many parts of the county, this has led to land degradation and soil mass wasting, due to continuous extraction of soil.

Riverbank erosion and siltation due to sand harvesting has occurred on rivers such as Yala, Isiukhu, Shatsala. Mining is also undertaken on both private and public land. This research therefore evaluated current restoration strategies on mines in both private and public lands from 2000 when EMCA 1999 came into force, to 2015. The research also determined community attitudes towards these mines. The findings from this research will benefit the National Government, NEMA, County Government and the local community. The local community will be able to understand that abandoned mine pits can be reclaimed and rehabilitated to become income generating places. The government, County Government and NEMA will be able to re-evaluate and strengthen programmes and initiatives to hasten sustainable restoration of abandoned mine pits. This research will also make a basis for other research work.

1.6 Scope of the Study

This study covered mining activities with a greater emphasis on Gold mines, sand harvesting and murram pits in Kakamega County. It also examined restoration strategies undertaken since 2000 – 2015.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents review of relevant literature in line with the context of the study problem and research objectives formulated. The literature is reviewed starting from global, regional and narrows down to local perspective. It covers the following areas: the theoretical concept on ecological restoration, Environmental degradation due to mining, Restoration Strategies, the Legislative framework on mining and Environment Management in Kenya and community attitudes towards mine pit risks and their restoration. A conceptual framework is presented showing the relationship between the independent variable and dependent variables which is important in clearly showing the relationships and methodological approaches in this research.

2.2 Ecological Restoration

The Society for Ecological Restoration International (SER, 2004) has defined Ecological restoration as "an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability". According to Cooke and Johnson (2002), the restoration of mined land can largely be considered as ecosystem reconstruction which involves the re-establishment of the capability of the land to capture and retain fundamental resources. According to Falk *et al.* (2006), ecological restoration is an attempt to return a system to some historical state, although the difficulty or impossibility of achieving this aim is widely recognized. That a more realistic goal may be to move a damaged system to an ecological state that is within some acceptable limits relative to a less disturbed system.

The practice of ecological restoration has frequently been based largely on local understanding of how particular ecosystems work, without any real reference to a recognized body of theory or generalized framework. (Falk *et al.* 2006). However (Van Digglen *et al.* 2001), notes that while restoration is sometimes considered an art or a skill that is honed by practice and tutelage, science-based restoration are those projects that benefit from the infusion of ecological theory and application. That science based restoration follow. (1) Explicitly stated goals, (2) a restoration design informed by ecological knowledge and (3) quantitative assessment of system responses employing pre and post-restoration data collection. Such restoration becomes adaptive when a fourth step is followed: (4) analysis and application of results to form subsequent efforts. (Zedler and Callaway, 2003).

Cooke and Johnson (2002) also agreed that ecological theory lacks general laws with universal applicability at ecosystem level. They concur with the concept of adaptive management and that a restored site should be regarded as a long-term experiment. They further note that the lack of post-restoration monitoring and research has meant few opportunities to improve the theory and practice of ecological restoration in mining. According to Zedler (2005), that despite an abundance of theory and guidance, restoration goals are not always achieved, and pathways towards targets are not highly predictable. She states that this is understandable because each restoration project has many constraints and unique challenges. According to her, to improve restoration progress sites should be designed as experiments to allow learning while doing. That the larger projects can be restored in phases, each designed as experimental treatments to test alternative restoration approaches.

Falk *et al.* (2005) also notes that restoration follows multiple pathways which means that outcomes are difficult to predict. That part of the difficulty is that restoration takes place across a multidimensional spectrum of specific sites within various kinds of landscapes, and where goals range from highly specific to general and that the task of developing theory that offers a high level of predictability is difficult.

The above literature reveals that the lack of post-restoration monitoring and research has resulted in few opportunities to improve ecological theories and ecological restoration in mining. This study seeks to address this gap by evaluating restoration strategies in mines and recommend continued post-restoration assessment.

2.3 Environmental degradation due to mining

The environmental, social and economic problems associated with abandoned mine sites are serious and global. These problems have social and economic impacts on countries and individual communities due to: loss of productive land: loss or degradation of ground water: pollution of surface water by sediments or salts: fish affected by contaminated sediments: changes in rivers regimes: air pollution from dust or toxic gases: risk of fall into shafts and pits: and landslides (UNEP, 2001).

The International Institute for Environmental Development (IIED) identified that globally, the most important issues of abandoned mines are the physical hazards (safety of excavations and structures), and environmental contamination, but that public opinion especially in the western world has usually been on visual impacts of mining. IIED further notes that some abandoned mines present only physical concerns. That these concerns include public health and safety, visual impacts, stability issues and dust problems. It also identified that accidents related to vertical openings or deteriorating structures are the most common cause of death and injury in abandoned mines (IIED, 2002).

2.3.1 Environmental degradation and mining in Africa

Kiluta (2005) indicates that mining is a major economic activity in many developing countries and those operations whether small or large-scale, are inherently disruptive to the environment. He states that the environmental deterioration caused by mining occurs mainly as a result of inappropriate and wasteful working practices and rehabilitation measures. That mining has a number of common stages or activities, each of which has potentially adverse impacts on the natural environment, society and cultural heritage, the health and safety of mine workers, and community based in close proximity to operations. In Tanzania, there is growing realization that mining activities can be undertaken to ensure that economic contributions are maximized, social conditions are improved and damages to the environment are minimized. Though there is documentation of increased mineral production in Tanzania, minimal analysis has been undertaken to determine the impacts associated with the same (Kiluta, 2005).

Nwachukwu and Mbanemu (2012) in a study of abandoned pits in Nigeria were concerned that if the habit of not protecting both active and abandoned quarry pits continues, future generations of human inhabitants in the lower Benue Trough will face danger, displacement, greater poverty and hunger due to lack of farmlands. That the quarry operators are mainly concerned with economic benefits of producing the rock aggregates but not extending the benefits to reclaiming the abandoned pits for sustainability of land, environmental protection, and safety of ecosystem in the area. This concern gives further justification to this study which seeks to evaluate restoration strategies and recommend for sustained remediation activities.

According to Lameed and Ayodele (2010), pits may be used for waste dumping or may contain contaminated pools of water, thus becoming source of ground water pollution and breeding place for insect vectors such as mosquitoes. Nawachukwu and Mbaneme (2012) also concur that many quarries naturally fill with water after abandonment and become lakes. Those water-filled quarries can be deep with water, often 50 feet or more. They also stated that community members reported presence of a species of mosquito and tsetse fly bigger in size than the normal. Abandoned quarries have also attracted dangerous criminals who have turned them into dumping ground for victims of murder (Okanga, 2010).

Kiluta (2005) also observes that some of the typical environmental impacts caused by artisanal mining activities include diversion of rivers, water siltation, landscape degradation, deforestation, destruction of aquatic life habitat, and widespread mercury pollution. Metallic mercury discharged into the environment may be found in aquatic system. Individuals reliant on fish may be particularly susceptible to exposure to accumulate dangerous levels of methylmercury. That methylmercury is easily transferred from women to the fetus, with effects ranging from sterility, spontaneous abortion, and from mild-to-severe neurological symptoms.

2.3.2 Environmental degradation and mining in Kenya

Mining in Kenya is mainly open cast due to the nature and occurrence of minerals mined. Instances of environmental degradation due to mining are therefore more severe (Kariuki, 2002). According to NEMA the past and present environmental problems associated with the extraction of minerals in Kenya include: the existence of dangerous open shafts, some as deep as 100 feet and linked to underground tunnels, which pose danger to local inhabitants and their livestock; abandoned large open pits have become breeding ground for vector insects; atmospheric pollution by dust rich in silica arising from manual pounding of the gold bearing ore may cause various respiratory complications; mass wasting of land slopes as a result of poor mining practices; panning taking place on flowing streams contributes to water contamination and siltation (NEMA, 2004).

A taskforce constituted to look into the management of quarrying activities in Kenya to establish reasons for various quarry disasters identified among other issue encroachment into ecologically fragile environment, water ponding in quarry pits, undercutting of cliffs, negative landscape effects due to presence of abandoned quarries, pits and heaps of quarry wastes (MEMR, 2010). Mining disrupts the aesthetics of the landscape and disrupts along with it soil components such as soil horizons and structure, soil microbe populations and nutrients cycles which are crucial for sustaining a healthy ecosystem. Kariuki (2002) concurs that mining operations often involve cutting the land surface and moving the earth to other locations as waste materials affecting the natural topography and scenic beauty as well as removing the surface vegetation which affects the ecosystem, thereby disturbing the balances of nature. Explosives used to blast rocks lead to distortion of landscape into scarred, disfigured and very different from the original state. This in turn facilitates soil erosion associated with erosion agents such as wind and run-off water.

In Kakamega, quarrying and sand harvesting activities are increasingly important as the pace of construction undertakings accelerates NEMA (2007) has noted that this great demand on materials for construction has highly interfered with the natural environment. Land degradation, mass wasting, air and water pollution were noted to occur due to the mining activities. Major gold mining closed in the 1950s but small artisanal mining is particularly in Lirembe, Emalinya, Shivaka, Emalindi and Rosterman. Accidents and deaths in the mines have been reported, and according to the western provincial mines and geology officer, fencing off mining areas, covering of tunnels, timbering of tunnels to avoid caving in, digging of breathers for pumping air into the mines to avoid suffocation and use of strong and fastened hand pulleys are some of the measures being enforced to reduce accidents and death. To safeguard the environment, miners have been directed to fill all holes which are not in use and to stop dumping mercury into the ground so as not to get into rivers (Mahandara, 2011). It is imperative from the above that the mineral extraction process must ensure return of productivity of the affected land. Post-mining reclamation of degraded land should therefore be an integral feature of the whole mining spectrum as stated by Ghose (1989).

From the above, environmental degradation caused by mining has been noted to occur mainly due to inappropriate and wasteful working practices and rehabilitation. This study sought to fill this gap by establishing the sufficiency, effectiveness and efficiency of rehabilitation measures and propose for sustainable remediation measures.

2.4 Restoration Strategies

Remediation of abandoned mine sites has been noted by UNEP (2001) to be the major outstanding environmental problems related to mining. Even though it may be a legacy of inadequate or neglected mine closure in the past, it is an issue that has real environmental, social and economic implications today. Absolom and limpitlaw (2005) concur that sustainable development with its premise of equity amongst the present and future generations, requires us to address impacts today and leave to our descendants a landscape that will support life-giving ecosystem and economic activity. The Brundtland commission in 1987 also noted that “the downward spiral of poverty and environmental degradation is a waste of opportunities and resources. What is needed is a new era of economic growth that is forceful and at the same time socially and environmentally sustainable (UN, 1987).

Mining is a temporary land use because the mineral deposit is finite and eventually exhausted. The social and legislative context of mining in many parts of the world today means that some form of land rehabilitation goals will have been set for the post-closure situation (Cooke and Johnston 2002). UNEP (2005) also agrees that mining for closure requires recognition that mining is a temporary use of land and that mine closure activities can be planned for to avoid abandonment. In mining for closure approach which this study wishes to borrow from, the mine closure plan should be an integral part of the project cycle. The preparation of the plan should be done early in the process of mine development and in consultation with the regulating Field Dataity and the local community.

According to Shau and Dash (2011) post-mining site reclamation and restoration is the final and crucial stage which requires proper planning. Reclamation should not be confined necessarily towards the decommissioning phase of the project. Rather site reclamation should be progressive such that the rate of restoration is more or less similar to the rate of mining. They indicate that the topographic conditions refer to the surface, configuration of an area described as rugged, rolling, gentle or smooth. The topography surrounding the disturbed sites also influences reclamation plans and practices. The reconstruction surface must blend with the undisturbed landscape. Topographic reconstruction can therefore not be neglected because the resulting land forms are the foundation upon which other reclamation practices are executed and eventual land uses takes place.

In New York, regulated mining operations have an approved mining plan that specifies how mining will take place, and an approved reclamation plan that provided for return to productive use. Financial security submitted by the mining permit applicant ensures that the land will be reclaimed. Since the state Mined land Reclamation Law was enacted in 1975, more than 2500 mines have been reclaimed. Today, sites in New York state that were once mined are used as farms, wetlands, wildlife habitats, residential developments and public recreation areas (DEC, 2012). Revegatation is a principal goal of reclamation and results in many desirable secondary water quality and aesthetic beauty. Revegetation goals are from simpler erosion control to the full restoration of complex nature communities (Shau and Dash, 2011). Roe (1997) notes that revegatation can be extremely difficult if the topsoil is not available for respreading after the mineral has been extracted. In Australia legal requirements have been imposed on the mining industry necessitating revegetation of mined areas. Roe further states that areas being revegetated are generally vulnerable to future degradation and that species used in revegetation should probably be relatively unpalatable to domestic livestock to reduce risks of overgrazing and subsequent erosion. According to Burger and Zipper (2011), The Forest Reclamation Approach (FRA) is a revegetation method of establishing tree-compatible grasses and legumes to minimize competition with tree seedlings. The ground cover vegetation will control erosion without hindering the survival and growth of planted trees. Mine reclamation procedures for establishing forests differ from those of establishing hay land/pasture and other uses that require agricultural grasses.

Managing and reclaiming mine areas to establish vegetation patches of different stages can provide habitat for diverse wildlife and aquatic species. Establishing a variety of vegetation can create habitat for many wildlife species (Carrozzino *et al.* 2011). The Haller Park at the Bamburi cement factory in Mombasa, Kenya is a rare success of land reclamation in Africa. Land reclamation started in 1971, by initially planting 26 tree species in open quarries. After six months only 3 species had survived. The casuarina tree or the 'whistling pine' was identified as a better pioneer because it can tolerate saline water. By the year 2000 more than 300 indigenous plant species had been introduced, 30 species of Mammals and 180 species of birds had found a home in the Park. Although the Haller Park is a tourist attraction it was not the original vision of the company in carrying out land reclamation. Its main aim was to revegetate the area with suitable tree species and other forms of flora and land degradation. The Park land use now involves tourism, game farming and a complex aqua-culture system involving fish, crocodile and paddy-rice farming which gives the park additional income (Siachoono, 2010).

Existing and Abandoned pits, quarries and Mines are attractive for waste disposal because a hole to contain the wastes has already been excavated (Tammemagi,1999). According to Michaud and Bjork (1995), the closure of a mine can cause severe economic problems for the communities near the mining area. Reclamation of a mined area through the construction of a solid waste landfill can offer many benefits to these communities, if the landfill is properly designed and maintained. This can include economic benefits to the community by creating a use for land which was previously devastated, revenue for the community, county, and state in the form of taxes and tipping fees and employment opportunities in an area which was negatively impacted by mine closure. They further state that the development of a solid waste landfill in an abandoned mine can also be beneficial to the local environment as it can accomplish many of the goals of a standard mine reclamation program, at no cost to the government. The Freshkill landfill, located on the western shore of Staten Island in New York City is over 2200 acres and has become a model for landfill reclamation. The methane produced as the existing materials breakdown is now being harvested, resulting not only in decreased greenhouse gas emission but providing heat to around 22,000 homes (Bloomberg and White, 2011).

Abandoned mine pits can be beneficial if taken advantage of, but can be dangerous if left unattended to or lack of planned post-closure activities as revealed in the literature results in abandoned mines. The results from this study will therefore help to strengthen the planning and management of mine rehabilitation in order to enhance sustainable remediation activities.

2.5 Legislative Framework on Mining and Environment Management in Kenya

The international community recognized the importance of Environmental Action Planning during the earth summit that was held in Rio de Janeiro in 1992. One of the outcomes during the summit was Agenda 21, a Global Environmental Action Plan. The Government of Kenya embraced this novel idea when it developed the first National Environment Action Plan (NEAP) in 1994 and anchored its provisions by enacting the Environment Management and Coordination Act (EMCA) 1999 (NEMA, 2007).

The promulgation of the Kenya Constitution 2010 marked an important chapter in Kenya environmental policy development. Hailed as a green constitution, it embodies elaborate provisions with considerable implications for sustainable development. The right to clean and healthy environment is enshrined in the Bill of Rights, while its chapter V is entirely dedicated to land and Environment (The constitution of Kenya, 2010).

Under EMCA, Institutional Structures provided for include the National Environment Council (NEC), National Environment Management Field Dataity (NEMA), National Environment Trust Fund, National Environment Restoration Fund and a number of national statutory and decentralized environment committees at the Provincial and District level. (EMCA, 1999).

The National Action planning framework provides for decentralized planning where, Provincial, District and National Environment Action Plan Committees are to prepare environment Action Plans every five years. They then recommend legislative measures for preventing, controlling or mitigating adverse environmental impacts. The objective of the Restoration Fund is to act as supplementary insurance for mitigation of environmental degradation. It is to be used in cases where the perpetrator of the damage is not identifiable or under exceptional circumstances that force the Field Dataity to intervene. Through restoration, conservation or easements, the Field Dataity can effectively demand restoration, conservation or restrict the right, interest and use of a burdened land with compensation as deemed appropriate (EMCA, 1999). In the year

2010, a task force formed to inspect the safety of quarrying activities in Kenya recommended that quarries be restored within twelve months of depletion of the quarry (MEMR, 2010).

The Environmental Impact Assessment (EIA) refers to a procedure that identifies, predicts and evaluates the environmental effects of proposed actions and projects. It aims at preventing, mitigating and offsetting significant adverse effects of proposed developments. EIA's provide information for decision making thus promoting environmentally sound and sustainable development. In Kenya the EIA process is governed by EMCA 1999 and subsequent regulations like the Impact Assessment and Audit Regulations 2003-Legal Notice 101.

If a proper EIA is carried out, then the safety of the Environment can be properly managed at all stages of a project – planning, design, construction, operation, monitoring and evaluation as well as decommissioning (Creek, 2012). Kakonge (1996) indicates that effective EIA depends upon full rigorous community participation. The National Environment Policy (2012) stresses that public participation which is a coordinated and participatory approach to environmental protection and Management will be enhanced to ensure that relevant government agencies, local Field Dataities, private sector, Civil Society and communities are involved in planning, implementation and decision making process. It further states that broad public participation in decision making process is one of the fundamental pre-conditions for sustainable development.

The mining and minerals sector in Kenya is very diverse and multifaceted. According to Mujiri (2009) Kenya has a wide variety of minerals which are known and mapped, but most of its potential lies in the yet undiscovered mineral deposits. In Kenya, all unextracted minerals are government property according to the Mining Act Cap 306, the Government of Kenya recognizes that mining can act as an engine for economic development however like other African countries with similar natural endowment, there are policy challenges. That the mining Act cap 306 of 1940 is outdated and has been replaced by the mining Act 2014 which states that; the holder of a permit or license under this Act shall use the land in accordance with the terms of the permit or license and shall ensure- (a) the sustainable use of land through restoration of abandoned mines and quarries; (b) that the seepage of toxic waste into streams, rivers, lakes and wetlands is avoided and that disposal any toxic waste is done in the approved areas only; (c) that blasting and all works that cause massive vibration is proper!), carried out and muffled to keep such vibrations and blasts to reasonable and permissible levels in conformity with the Environmental Management and Coordination Act; and (d) that upon completion of prospecting or mining, the land in question shall be restored to its original status or to an acceptable and reasonable condition as close as possible to its original state (The National Assembly Bill, 2014).

The restoration fund as indicated above was envisaged to act as a supplementary insurance for mitigation of environmental degradation yet restorations of mines are still minimal. This study addressed this gap by identifying why rehabilitation was minimal and suggest ways to enhance remediation activities.

2.6 Community attitudes towards mine pit risks and their restoration

Mine closure plans according to UNEP must contain detailed information on all the steps the company intends to take to preserve the natural environment and protect human health, both among miners and local populations (UNEP, 2001). Local communities have become increasingly aware of the negative impacts of major macro-economic developments on their resource base and are now rising up in defense of their user rights or resource ownership to sustain their livelihood (Mehta and Kellert 1998).

Growing community concern on environmental issues has led to increasingly stringent regulations governing activities that have an impact on the environment regulations and industry practices have evolved in an attempt to minimize the potentially negative effects of mining on the environment while also recognizing the important contribution that the sector makes to society (Allen *et al.* 2001).

According to Arbogast *et al.* (2000), people want affordable homes and schools, green lawns, more and improved schools, cheap and abundant fuel and convenient shopping. That many of these same people do not want natural aggregate mines, dams to collect water, more drilling rigs and uncontrolled growth. Material things that people desire cannot be provided without the undesirable processes that produce them. They state that conflict is inevitable but with careful resource management, many undesirable processes can be eliminated or minimized. They further note that the greatest challenge facing the world today is integrating economic activity with environmental integrity, social concerns and effective governance systems.

There is growing concern in Kenya and at global level that many forms of development activities cause damage to the environment. That there is limited local communities' involvement in participatory planning and management of the environment and natural resources. Rehabilitation efforts in Kakamega have been undermined by local artisanal miners who excavate the fill materials in their search for gold. Others excavate rock materials to use as hardcore for their buildings (NEMA, 2007).

Personal and community perceptions have fundamental impact on infrastructural developments (Jobert *et al.* 2007). It is very critical for communities, policy makers, and developers to understand factors that provoke or reinforce opposition and acceptance, to such developments. In the renewable energy (RE) field, the formation of perceptions towards renewable infrastructure is well studied by various researchers (Devine-Wright, 2007; Jobert *et al.* 2007). The role of place attachment (Cass and Walker, 2009; Devine-Wright, 2009), background conditions (Devine-Wright, 2007; Jobert *et al.* 2007), trust (Tokushige, *et al.* 2007; Bronfman *et al.* 2012), communication (Jobert *et al.* 2007; Dütschke, 2011), and participation have all been investigated with respect to their influence on community perceptions (Corscadden *et al.* 2012). Applying these findings to mining developments may occasionally prove effective, but mines are distinct in character to other infrastructural developments, with a vastly different range of impacts and life cycles.

Potential environmental impacts, such as effects on terrestrial and aquatic systems, play a key role in shaping negative community perceptions towards mining projects, with community benefits and impacts on lifestyle exerting less influence (Charlier, 2002).

Recent research reveals that communities almost always view landscape and environmental impacts as negative (Miller and Sinclair, 2012). This is especially true with respect to open-cut mining (Cheney *et al.* 2001). Further negative consequences include undesired demographic and social changes (Petkova *et al.* 2009). Perceived positive impacts are also reported in the literature and encompass demographic change through diversification, the provision of additional services, job creation, community development, and increased income (Petkova *et al.* 2009; Zhang and Moffatt, 2015).

Efforts have been made to understand the economic, social and environmental impacts of mining activities (Petkova *et al.* 2009), along with the concept of social license to operate (Dare *et al.* 2014). Previous research on community-mine relations has largely focused on community experiences of functioning mines, rather than exploring the factors which shape attitudes towards proposed mines, abandoned mines and their impacts. Since the demand for mineral resources will persist for the foreseeable future, and interactions with local communities are likely to continue, it is crucial that community-mine relations continue to be explored. This research provides new insights by focusing on community and individual attitudes of the impacts of mining activities.

This research is relevant to stakeholders such as developers and government agencies who can use these findings to develop sustainable planning and development approaches, as well as mitigation strategies that are informed by both community knowledge and needs.

2.7 Ecological restoration theory

Abandoned mine land referred to the land that were destroyed in the mining process and could not be used without restoration or the land use function declined, including the open pit, waste dump, tailings pond, subsidence land and the land that lost economic value in use caused by heavy-metal contamination (Xian *et al.* 2009).

The ecological restoration of abandoned mine land was a complex engineering problem, which was related to many disciplines, such as ecology, geology, mining, soil, crop cultivation, forestry, environment, aesthetics, agronomy, geography, land and so on. The domestic early research of land reclamation laid emphasis on engineering design and relatively lacked research in the theories. Hu (1997) believed the comprehensiveness of the basic theories of the related disciplines should be the basic theory of land reclamation, including soil and botany theory, ecological theory, mining subsidence theory, as well as soil reconstruction theory (Hu *et al.* 2008). Bai *et al.* (1999) regarded restoration ecology as the theoretical foundation of the ecological reconstruction in mining area. Hu *et al.* (2008) stated the connotation and relationship between land reclamation and ecological reconstruction on the basis of analyzing the definition of land reclamation, understanding the reclamation goals in the foreign countries and introducing foreign reclamation regulations, the contents and history of land reclamation, thinking that "reclamation" itself contained many ecological reconstruction (restoration) contents, the core contents and English name of them had no difference, and there were certain problems of the translation of "reclamation" in our country. Long (1997) proposed five principles of ecological reconstruction of abandoned mine land from the perspectives of landscape ecology: imitation natural prototype principle, the principle of spots-gallery-base relations, the principle of diversity and heterogeneity, the principle of combination of external conditions and man and nature biological control symbiosis theory. Zhang and Zhang (1999) discussed the basic theoretical issues of land reclamation systematically, such as the concept, objects, nature, disciplinary affiliation, research space and its theoretical framework, believing that the basic theories of land reclamation should include: land failure mechanism and land loss theory, the basic principles and laws of land reclamation, and the theory of sustainable and efficient use of reclaimed land. Bian (2005) considered that ecological succession theory provided a good theoretical basis for vegetation recovery and the establishment of a reasonable population pattern of land reclamation and ecological reconstruction in coal mining area, the principles of landscape ecology can be used for the planning of ecological reconstruction and choice of land-use direction. Zong (2010) regarded ecological succession theory as the principles of ecological restoration in coal mining area, and many other ecological theories were used in the recovery process, including: limiting factor principle, the laws of thermodynamics, population density constraints and distribution pattern principle, ecological adaptability theory, niche principle, succession theory, plant invasion theory, biodiversity principle, the patch-corridor-base theory and so on. The ecological restoration of abandoned mine land was a multidisciplinary research area, not only should it learn from the ecological theories and principles, but it also should draw lessons from other discipline theories, to build its own unique basic theory system.

2.8 Conceptual Framework

A mine begins usually with two plans – a mining plan which specifies how the mine will operate and a reclamation plan which set up the returning of sites to productive use. Mine closure activities can therefore be planned to avoid abandonment. Abandoned mine pits results to various hazards to the neighboring community members. These hazards are; mine degradation of land, soil erosion, pollution, floods and attitudes amongst the community members. The dependent variables are used in restoration of hazards caused by abandoned mine pits, such as; revegetation, landfills, recreational centers and topographic restoration. The intervening variables are; environmental management laws, community attitudes and post mine environmental management plan.

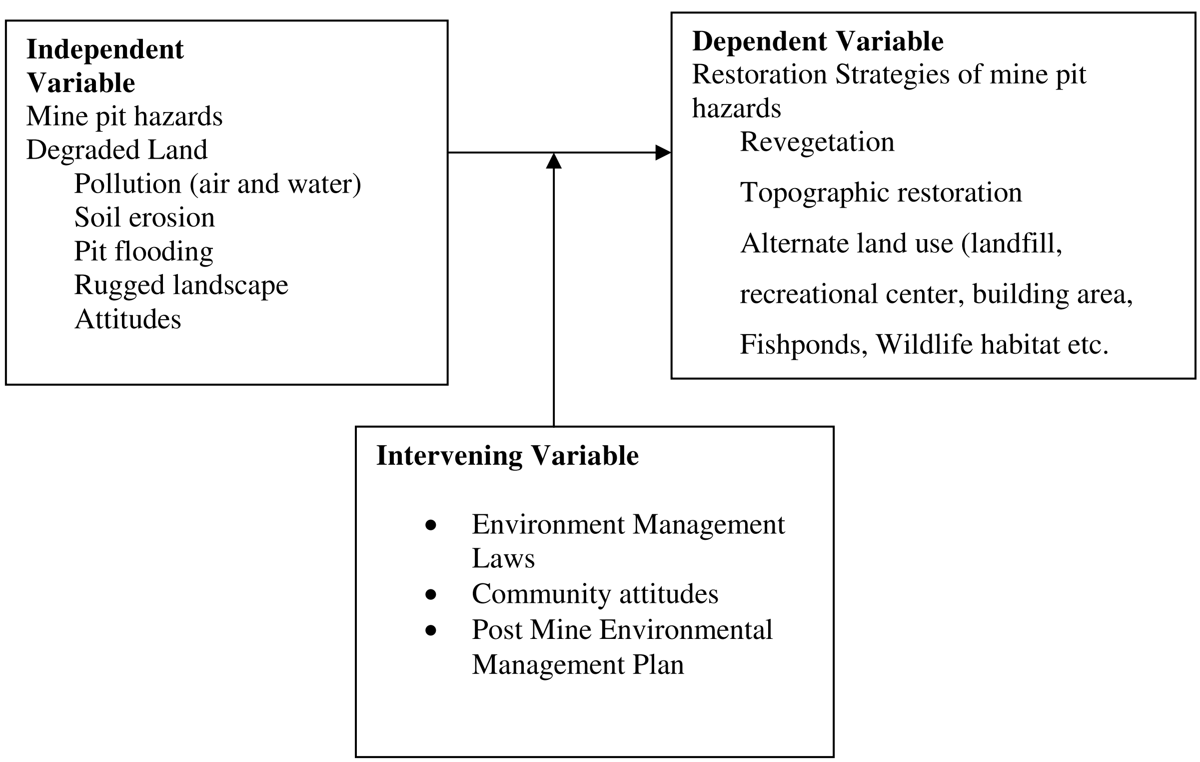

Figure 2.1: Conceptual framework for the study

Source: Research (2013)

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents a description of the study site and research methods. It describes the physical features, geographic features, and main socio-economic activities of the study site. The study population, research design, sampling strategies, data collection and data analysis techniques is also described.

3.2 Study Site

This research was conducted in Kakamega County of Kenya. Kakamega County has a population of 1,660,651 people (KNBS, 2009) and is the second most populous county after Nairobi. Poverty levels in the County stand at 57%. The county has 12 constituencies and 12 Sub-counties (Navakholo, Khwisero, Butere, Mumias, Matungu, Matete, Likuyani, Lugari, Kakamega North, South, East and Central), and the local inhabitants are mainly Luhya tribe, whose main economic activity is farming. The average population density is 495 persons per km². The county lies within altitude 1,250m-2000m and lies between latitude 0^{o} 07' 30" North and 0^{o} 15" of the Equator and longitude34^{o} 32" and 35^{o} 57' 30" east of the Prime Meridian. Masinde Muliro University is an institution of higher learning which is in the heart of Kakamega town. Kakamega a forest is the main tourist destination in the area. The crying stone of Ilesi is also another attraction.

Kakamega was the scene of the Kakamega gold rush in the early 1930s (Shilaro, 2000). This site was chosen because there are several mine pits like the Rosterman Goldmines in Ikolomani constituency. Other mine pits can be found in Lutonyi and Lumbesa areas of Lurambi Constituency, Lubinu in Mumias and Mayoni in Matungu. The site also has several rivers where sand is harvested. Brick and pottery making also takes place in the entire County. There is also great demand for construction materials since the pace of construction has accelerated in the county and this has highly interfered with the natural environment (NEMA, 2007). These mine sites acted as a representation of other sites in the County.

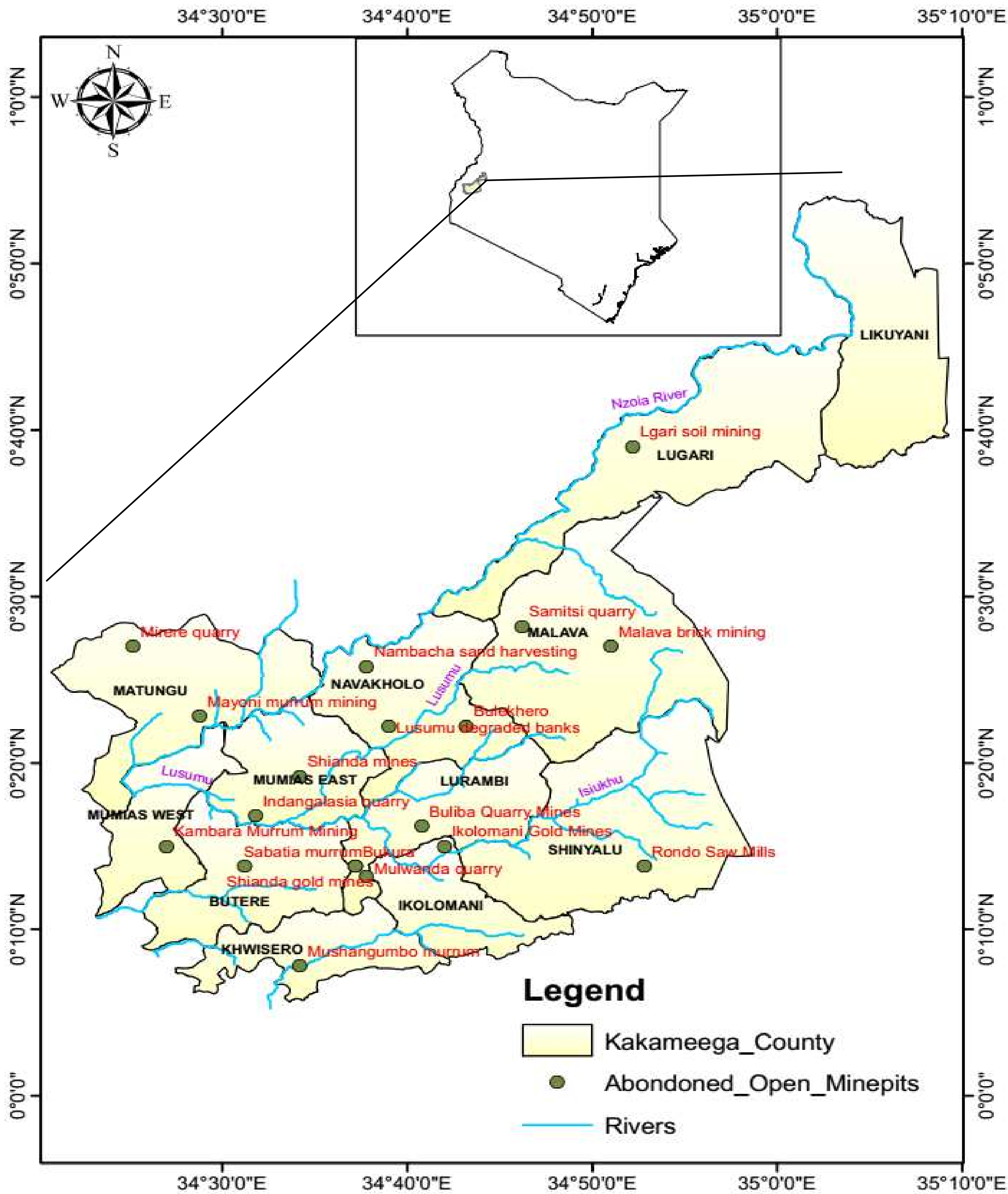

Figure 3.1: Map showing mining sites in Kakamega County Kenya

Source: The Kenya County map (2010).

3.3 Study Population

The study population comprised NEMA, Murram and Gold pits in Kakamega County and 60 mine pits. The researcher sourced data from mines and geology experts, Construction Companies, Sub-County Environment Officers, County Environment Committees (CECs), Constituency Roads Committees (CRCs), Sub-County Environment Committees (SCECs), Miners, owners of the mine sites, local leaders, land valuers, District Development Officers, Sub-County Physical Planning Officers, Geology Officers, Associations of mining companies, residents neighbouring the pits and Provincial Administrators of the areas with mine pits. Table 3.1 gives a Summary of the study population.

Table 3. 1: Study population summary

Study Population Unit	Study population	Source
1. Constituency Roads Committee	73	
2. Association of Mining Companies	1	Kerra Kakamega (2013)
3.Construction companies	163	
4.Sub-County Environment Officers	3	Nema office Kakamega (2013)
5. Sub-County Environment Committe	72	
6. Land Valuers	2	Lands office Kakamega (2013)
7.Mine and Geology Experts	3	
8.Miners	154	Mines and Geology office Kakamega (2013)
9.Mines	60	
10. Owners of mines	60	
11. Residents neighboring mines	300 households	Regional Materials office Kakamega (2013)
12. Chiefs	54	County HRM (2013)
13. Sub-County Development Officers	6	
14. Sub-County Physical Planning Officers	3	Sub-County Physical Planning office (2013)
15. County Environmental Committee	11	County Government office Kakamega (2013)

Source; Field Data (2015)

3.4 Research design

This research utilized an evaluation research design because it was in line with the main objective. The researcher established the level of degradation and restoration strategies in mines using parameters such as soil erosion, vegetation cover and availability of backfilling material. Table 3.2 below shows the relationship between objective and variable.

Table 3. 2: Research design based on objectives

Specific Objective	Research Design	Measurable Indicator
i) Establish various Types of abandoned Mines and Degradation of Surrounding environment	Descriptive Design	Mine types Level of degradation Land bareness due to grazing Tree density Vegetation cleared Sizes of mined land Amount of murrum needed
ii) Determine community attitudes towards mine pit risks and their restoration	Descriptive Design	Community attitudes
iii) Evaluate current restoration strategies	Descriptive Design	Restoration strategies Backfill material available Tree/shrub canopy cover Pasture cover

Source; Field Data (2015)

3.5 Sampling strategy

Purposive sampling was used to select the (CRCs), Sub-County Environment Officers (NEMA), Mine and Geology experts, Miners, Sub-County Physical Planning Officers, County Environment Committees and Sub-County Environment Officers Sub-County owners of the mine pits and the local chiefs. Systematic random sampling was used to select miners and residents neighboring the mines. According to Mugenda and Mugenda (1999) a researcher would have to use 30% of the total target population as a sample size for it to be accepted as a good representative sample. The total population targeted was 60 mine pits. The sample size was therefore 18 mine pits. The mines were clustered into

12 constituencies and proportionate sampling used to determine number of mines to constitute the sample (See Table 3.3 and Appendix 7). Random sampling was eventually used to select the mines to be observed.

Table 3. 3: mining pits and sample size taken per constituency

Constituency	Total number of mines pit =60	Number of sampled mines
Navakholo	Lusumu, Nambacha	1
Khwisero	Khwisero, Emasatsi, Mulwanda	2
Butere	EmukhalwayeSabatia, Marenyo, Shianda	2
Mumias	Mayoni,Mumia, Mayoni	1
Matungu	Ikhonje,Ejinja,Stone shine,Luanda, Ekamashia	2
Matete	Matete Nabuyole	1
Likuyani	Likuyani	1
Lugari	Lugari Mugunga	1
Kakamega north	Malekha,Samitsi, Malava,Shikutse, KambiMwanza	2
Kakamega south	Ivakale Murhanda Rondo	2
Kakamega East	Kilingili Eshangwe, Rosterman	1
Kakamega central	Bukura, Lutonyi Bushiri, Eshisiru, Shimanyiro Emukaba	2

Source: Field Data (2015)

The researcher used Cochran's (1977) formula in determining the sample size for CRCs, DECs, construction companies, chiefs, residents neighboring mines and miners.

n = N

$\mathbf{1+N(d)^2}$ **Equation ……………………………………………….. (3. 1)**

Where 'n' is the desired sample size N is the target population and'd' is the acceptable error estimated at 0.10 (at 90% confidence level). This is depicted in the Table 3.4

Table 3. 4: Sample strategy summary

Study population	Sampling method	Study Population	Sample size determination	Sample size (n)
Constituency Road Committee (CRC)	Purposive	73	$n = \frac{N}{1 + N(e)^2}$	42
Sub-County Environment officers	Purposive	3		3
Mine and Geology experts	Purposive	3		3
Sub-County Environmental Committees	Purposive	72	$n = \frac{N}{1 + N(e)^2}$	42
Land Valuers	Purposive	2		2
Construction Companies	Purposive	163	$n = \frac{N}{1 + N(e)^2}$	62
County Environmental Committee	Purposive	163		11
Chiefs	Purposive	54	$n = \frac{N}{1 + N(e)^2}$	35
Association of mining companies	Purposive	1		1
Residents neighboring mines	Systematic random sampling	300 households	$n = \frac{N}{1 + N(e)^2}$	75
Miners	Systematic random sampling	154	$n = \frac{N}{1 + N(e)^2}$	61
Mines	• Proportionate sampling • Random sampling	60	30% of total population	18
Owners of mine pits	Purposive	60	30% of total population	18

Source; Field Data (2015)

3.6 Data schedule

The researcher used an observation checklist to observe the degradation and restoration levels of the various mine types. A questionnaire was used to collect data from members of the (CRCs), (CECs), Sub-County Planning Officers, construction companies, Sub-County Development Officer, land valuers, Association of mining companies and (SCECs). A five- point Likert scale questionnaire was used to collect data from residents neighbouring the pits, owners of the mine pits, local leaders and Miners. An interview schedule was used to collect data from the Sub-County Environment Officers and Mine and Geology experts. Focus Group Discussions was used to collect data from stakeholders i.e. owners of the mine pits, local leaders and the chiefs. One FGD was held in the larger Kakamega districts, another in the larger Butere – Mumias and a final one in the larger Lugari. Each FGD consisted of 4-12 stakeholders. The researcher also used Document content analysis to obtain data from secondary sources. A camera was used to take pictures in the selected mine pits. Table 3.5 gives a summary of the data schedule

Table 3. 5: Data schedule summary

Study Population	Sampling Method	Sample Size	Data Instrument	Appendix Number
Sub-County Environment Committees	Purposive	42	Questionnaire	1
Sub-County Physical Planning Officers	Purposive	3	Questionnaire	1
Kenya Rural Roads Field Dataity	Purposive	42	Questionnaire	1
Mines and Geology experts	Purposive	3	Interview Schedule	4
Sub-County Development Officers	Purposive	6	Questionnaire	1
Construction Companies	Purposive	62	Questionnaire	1
County Environment Committee	Purposive	11	Questionnaire	1
Chiefs	Purposive	35	Questionnaire FGD	5 3
Residents neighboring mines	Systematic Random Sampling	75	Questionnaire Focus Group Discussion	5
Association of Mining Companies	Purposive	1	Questionnaire	1
Miners	Systematic Random Sampling	61	Questionnaire	5
Owners of Mines	Purposive	18	Questionnaire FGD	5 3
Mines	• Proportion Sampling • Random Sampling	18	Observation checklist Assessment form Questionnaires	2 6A, 6B 1,5

Source; Field Data (2015)

3.6.1 Determination of degradation and restoration levels

The researcher determined degradation and restoration levels of mine pits by use of an assessment form (Appendix 6A and B) and the results were calculated as presented below.

3.6.1.1 Tree density

The term density is applied to the number of plant units per unit area. Tree density determination exercise was done during the field investigations of mine pits. Tree density measurements were taken by practically counting the number of trees in each of the sample sites (40m x 35m plot). This sampling plot size was found appropriate for tree sampling (Obiri and Lawes 2000). The abundance of a particular species was achieved by dividing the density for a given species of plant by the total density for all types of plants and then multiplying by 100 to get the percentage. It is important to note that shrubs which grow in clumps were counted as single plant units.

$$\textbf{Density of a plant species (X) \%} = \frac{\textbf{Tree spicies}}{\textbf{Total number of all tree spiecies}} \times \mathit{100}\% \quad \textbf{Equation ...(3. 2)}$$

Source: (Obiri and Lawes 2000)

3.6.1.2 Size of mining area

The data about the size of mining area was obtained from the land owners who were asked to give the size of land under mining activities. The sizes were then used to approximate size of mined and abandoned pits.

3.6.1.3 Soil extraction Volume

Extraction volume was determined from the data that was found at the Kenya Rural Roads Field Dataity (KERRA). The information included the total length in kilometers of the road network in the county, and the amount of murrum material used for construction.

3.7 Data Reliability and validity

3.7. 1 Validity

Reliability is the degree to which measures are free from error and therefore yield consistent results while validity refers to sampling adequacy and representatives of the instruments. Best (1981) asserts that experienced researchers should be used to determine the content validity of the research instruments. The researcher presented the instruments to research advisors to evaluate the exactness and adequacy of the items in the instruments. In this study, validity was further improved by pre-testing the questionnaire in a pilot study in Vihiga County. Vihiga County was selected as a pilot study area since mining activities are similar with the study site. The researcher used the feedback from the pilot study to rectify any unclear statements or make necessary alterations in the instruments. The researcher used various sources of information in form of literature review, interview, direct observation, Focus Group discussions and questionnaires.

3.7.2 Reliability

According to Mugenda *et al.* (1999), reliability is a measure of degree to which a research instrument yields consistent results or data after accepted trials. Reliability of measurements is the degree to which a particular procedure gives similar results over a number of repeated trials. This was reached at after administering the same instrument more than once to the same group, a method referred to as test-retest. The researcher administered the questionnaire to the pilot sample and then scored the questions. To measure the reliability, Alpha (Cronbach) technique was used. In this approach, a score obtained in one item is correlated with scores obtained from other items in the instrument; Cronbach's Coefficient Alpha is then computed to determine how items correlate among themselves. Cronbach's Alpha is a general form of the Kunder-Richardson (K-R) 20 formula.

The use of K-R 20 formula in assessing internal consistency of an instrument was based on the split – half reliabilities of data from all possible halves of the instrument. Use of K-R 20 formula reduces the time required to compute a reliability coefficient in other methods. Its application also results in a more conservative estimate of reliability; the estimated coefficient of reliability of data is lower.

The K-R formula is as follows:

$$KR_{20} = \frac{(K)\ (s^2 - \sum_s{}^2)}{(S^2)\ (K-1)} \qquad \textbf{Equation} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\textbf{(3. 3)}$$

Where

$KR_{20=}$ Reliability Coefficient of internal consistency

K= Number of items used to measure the concept

S^2= Variance of all scores

s^2= Variance of individual items

A high coefficient implies that items correlate highly among themselves meaning there is consistency among the items in measuring the concept of interest. This is sometimes referred to as homogeneity of data whereby the researcher can confidently depend on the information gathered through various sources of data adopted for the study. Alpha (Cronbach) is a model of internal consistency based on the average inter- item correlation. The instrument was divided into two parts using the even and odd numbers. A large value of alpha (preferably greater than 0.6) indicates high level of consistence of the instruments in measuring the variables. Respondents in the pilot sample were asked to comment on the clarity and time taken to fill one instrument. The co-efficient of internal consistency was established at 0.86. The 0.86 point indicated a high degree of reliability of the instrument. The instrument was then adjusted on the basis of the findings of the pilot test and the final version was developed thereafter.

3.8 Data analysis

Data obtained for specific objective (i) was summarized in tables, bar charts in percentages and descriptively analyzed. On the other hand, data obtained for specific objective (ii) and (iii) was summarized in tables and inferential statistics used to analyze it. Table 3.7: gives a summary of the same.

Table 3. 6: Data analysis method with reference to the specific objectives

	Specific objective	Measurable Variable/indicator	Data Analysis method
1.	Establish various types of mines and their level of abandoned mines And degradation of surrounding environment	• Mine types • Level of degradation ▪ Land bareness due to grazing ▪ Root exposure due to erosion ▪ Vegetation cleared	• Descriptive Statistical Analysis • Observation
2.	Determine community attitudes towards mine pit risks and their restoration	• Community attitudes	Chi-square Test
3.	Evaluate current restoration strategies	• Restoration strategies ▪ Backfill material available ▪ Tree/shrub canopy cover ▪ Pasture cover	• Descriptive Statistical Analysis • Observation

Source; Field Data (2015)

3.9 Limitations

(i)The researcher anticipated that some miners may regard her as an outsider and undesirable intruder who may be out to enforce the law, which would result in protection of information. This challenge was overcome by establishing a rapport and use of the local administrators to explain the purpose of the research.

(ii)The researcher also anticipated communication barrier. This challenge was overcome by use of local enumerators.

3.10 Scope.

The study was conducted in Kakamega county. The study covered mining activities with a greater emphasis on hold mines, and harvesting and murrum pits

3.11 Assumptions

The assumption of the study was:

i) Environmental Impact Assessment was done for all mines in Kakamega County

ii) All mines in the county had post-mine Environmental Management Plan

iii) There was public participation in decision making towards environmental protection and management.

iv) During the study the respondents to questionnaires volunteered correct information

3.12 Ethical considerations

A research letter introducing the researcher was sought from the University. A research permit was sought from the National Commission for Science, Technology and Innovation (NACOSTI) to conduct research. Authority was sought from all respondents individually and collectively from the respective agencies, Sub-counties and local administration in the study area. The confidentiality of information given by respondents was guarded and the dignity of the respondents protected by the researcher.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and discussions on the various types of mines and their level of degradation in Kakamega County. The rationale of research methodology, data collection, collation, and methods of data analysis were presented in Chapter three. In this chapter the results and their discussion are presented. Presentation and discussion of data would be in two major parts: descriptive discussion of data collected for each section of the questionnaire related to the appropriate research aims as well as discussion of results from inferential statistical analyses.

4.1.1 Sources of data

The data that were used for this study was primary and secondary, where primary data was obtained from the researcher's observation and interview which was conducted on the communities at the or neighboring mine pits, companies operating mining activities and stakeholders like ministry of mining in Kakamega County. It is crucial to note that to obtain detailed primary data to help answer the objectives, the observation and interview was divided into two levels. The first level was identification of the sites, and sampling of 18 mined pits out of 60, using the stratified random sampling technique. In these selected sites, level of degradation was determined by practically measuring the depth of each mined pit and determining vegetation density of the land at mined areas with comparison with adjacent unmined areas. The last level involved data collection on land uses, with observation to identify various levels of degradation resulted from various mining activities this was with reference to vegetation cover (density and composition) between adjacent areas and landforms that have developed and measurements taken. Community perception and attitude towards mine pits was gauged from the dangers and advantages that the community are exposed to from the mine pits and the restoration strategies. The restoration strategies were also assessed through looking at the efforts of revegetation of mined pits, and budgeting of financial resources to be put in mined pits reclamation. Photographs depicting environmental degradation of mined sites were also captured at different locations within the study area. The last level in the study involved an interview with key informants such as the NEMA officials, mine and Geology Experts at the ministry of Geology and mining and finally administering questionnaires to local residents around mine areas. From these groups, a few key people were selected to form a Focus Group Discussion (FGD). The information found was approached based on the people's perception to present the findings.

Out of the 382 respondents for all tools and interview guides, 356 returned their questionnaire which is 92% response rate. According to Mugenda and Mugenda (2003) a response rate of 50% is adequate for analysis and reporting; a rate of 60% is good and a response rate of 70% and over is excellent. This therefore shows that decisions can be made based on the findings of this research. All the interview schedules were picked immediately after respondents filled. The following is the demographic information extracted from the residents neighbouring mines questionnaires.

4.2 Demographic Information

The information of the respondents about age, education and gender will be presented and discussed in this chapter.

4.2.1 Age of the respondents

The age distribution in this research was 18 years to 50 years. The majority 38% (63) were youth aged between 26 to 35 years. Age distribution of the residents neighboring mines was important in assessing the level of land degradation over the years. Residents who had stayed in respective locations for a period more than 50 years, who amounted to 8% (13), this population was instrumental in determining the level of degradation.

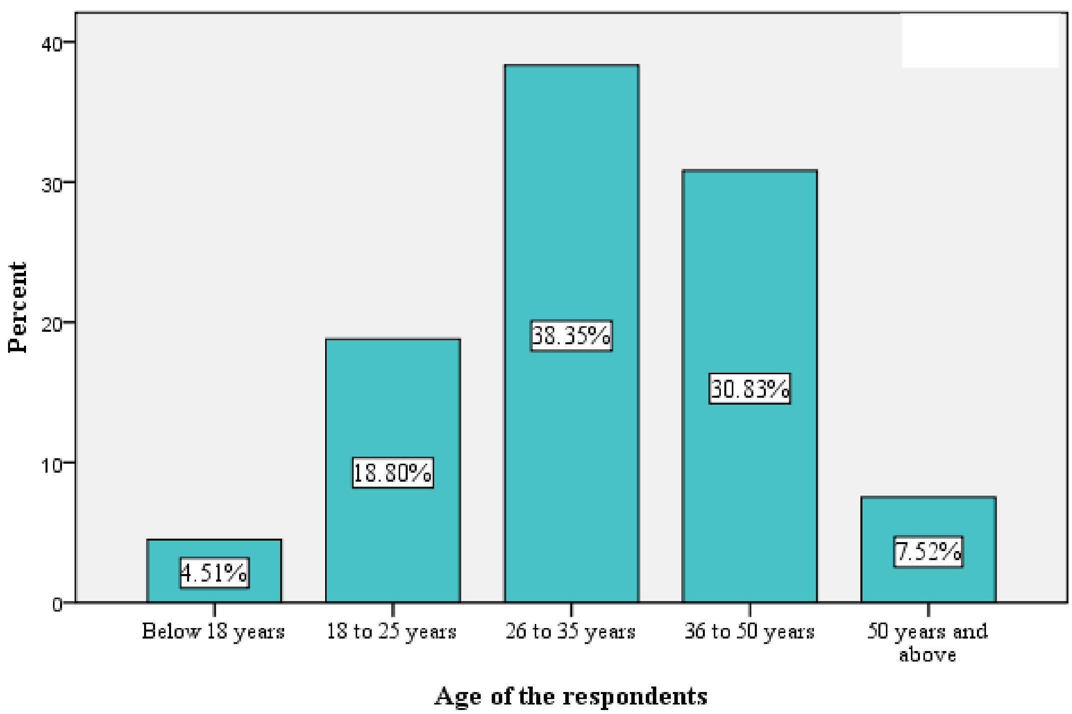

Figure 4. 9: Respondents age distribution in Kakamega County, Kenya

Source; Field Data (2015)

4.2.3 Education

A review of residents neighboring the mine showed that the majority who had attained secondary school education 44% (7) and 15% (25) primary level. About 35% (58) had post-secondary education, in tertiary institutions. However, 5% (8) had not attained formal education as shown in Figure 4.2 below.

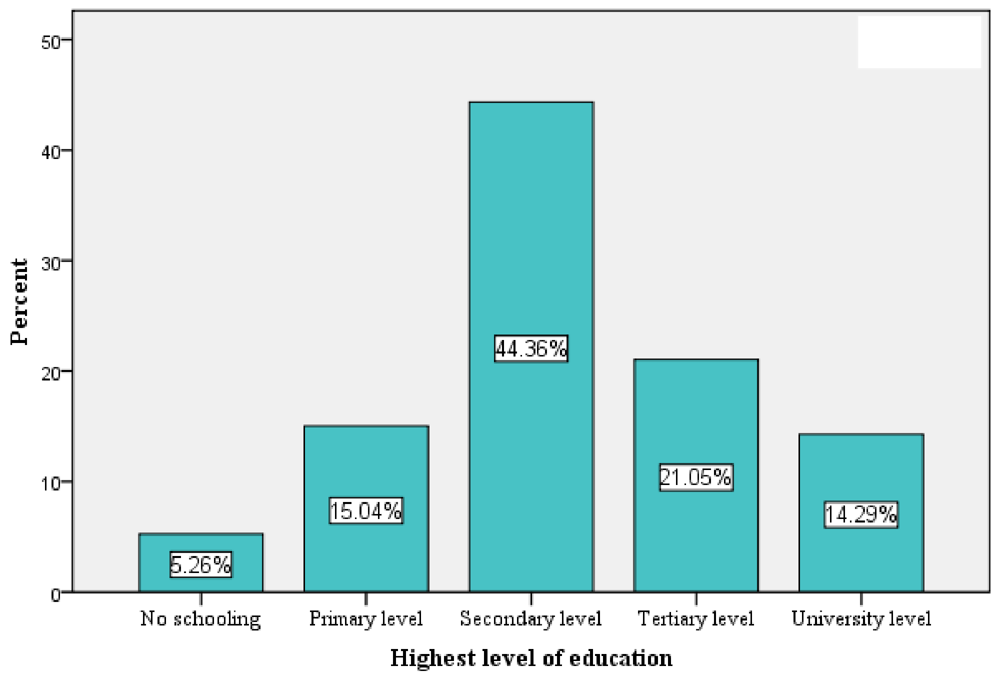

Figure 4. 10: Education level of respondents in Kakamega County, Kenya.

Source; Field Data (2015)

Nakileza, (2007) points out that education is frequently touted as the most important factor for achieving sustainable development and used as an important means for changing attitudes and behaviors. The Hyogo Framework for Action, which was adopted by 168 nations in January 2005 recognize this and encourages government and civic society to use education which facilitate knowledge and innovation, in order to build a culture of safety and resilience at all levels of the nation.

4.2.4 Occupation

Occupation was an important aspect to consider in this study. Population increase puts a strain on the environment and unemployment in a particular society, endangers the environment even more.

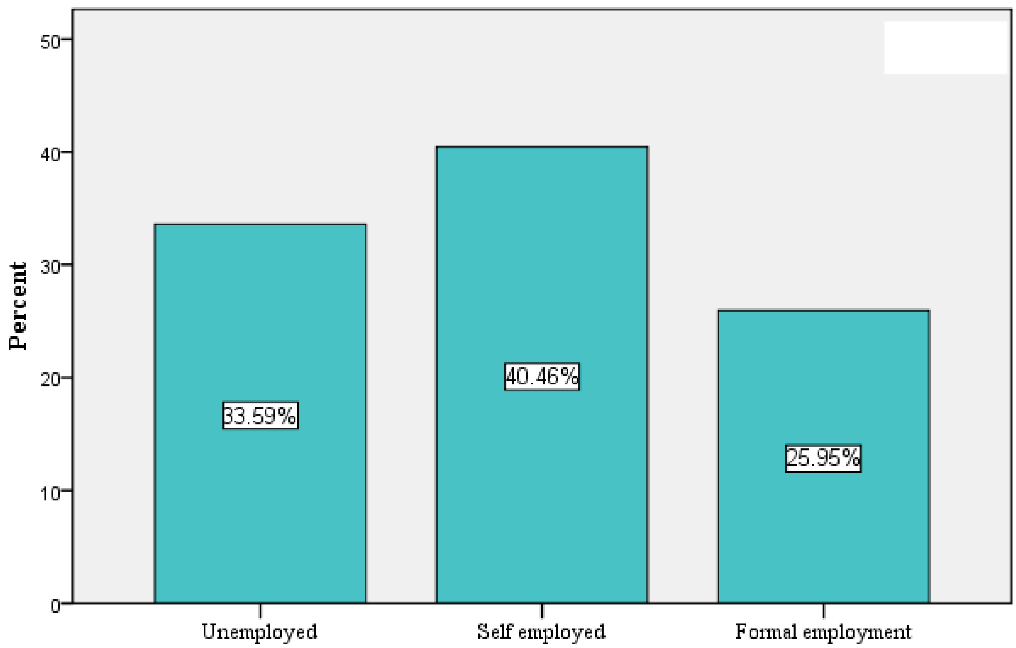

Figure 4. 11: Occupation of respondents in Kakamega County, Kenya

Source; Field Data (2015)

In the research, it was found that 26% (43) were formally employed, 40% (67) were self-employed, with a majority working in mine pits, because sand, soil and Gold mining are the main economic activities in the region. However, 34% (57) of the respondents were unemployed as shown in Figure 4.3. This clearly shows the amount of strain put on the environment, which in the end leads to highly degraded environment in the region. The increasing rate of unemployed population can accelerate the rate of environmental degradation, as Kaufmann (1999) argues convincingly that the environmental destruction in Kosovo was used by the Kosovo-albanians as an argument against Yugoslav rule (although other parts of Yugoslavia was equally polluted). In other aspects as well, his main argument runs parallel to the livelihood conflict approach. The discontent that finally led to open conflict was created by poverty, in turn caused by unemployment due to industrial decline. Other sources of fresh livelihoods were limited by land scarcity and degradation, in turn creating conflicts over land-rights.

4.3 Types of abandoned mines

Kakamega County is the second populated County in Kenya, with various economic activities undertaken as peoples' source of livelihoods. Mining is one of the most common economic activities practiced in Kakamega since 1930, (Shilaro, 200). The respondents in this research are miners, or employed in mining companies or are neighbors to mining sites.

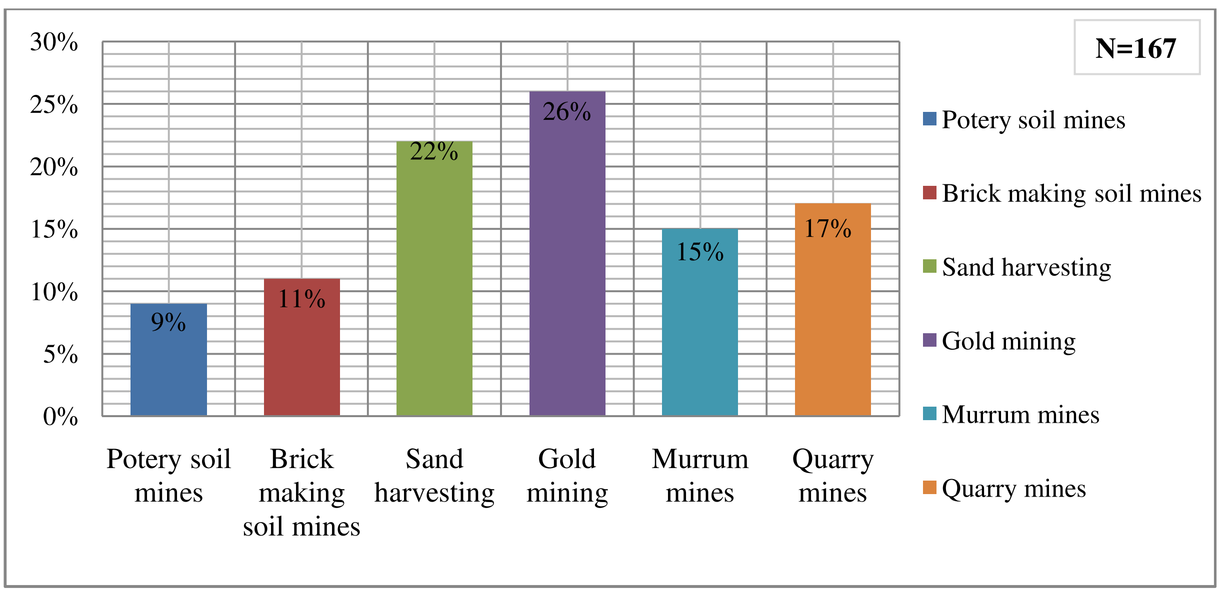

Figure 4. 12: Types of mines in Kakamega County, Kenya

Source; Field Data (2015)

The research identified several types of mining in Kakamega County as shown in the Figure 4.4. Gold mining at 26% (38) was the most common type of mining in the region. Gold mining is majorly practiced in Ikolomani constituency since the year 1930 (Shilaro, 2000). Sand harvesting is another mining activity 22% (37) commonly practiced along major rivers, flood plains and surface run off in Kakamega County. Rivers affected by sand harvesting activities include; Shatsala, Yala and Isiukhu. Quarry mine 17% (28) is commonly practiced especially in rocky areas in the County. The most common and biggest quarry is on Buliba's farm, where quarry mining took place during the years of 1990s. Since then, the site has been abandoned, and remains a threat to people and animal neighboring it. It has claimed many lives of both people and animals. A section of Buliba's quarry is shown in Plate 4.1 below;

Plate 4. 1: The researcher observing an abandoned mined pit on Buliba's farm in Kakamega County

Source; Field Data (2015)

Mining for murrum 15% (25) has been on the increase because of the increased demand of construction materials for houses and roads. Murrum mining has been widely practiced in the County, and its impacts on the environment in some areas are unbearable. Soil mining for brick making and pottery is very common 20% (14) and a source of income for residents in the county. Bricks are the main raw material for building and pots used as containers or for decorations.

In Kakamega County, Kakamega, Butere and Mumias sub-counties are famous for a number of economic minerals that have been mined from early 1920s (Shilaro, 2000). Sand harvesting quarrying, murram and gravel extraction for building materials also takes place in the County. NEMA reports that, there is great demand of materials for construction in Kakamega County and the natural environment is highly interfered with (NEMA, 2007). Pottery and brick making takes place in the entire county which has led to land degradation and mass wasting.

4.3.1 Size of mined areas

Sizes of mined areas in these study areas were used to determine the area of degraded land. The mine pits sizes are presented in the Table 4.1.

Table 4. 4: Size of mined land in Kakamega County, Kenya.

Size of mined areas	Frequency	Percent
0.5 to 2.5 acres	11	61
2.6 to 4.5 acres	5	28
4.6 to 14.5 acres	2	11
Total	18	100

Source: Field Data, 2015

The total mined land acreages for the selected 18 pits were as follows, 61% (11) of the mine pits being between 0.5 to 2.5 acres, 28% (5) being between 2.6 to 4.5 acres, while 4.6 to 14.5 acres were 11% (2). This shows that a large area of production land is degraded and the land quality, in terms of productivity, is adversely affected. Mining is bereft with its own problems and challenges. The "footprints" it usually leaves behind are tremendous especially when it is not managed well because,badly managed impacts of mining on the environment or the social fabrics of society can reflect negatively on economic parameters countrywide" (World Bank & International Finance Corporation, 2002). Resulted from mining operations it is noted that most of "these communities have been victims of air and water pollution as well as other forms of environmental degradation resulting" (Akabzaa and Darimani, 2001). Mining can therefore have "decisive impact on the communities in which or near which the mines are located" (Anyemedu, 1992 cited in Akabzaa and Darimani, 2001).

4.3.2 Murrum Extraction volume

The extraction volume for mining material was done for murrum mining. According to the Kenya Rural Roads Field Dataity (KERRA), the total length of road network is 1683.35km in all the constituencies. From field observations and the information from KERRA, murrum is the main raw material used in roads construction. There is continuous need for murrum, for construction and rehabilitation of roads in the county. The extraction volume can be determined from the calculation below as adopted from the Kenya Rural Roads Field Dataity's Roads design manual (1987).

Total road network in Kakamega County is 1683.35km

Gravel per Km = 1000 x 0.15 m (murrum layer) x 6 m (width of the road) = 900m^3

900 x 1683.35 ≈ 1, 515, 015 m^3

This is the amount of murrum that has been extracted to build and rehabilitate roads in Kakamega County. The need for murrum is continuously increasing with the new roads being created and rehabilitated, as well as other construction activities. A key informant a construction company pointed that;

> We know that extraction of murrum has bad impacts on the environment, but given that there is lack of alternative material and increasing demands for construction activities we have no option

This shows that the exploitation and destruction of land is not to end any time soon as long as life has to go on. These construction activities require very large amounts of murrum leaving open mine pits deep down the land. According to the Key informant form the mining and geological departments, the restoration strategies adopted by these companies are not practical and therefore these areas end up being unproductive and very dangerous to both people and animals.

4.4 Level of environmental degradation due to mining

The level of degradation in this study was measured by indications observed at mining areas. This included land bareness, root exposure and land clearing. Kiluta, (2005) indicates that mining is a major economic activity in many developing countries and those operations whether small or large-scale, are inherently disruptive to the environment. He states that the environmental deterioration caused by mining occurs mainly as a result of inappropriate and wasteful working practices and rehabilitation measures. Mining has a number of common stages or activities, each of which has potentially – adverse impacts. The impacts range from the natural environment, society and cultural heritage, the health and safety of mine workers, and community based in close proximity to operations.

The research sought to bring out the indicators of degraded environment in Kakamega County. Figure 4.5 shows the indicators reported by the residents of the areas around the mine pits. Loss of vegetation as reported by 45% (75) of the respondents was one of the main indicators of degraded land. Interestingly, 20% (33) respondents compared their agricultural yield before and after mining, and reported that their poor agricultural yield was an indicator of degraded land, caused by poor mining activities.

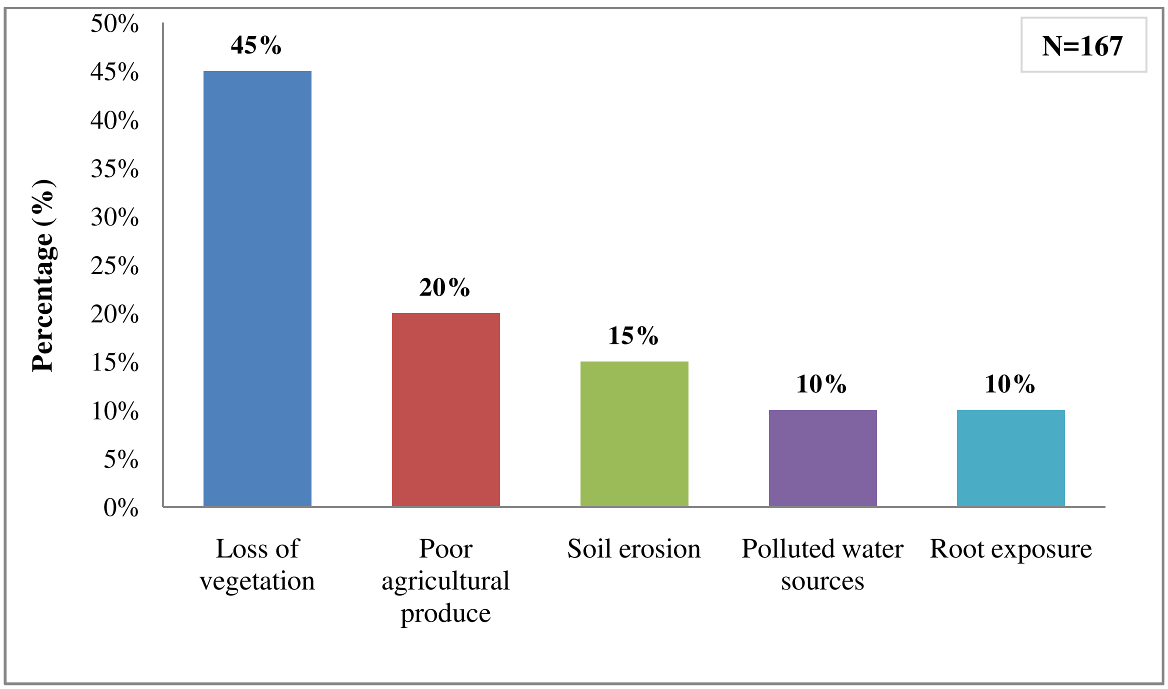

Figure 4. 13: Indicators of degraded environment in Kakamega County, Kenya

Source; Field Data (2015)

Soil erosion was reported as an indicator of land degradation as reported by 15% (25), contamination of water bodies and root exposure at 10% (17) each, was also an indicator of degraded land.

One of the FGD respondents;

> In our years, agriculture was very productive and many people depended on it for food and income. But since the excavation for gold and murrum became more serious, more farming land has been taken from us by rich people so that they can mine. This has ended up affecting farming areas and agriculture seems to be dying, and land degrading very fast.

4.4.1 Degradation of water bodies

Sand and gravel have been used in the construction of roads and buildings in the County. The demand for sand and gravel continues to increase (Isaac *et al.* 2015). Residents reported that sand mining from the rivers is of great demand due to its purity and is very inexpensive in that it doesn't require a lot of sieving. Excessive in stream sand-and-gravel mining has caused the degradation of rivers in the County. The banks of Isasala, Iguhu and Isiukhu rivers have been highly degraded, endangering the farming activities along riparian zones.

The key informants from Kakamega County environmental committee indicated that sand mining had led to environmental degradation up to a level where various hazards had come in. Respondents reported that sand mining activities have resulted in the following effects as shown in the Table 4.2. These are frequent flush flood, erosion of river banks and river pollution as reported by 25%, 30% and 45% respondents respectively.

Effects of sand harvesting	Percentage (%)
River pollution	45%
Erosion of river banks	30%
Frequent flush floods	25%

Source; Field Data (2015)

From the observation, severe sand mining has led to encroachment of river banks. Most rivers in the region, like river shatsala, had severely eroded banks, but still sand mining was at its heights, and not showing any signs of ending soon. This agrees with NEMA (2007) findings which state that in Kakamega County, quarrying and sand harvesting activities have increased as noted by great demand on materials for construction and thus interfered with the natural environment.

Plate 4. 2: Sand harvesting at a section of shatsala River, Kakamega County, Kenya.

Source: Field data, 2015

In an FGD, a respondent pointed out that:

> Very soon, our rivers will not have bridges because of weak banks. In some of the rivers, bridges have been carried away, but we are not going to stop harvesting sand because it is the only source of livelihood.

Sand-and-gravel mining in stream channels can damage public and private property. Channel incision caused by gravel mining can undermine bridge piers and expose buried pipelines and other infrastructure. Several studies, (Mahandara, 2009, Roe, 1997 and Richling, 2000) have documented the bed degradation caused by the two general forms of in stream mining: (1) pit excavation and (2) bar skimming. Bed degradation, also known as channel incision, occurs through two primary processes: (1) head cutting, and (2)"hungry" water. In head cutting, excavation of a mining pit in the active channel lowers the stream bed, creating a nick point that locally steepens channel slope and increases flow energy. During high flows, a nick point becomes a location of bed erosion that gradually moves upstream.

The report by the IRIN (2012), reported that, daily, 180 trucks remove sand from the banks of a river near Lake Victoria their cargo fuels Kenya's construction boom and the local labor market, but the extraction could spell disaster for the village of Nyadorera. Government officials told IRIN that sand harvesting along the banks of River Nzoia, the biggest source of income for many of the area's residents, risks displacing some 7,000 people. Some of the most notable negative environmental effects of sand harvesting include the drying of aquifers, riverbank and riverbed erosion, water and air pollution, and the loss of valuable trees and animal species (Shilaro, 2000). Many people along River Nzoia have had their crops swept away by flood waters, raising fears of food insecurity.

4.4.2 Deforestation

This subsection deals with the changes in vegetation parameters, such as density and composition within the entire study area and a detail survey of those within the mined area. Mining is generally very destructive to the environment. It is one of the main causes of deforestation. In order to mine, trees and vegetation are cleared and burned. With the ground completely bare, large scale mining operations use huge bulldozers and excavators to extract the metals and minerals from the soil. In order to amalgamate (cluster) the extractions, they use chemicals such as cyanide, mercury, or methyl mercury. These chemicals go through tailings (pipes) and are often discharged into rivers, streams, bays, and oceans. This pollution contaminates all living organisms within the body of water and ultimately the people who depend on the fish for their main source of protein and their economic livelihood, Kricher, (1997).

The study sees land degradation as an output of the mining. Land degradation such as loss in vegetation cover, changes on the landscape is therefore seen as the reaction of the mining to environmental demands and pressures. Land degradation which includes degradation of vegetation and soil has been identified as a major problem in Africa, according to FAO, (2014). From the foregoing therefore, the systems theory sees land degradation as the output of the mining.

Table 4. 5: Showing tree and grass density in Kakamega County Kenya

Name of mining area	Tree density of unmined area	Shrub density of unmined area	Tree density of mined mined area	Shrub density of mined area
Buliba quarry	40	5	4	0
Eshisiru	34	12	3	1
Muranda	12	7	2	0
Ivakala	42	12	0	4
Rosterman	52	12	0	3
Eshangwe	40	17	2	1
Kambi ya mwanza	30	6	4	3
Samitsi	56	13	2	0
Nambacha	80	11	3	0
Ejinja	54	10	2	0
Luanda	50	15	0	2
Mayoni	48	23	2	1
Likuyani	50	18	0	1
Matete	20	5	2	0
Mufunga	10	2	2	7
Shianda	24	5	1	0
Marenjo	12	2	1	0
Mushichibulu	6	1	3	1
Total	660	176	33	24
Density ratio		Unmined site	Mined site	Ratio
Trees		660	33	20:1
Shrubs		176	24	7:1

Source: Field Data (2015)

The study revealed that the mining has adversely affected population of trees and grass species found in the area, because of clearing of site for mining. The decline in the tree density particularly in the mined sites has been attributed to cutting down of trees to give way for the mining. The population of trees has been reduced due to mining. At times mining activities around has had effect on the trees where they eventually fall down due to lack of support from surrounding area which has hitherto affected tree population. The result also shows that there are less shrubs on the degraded surface compared to the relatively undisturbed (unmined) area in Kakamega County. There are seven times trees in the unmined than the mined sites; the same thing applies to shrubs where they are two times more in the unmined than in the mined sites. This can be witnessed in the Plate 4.3 below as obtained from the field.

Plate 4. 3: Degraded land due to murrum mining in Eshisiru Kakamega County, Kenya.

Source; Field Data (2015)

4.4.3 Depletion of grazing lands

The respondents reported that the conversion of the land for mining has affected their grazing areas, wood sources for fuel because, before the commencement of the mining, some sites were used for farm lands and animals grazing; but due to the mining the presence of big stones, have hitherto forced the inhabitants and farmers to abandon the land due to hazards to lives. Observation revealed that most of the pits would increase in size during rainy seasons. Therefore, it has now become difficult for people to move around freely because of the scattered pits around the mined areas. See Plate 4.4 below.

Plate 4.4: A section of Abandoned mine pit on Buliba farm

Source; Field Data (2015)

The inhabitants do not like the environment as it is now but said they cannot work on reclamation because it will not fetch them any cash that is to say it has no economic benefits. Table 4.3 shows the distribution of the depth of selected pits in the area.

Table 4. 6: Mine pits and depth distribution in Kakamega County, Kenya

Name of mining area	Depth in metres
Buliba quarry	6
Eshisiru	0.9
Muranda	0.9
Ivakala	2.9
Rosterman	>6
Eshangwe	4.9
Kambi ya mwanza	2.9
Samitsi	56
Nambacha	2.9
Ejinja	4.9
Luanda	2.9
Mayoni	3.9
Likuyani	4.9
Matete	0.9
Mugunga	4.9
Shianda	3.9
Marenyo	3.9
Mushichibulu	6

Source: Filed research, 2015

The study has revealed that mining has devastated and brought about life threatening changes on the landscape, with scattered pits, loss in vegetation cover. The study agrees with the findings of Mohammed (1996), that the mining has been largely responsible for changes in the landscape pattern over the years. The findings further reveal that there are obstruction of stream channels characterized by blockage of passage ways due to deposit of residue and debris from dug pits which are being dug further to extract diatomite use for painting in building work.

Summary

Land degradation due to mining was examined. The study showed that mining has resulted into land degradation in the area. The pits which are further dug to extract building materials and the overburden dumps are indicators of land disturbance in areas affected. Vegetation cover has reduced as a result of deforestation, which has in turn led to the exposure of the soil surface, which in some cases has initiated gully erosion and has expanded the cuts. There is also poor farm output due to mining and depletion of grazing lands too.

4.5 Community attitudes towards mine pit risks and their restoration

This section presents the findings on community attitude towards mine pits and their restoration strategies. It looks at how the community perceives the mining activity as whole and the impacts of the abandoned mine pits in their areas. The chapter therefore determines this by assessing the respondents' views and in this case, the respondents are the community members, who own, work or are neighbors to the mine pits, and are therefore affected directly by the impacts of mining activities.

4.5.1 Site of mine pits

Respondents view mine pits as ugly features which inconvenience their operations within the environment. Mine pits inconvenience economic activities such as farming, grazing and road networks. Respondents were asked to describe the land scape around natural mine pits in the community.

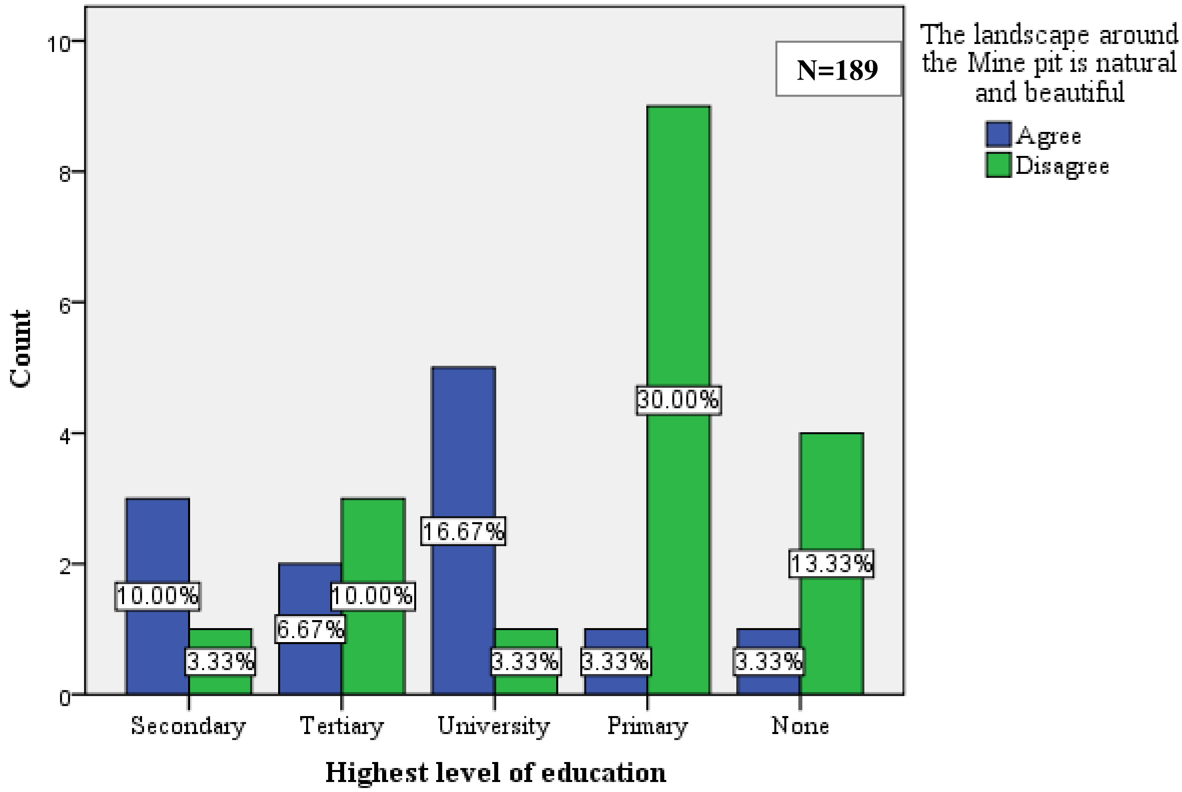

Figure 4. 14: The nature of land scape in Kakamega County, Kenya

Source: Field data, 2015

The data was cross tabulated to find various reactions from respondents based on the level of education. The results indicated that 30% (58) and 13% (22) respondents who had only attained primary education and those that had not attained formal education, disagreed that landscapes around mine pits in the community are natural and beautiful. However, some positive response that these mine pits were natural and beautiful were seen from the community members 16% (30) who had attained university education.

Chi-square test conducted Pearson Chi-Square value ($\chi^2_{3,0.01} = 10.530$) showed that there was highly significant (P<0.05) association between the level of education and the attitude of the community towards the mine pits. This is evident in the trend displayed in the results in Figure 4.6 where the positive attitude towards mine pits is slowly rising with the rise in the level of education. This indicates that as the community gets more educated, they can change their attitudes towards abandoned mine pits and help each other in converting the mine pits into some lucrative features.

Generally, it can be concluded that a great percentage of the population haven't gained formal education and still find mine pit to have no benefit other than endangering their lives and livelihoods. A taskforce constituted to look into the management of quarrying activities in Kenya to establish reasons for various quarry disasters identified among other issue encroachment into ecologically fragile environment, water ponding in quarry pits, undercutting of cliffs, negative landscape effects due to presence of abandoned quarries, pits and heaps of quarry wastes (MEMR, 2010). Mining disrupts the aesthetics of the landscape and disrupts along with it soil components such as soil horizons and structure, soil microbe populations and nutrients cycles which are crucial for sustaining a healthy ecosystem. Kariuki (2002) concurs that mining operations often involves cutting the land surface and moving the earth to other locations as waste materials. That this affects the natural topography and scenic beauty as well as removing the surface vegetation which affects the ecosystem, thereby disturbing the balances of nature. That explosives used to blast rocks leads to distortion of landscape into scarred, disfigured and very different from the original state. This facilitates soil erosion through erosion agents such as wind and run-off water.

The environment experiences a lot of problems as a result of mining, landforms, landscape, vegetation are all affected therefore land cover meets a fundamental attention in studies of landscape changes Richling *et al.* (2000). It is evident that all mining activities leads to one problem or the other, causing diverse kinds of disruption to the environment.

4.5.2 Risks caused by mine pits

Respondents indicated that mine pits had become a nuisance, and had reported about the issue to the Field Dataities in the region. The questionnaire schedule from the respondents neighboring mine pits indicated that 58% (119) of the respondents found mine pits a nuisance to the community, as shown in the Figure 4.8 below.

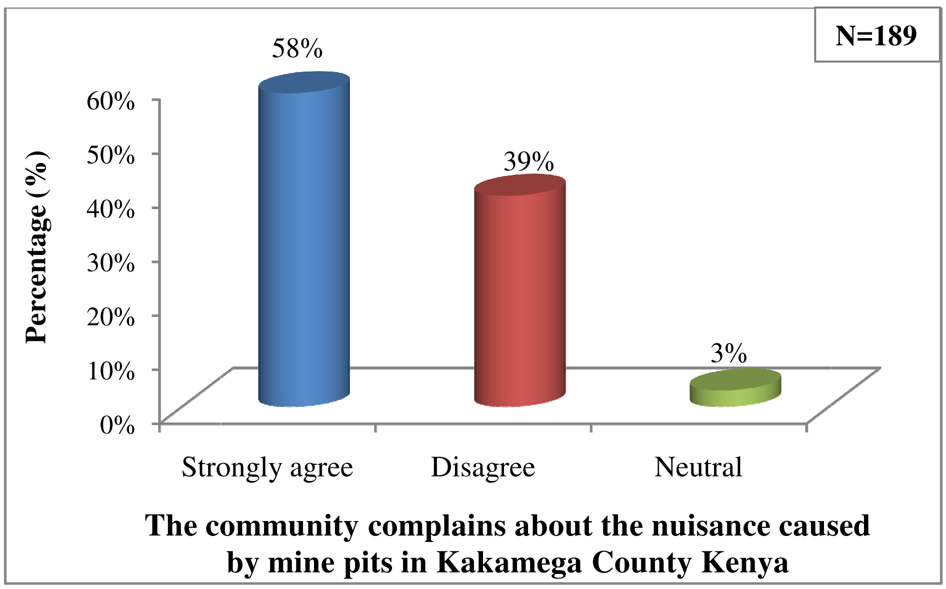

Figure 4. 15: Community attitudes towards mine pits in Kakamega County, Kenya

Source: Field data, 2015

They also termed mine pits as sources of hazards in the community. In a Fucus group discussion, one community member indicated that:

> Mine pits are becoming a nuisance. They are found everywhere and there are no grazing lands, no lands for farming and even building for our children. If this goes on we will live in a hole, there are so many open pits which injure both people and animals

According to the community members, some of the hazardous situations brought about by mine pits in their areas. As depicted in Figure 4.9 below, 68% (129) view mine pits as hazards to the community.

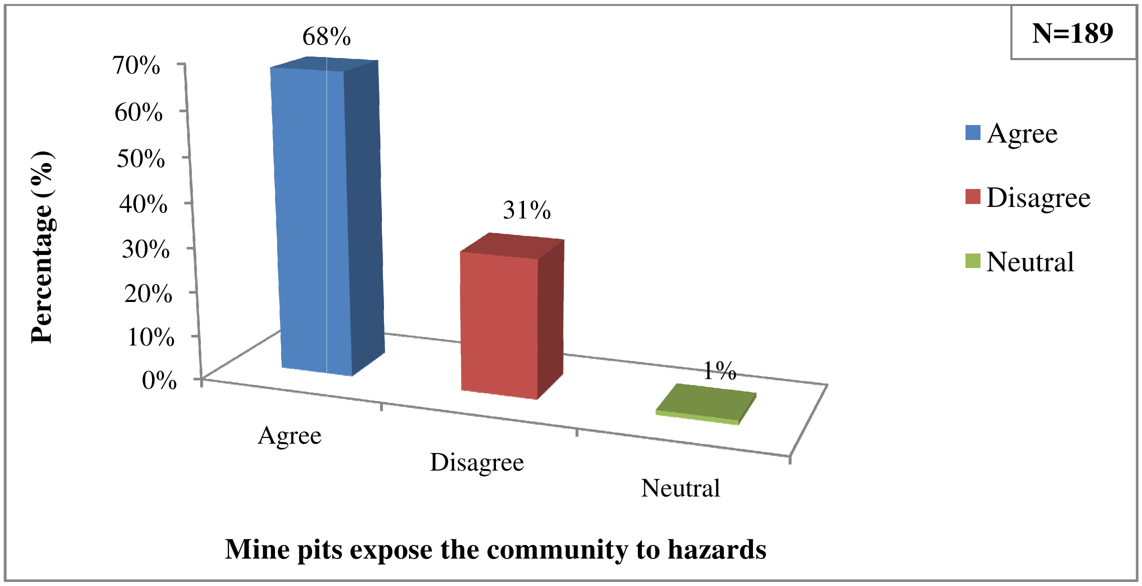

Figure 4. 16: Nature of mine pit to the Community in Kakamega, County Kenya

Source: Field data, 2015

The results show that 68% (129) respondents agreed that abandoned open mine pits expose the community to hazards, while 31% (59) responded that the abandoned mine pits were not exposing the community to hazards. In FGD with the community, it came out that some abandoned mine pit were used as "dams" to hold water for animals in grazing areas.

Respondents were asked to state some of the hazardous situation caused by the mine pits and the results are as indicated in the Figure 4.10 below.

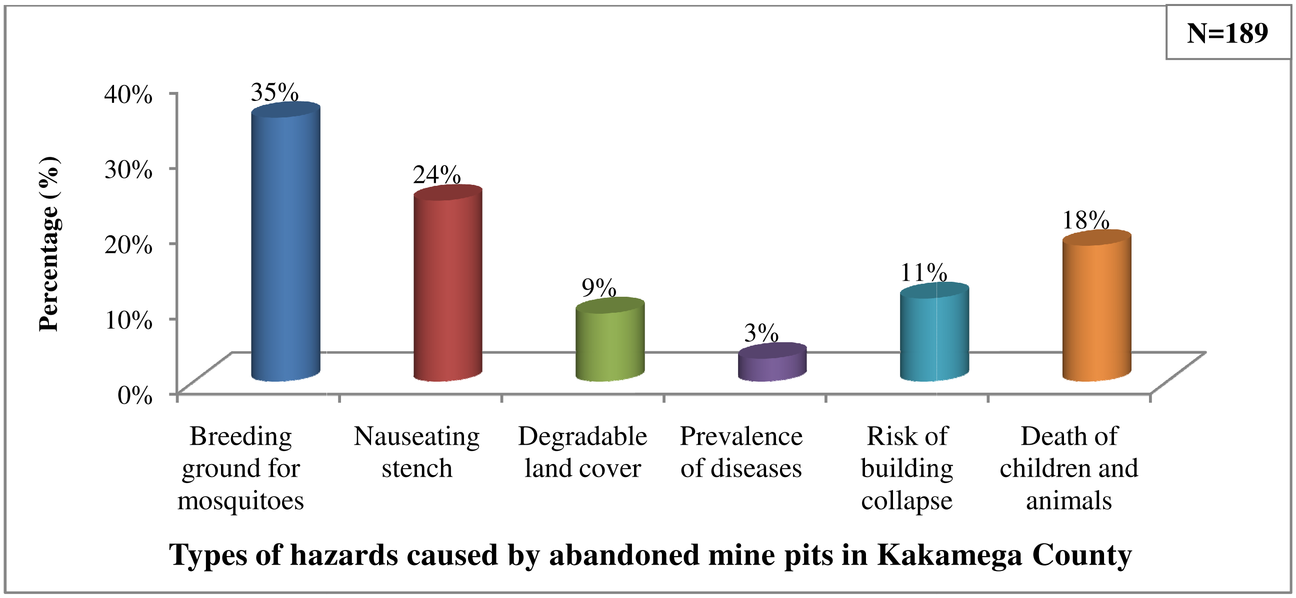

Figure 4. 17: Hazards caused by abandoned mine pits in Kakamega County Kenya

Source: Field data, 2015

The Figure 4.10 above shows the responses of respondents on the hazards of abandoned mine sites on the community and environment. The results indicate that, mine pits are breeding ground for mosquitoes 35% (66). The water in the sites remains stagnant as the place is just around the precinct of residential properties with no water flowing into or out of it, mosquitoes are breeding in the area and the resultant consequences of this may be a high rate of malaria fever in the area. Malaria fever is a major challenge in Kakamega County, Global Times (2015) following the recent outbreak, that lead to massive loss of lives. This is indicated by prevalence of sickness and disease as indicated by 3% (6) of the respondents. Stagnant water can also lead to a negative effect of awful smell in the surrounding areas. This is as depicted in the findings by 24% (45) of the respondents.

Abandoned mine pits are death traps for small children who play around it and also animals which are grazed around such areas, mine pits have become part of the externalities in this neighborhood, hence, children in the course of play, hover around these sites and ones they fall into it without the knowledge of adults they may lose their lives before it is known, as indicated by 18% (34).

These open mine pits are harmful to the wellbeing of residents in the study area because of the negative effect of other unwanted minerals that are extracted with other useful minerals especially in the Gold mines in the county. The study of Ngyang (2007) and Gyang and Ashano (2010) found that these minerals have terrible health implication and could cause death of people.

Another common hazard, ranked fifth at a means core of 11% (21), caused by mine pits in Kakamega County in Kenya is collapse of building. The key informant from the ministry of mining indicated that:

> Gold mining lead into an extensive excavation of the ground, and this has weakened the ground to a state where areas around rosterman village in Kakamega County, which affects up to the Kakamega municipality, cannot hold very heavy structures like very tall storey buildings.

This concurs with Kiluta (2005) that mining activities in most developing countries is not done with sustainability in view; this has left environment in a terrible devastated condition after the activity.

To this end one should understand that no mining ever took place without leaving a scar on the environment, and therefore the community attitude towards mine pits is negative as observed also by Dan‟azumi (1986), this further agrees with Bukar (1997) where it states that the mining and extraction of the gypsum causes varying degrees of landscape devastation characterized by mounds of dumps heaps and ubiquitous open pits.

Plate 4.5: Dwellings places around a mine pit in Rosterman, Kakamega County, Kenya

Source: Field data, 2015

The plate 4.5 above shows the distance between properties and an abandoned open mine pits which has over the years been widened due to neglect. The FGD with community members revealed that these open mine pits widen, especially during rainy seasons where the banks are broken and eroded.

4.6 Community attitudes towards mine pit restoration

This section contains the discussion on the attitudes of the community members on the restoration of mine pits.

4.6.1 Community participation in risk reduction in the mine pits

The respondents were asked if the warning and safety signs around the mine pits have reduced the accidents in the area. The analysis indicates that 52% (98) respondents disagreed that the warning signs around the mine pits have reduced the accidents.

Figure 4. 18: Safety warning signs at mine pit site, in Kakamega County, Kenya

Source: Field data, 2015

This shows that respondents are not satisfied with the current risk reduction methods used to mitigate the rate at which the community members are susceptible to hazards that are likely to be brought about by mine pits. The negative attitude is also depicted among the community members, when they were asked whether they ensure that the fences and warning signs around mine pits are not destroyed.

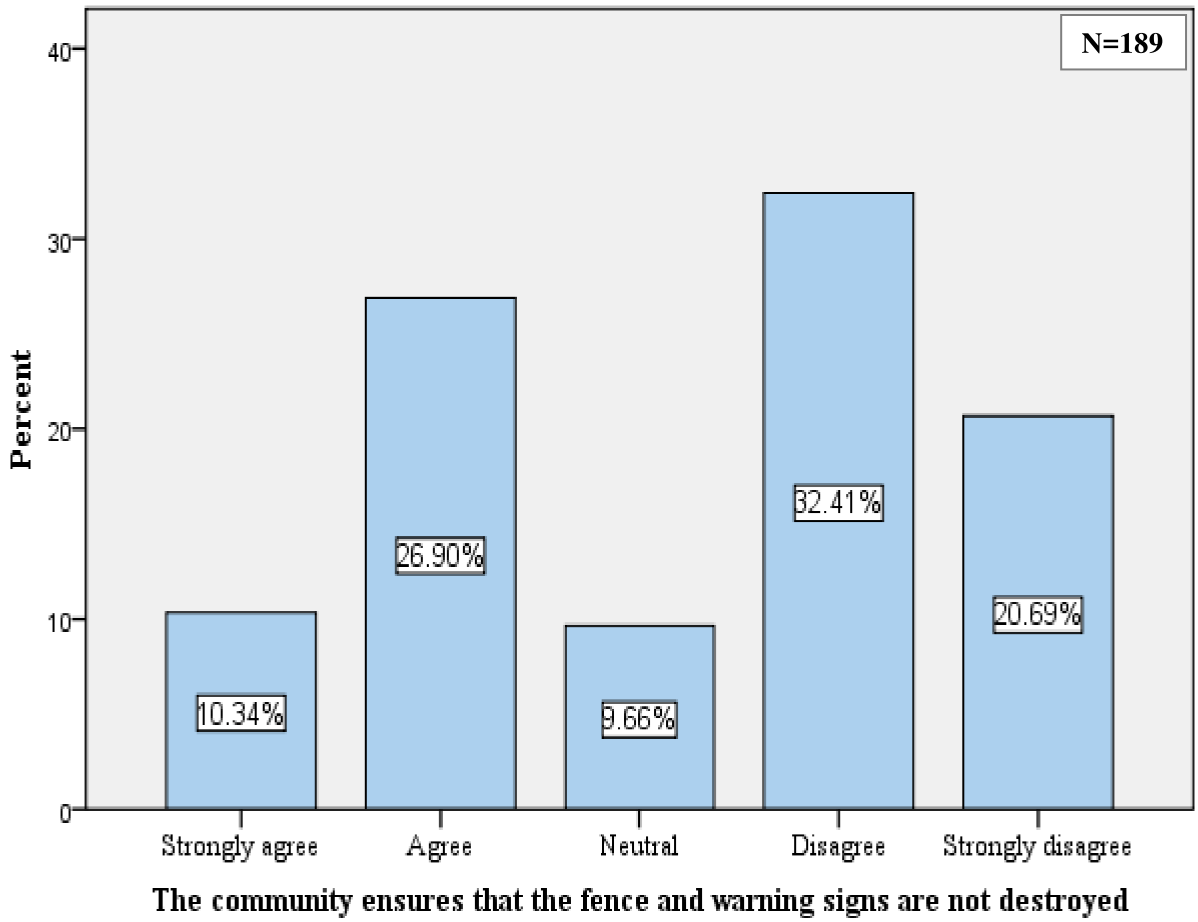

Figure 4. 19: Maintenance of safety signs around abandoned mine pits sites

Source: Field data, 2015

The analysis shows that 53% (100) of the community members do not participate in protecting the fences and signs around the mine pits. Poor community participation is also experience when the respondents were asked about their participation in tree planting to restore mine pits. The results were cross tabulated and results are as indicated in Figure 4.13.

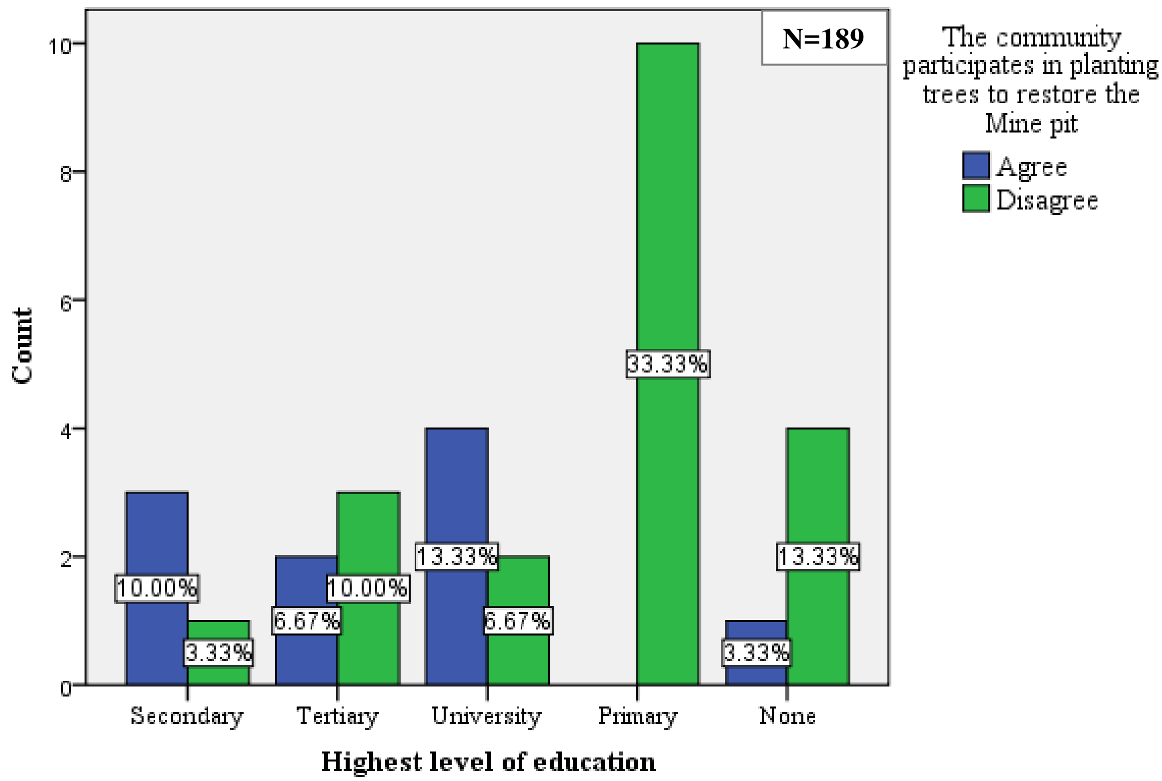

Figure 4. 20: Community participation in restoration mine pits

Source: Field data, 2015

The analysis results show that community participation in planting tree to restore mine pits rise with the trend of community education level. Figure 4.13 shows that 33% (62) who had only primary education and 13% (25) who had not attained any formal education, least participate in mine restoration. However, 43% (87) showed some level of participation although it was not fair enough. The highest level of participation was mainly seen in only 13% (11) respondents who had attained university education.

The chi square conducted with Pearson Chi-Square value ($\chi^2_{4,0.01} = 11.625$) showed that there was highly significant (P<0.05) association between the community participation in restoration of mine pits and the level of respondents' education. Community participation is a very important aspect when it comes to risk reduction measures. Therefore, lack of community participation is a big challenge that clearly depicts the negative attitude of the respondents towards the restoration measures employed in mine pits.

Summary

It is clear that the community in the Kakamega County has a negative attitude towards mine pits, as a result of the risks they pose to them. Mine pits have been expressed as sources of diseases like malaria. They are also known to cause bad smell because of the stagnant water. Mine pits have also led to death of people and animals. The restoration strategies are not also satisfying to the community in Kakamega County. The negative attitude comes in clearly when the community participation in mine pits restoration is poor.

4.7 Current restoration strategies on mine pits

Land is an important resource on which human beings depend. The rate of consumption of mineral resources is increasing with the advancement of science and technology, economic development, industrial expansion, acceleration of urbanization and growth of population. Growth of our society and civilization thus heavily rely upon the mining industry to operate and maintain comfort. The end result for mining activities on the surface is mining wastes and alteration of land forms which is a concern to the society and it is desired that the pristine conditions are restored. Mine wasteland generally comprises the bare stripped area, loose soil piles, waste rock and overburden surfaces, subsided land areas, other degraded land by mining facilities, among which the waste rocks often pose extreme stressful conditions for restoration.

The mining disrupts the aesthetics of the landscape along with it disrupts soil components such as soil horizons and structure, soil microbe populations, and nutrient cycles those are crucial for sustaining a healthy ecosystem and hence results in the destruction of existing vegetation and soil profile (Kundu and Ghose, 1997). This chapter focuses on the findings of research on the restoration strategies of mine pits in Kakamega County by assessing vegetation of mined areas, making mine pits desirable and attractive and removing wastes in mine pits.

4.8 Mine pits restoration strategies

This section will assess the current mine pits restoration strategies in Kakamega County.

4.8.1 Site leveling (backfilling)

To the extent possible, mine spoils need to be leveled or terraced in order to provide suitable substratum. Leveling will vary according to the type of mine, methods of mining and the way in which a particular area has been worked. For instance, in case of surface and opencast mines the procedures will be leveling and fencing of the area.

In case of shaft and underground mines although overburden can be treated in similar fashion but mined out areas and abandoned mines will have to have different strategy depending upon the context. Mined out areas in hillside slopes may require contour dikes. Leveling will provide a base of coarse material over which to spread sediment. Some of the large mining pits that have developed into reservoirs can be developed as water-bodies aesthetically appealing for ecotourism and simultaneous fish culture to support local livelihoods. Pandey *et al. (*2005).

The researcher observed that backfilling and grading of mine pits had been dismally done. Only 7% (1) of the 18 mine pits observed had been backfilled, while the remaining 93% (17) of the mine pits were not backfilled refer to Figure 4.13. This implies that backfilling as a restoration strategy for mine pits, has been dismally carried out in Kakamega County Kenya.

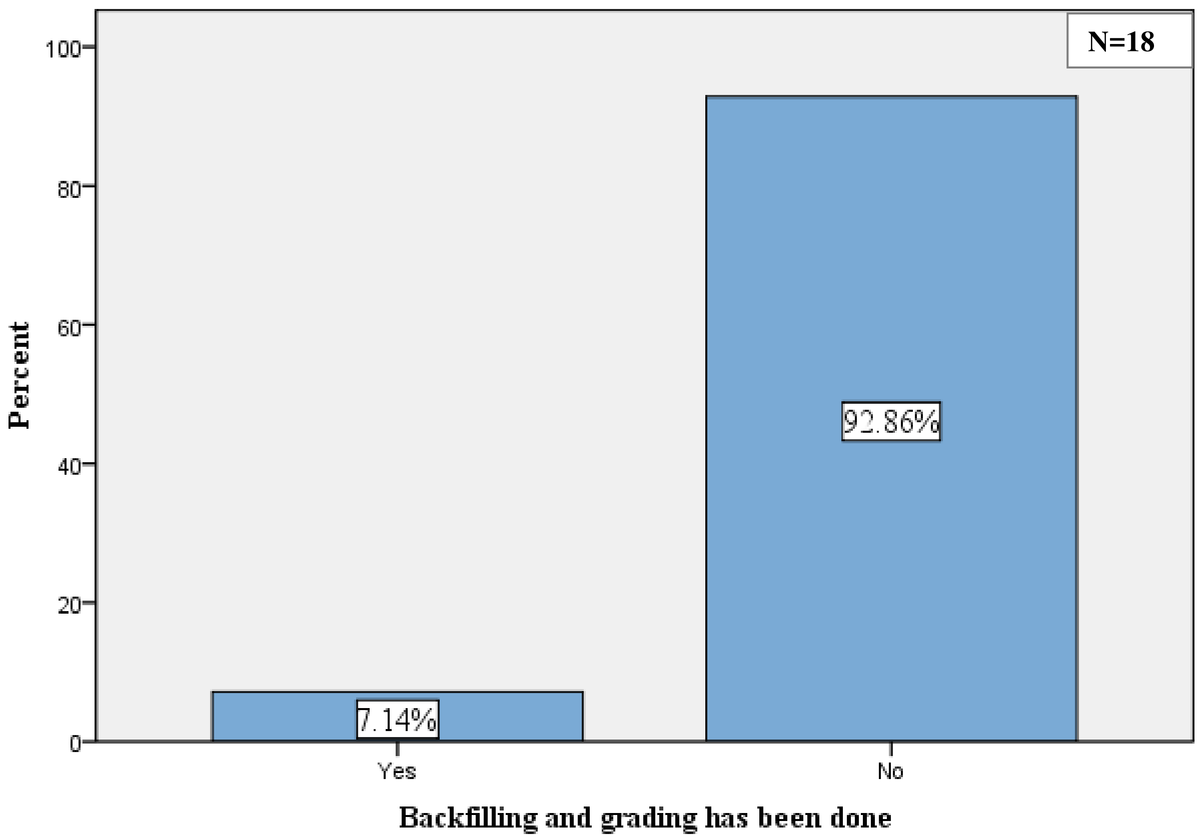

Figure 4. 21: Backfilling and grading of mine pits in Kakamega County, Kenya

Source: Field data, 2015

4.8.2 Direct seeding

Direct seeding of native species has been found to be is a useful and cost-effective restoration method globally (Camargo *et al.* 2002, Parrotta *et al.* 1997, Parrotta and Knowles 1999, Pandey 1996, Singh *et al.* 2004).

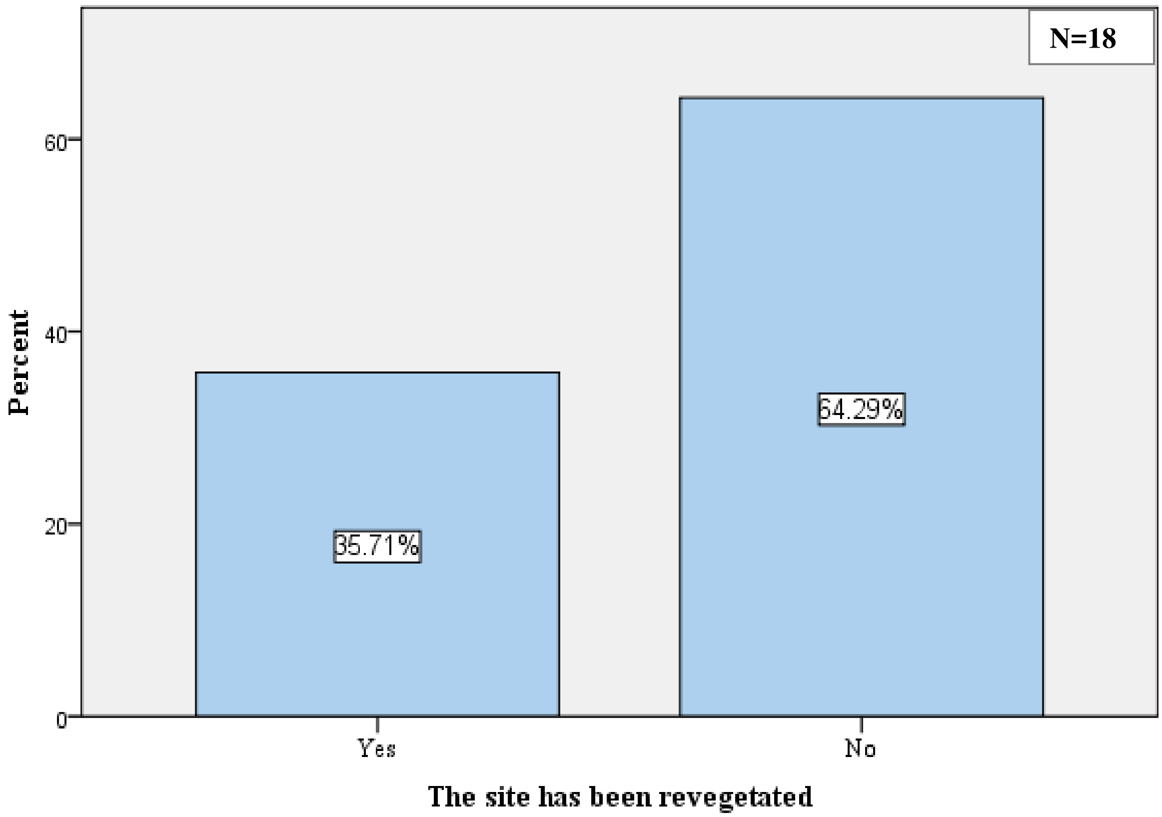

Figure 4. 22: Vegetation of mine pits in Kakamega County, Kenya

Source: Field data, 2015

It was observed that revegetation had not been practiced and acknowledged by the communities around the mine pits. It was observed that 54% (12) of the mine pits had been revegetated while 36% (6) had not been vegetated. The observation went further to identify the type of vegetation planted in the mine pits areas. The Figure 4.16 below shows the type of trees planted around the mine pits for purposes of restoration.

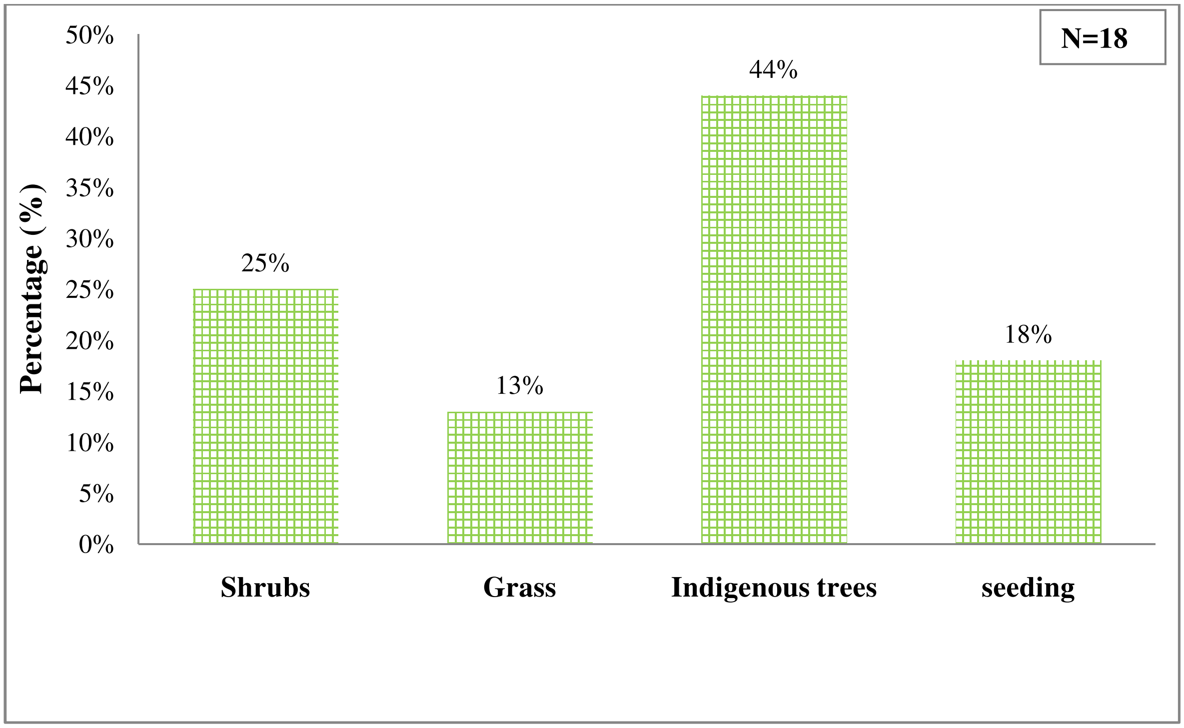

Figure 4. 23: Types of vegetation revegetated in mined areas in Kakamega county Kenya

Source: Field data, 2015

Production of seedlings in the forest nursery requires large inputs in terms of time and money. The expense can be reduced, by choosing a direct sowing method. Direct sowing is also comparatively easier in term of maintaining the proper proportion of species. It can be combined with planting and natural regeneration. Direct sowing helps in enhancing biodiversity per unit area, perhaps because it accelerates natural plant succession processes, as the ground cover created by newly germinated seeds acts as a nurse crop and can trap air-borne seeds from the vicinity (Jha *et al.* 2000; Jha and Singh 1993).

Direct sowing requires simple 12 Mine Spoil Restoration: A strategy combining rainwater harvesting and adaptation to random recurrence of droughts in Rajasthan technique for in situ collection of rainwater with the help of suitable soil work such as trenches and saucers. Thus, multi-tier vegetation (i.e. vegetation assemblage layers of herbs, shrubs and trees with differential height profiles) can be effectively developed (Pandey, 1996).

4.9 Financial Resources for Restoration

Dredging and transport of sediment and subsequent use for restoration is a costly affair. The society and the relevant organizations have very limited options: either keeping mine lands derelict and ponds ruined, or enhancing productivity through restoration and revival. The research conducted on the key informant reported that the financial resources are available for restoration of mine pits. But from the observation, the restored mine pits are hardly visible in the county.

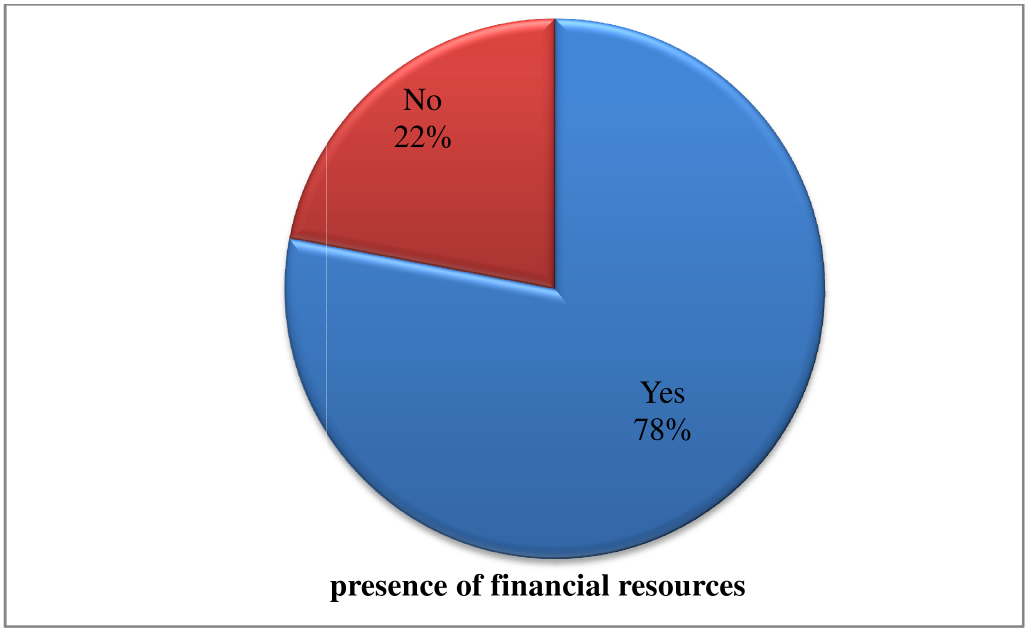

Figure 4. 24: Availability of Financial resources for restoration in Kakamega County, Kenya

Source: Field data, 2015

The assessment of the Key informant responses indicated that the availability of financial resources for mine pits restoration was up to 78%, although these allocations end up being misused or channeled into the other uses for lack of financial security.

In the year 1986 an economic analysis showed that costs for reclaiming mining overburden were INR 66000/ha (Soni and Vasistha 1986). The high costs, however, should not be surprising as a recent global analysis notes that annual cost in some cases can be as high as US$ 1 million per km2 in programmes that require restoration to recover conservation value (Balmford *et al.* 2003). A key informant from the county environmental committee pointed that the resources can be mobilized by three stakeholder-departments: Mines, Water/Irrigation and Forest. Finances for silt removal can be mobilized from the ongoing efforts of the government for promotion of rainwater harvesting. Transport and spreading of sediment and protective fencing of the restoration areas can be financed by Department of Mines in collaboration with mine owners. Forest Department may provide technical guidance and genetic resource (seeds, vegetative cuttings, plants).

4.10 Summary

Reclamation is an essential part in developing mineral resources in accordance with the principles of ecologically sustainable development. The goal of surface mine reclamation is to restore the ecological integrity of disturbed areas.

Revegetation constitutes the most widely accepted and useful way of reclamation of mine spoils to reduce erosion and protect soils against degradation. The revegetation must be carried out with the plants selected on the basis of their ability to survive and regenerate in the local environment, and on their ability to stabilize the soil structure. Revegetation facilitates the development of N-fixing bacteria and mycorrhizal association, which are fundamental for maintaining the soil quality by mediating the processes of organic matter turnover and nutrient cycling.

Most of the mine pits in Kakamega County are not restored, and the mine extraction is evidently higher than the restoration of mined sites. Grazing sites have been interfered with by reducing the pasture cover.

SUMMARY, CONCLUSION AND RECOMMENDATION

This chapter will give the summary, conclusion and recommendation of this study. This section is derived from the findings of all the three objectives used in this study.

5.1 Summary of the findings

From the findings, Kakamega County was hub of mining activities since the early 1930s. The mining activities were initiated by colonialists before the locals took over. The types of mining carried out in Kakamega County are sand harvesting 22% (37) along major rivers and flood plains, Gold mining 26% (38) in Ikolomani constituency, soil mining for bricks and pottery, 20% (14). All these mining activities have had several degrading consequences on the environment to the extent of leading to soil erosion, poor agricultural yields and depletion of grazing lands.

The communities in Kakamega County have developed a negative attitude towards mine pits in the region given that some of them have been abandoned since the colonial periods, which have ended up being a hazard, to life of animals and human beings, breeding places for mosquitoes, which to some extent, has resulted to malaria epidemic in Kakamega County.

The study found out that out of the 18 mine-pits selected for the study, 93% (17) had not been backfilled. There is very minimal community participation in tree planting around mine pits, misuse of funds allocated for restoration and poor security for the planted trees for restoration. Grazing of livestock around the mine pits also exacerbated the degradation process, putting the success of restoration of these degraded lands on question.

5.2 Conclusion

The first objective for this study was to establish types of abandoned mines and their contribution to degradation of surrounding environment. The study found out that there were many abandoned mine pits in Kakamega County, ranging from; gold mined sites, quarry sites, murrum sites and soil mined areas. These mining activities had many impacts on the environment. It was found out that abandoned mine pits was the major cause of pollution of water bodies. The community attributed the prevalence of malaria to the abandoned mine pits, as they become breeding ground for mosquitoes. Abandoned mine pits was also found to trigger soil erosion and finally flooding events as a result of land bareness and weakened river banks resulted from sand harvesting.

The community in the study showed a negative attitude towards abandoned mine-pits. This was as a result of the hazard these mine-pits pose to them. Prevalence of water vector borne diseases, floods, soil erosion and reduced grazing areas are the main reasons for negative attitude. The strategies fronted by the respondents to restore mine-pits were; reforestation, placement of safety awareness signs, community involvement in restoration and fencing affected areas.

The available restoration strategies are site levelling and revegetation, although this is limited by financial resources availability, and the community willingness to participate.

This study found out that restoration of abandoned mine-pits throughout the county is not practiced. Most of the mine-pits are open and hazardous.

5.3 Recommendations

Mining activities will always be there as long as human beings live. There are various types of mining activities in various parts of the County. This study recommends that before any mining activities, a proper plan on restoration should be put in place and made aware to all the stakeholders. This will task the law enforcers to ensure that the restoration process after mining is adhered to.

The community attitude towards abandoned mine-pit hazards and disasters can be changed if the community is involved and even asked for "permission" before the mining process begins. They should have a comprehensive understanding on objectives of mining and post mining strategies.

Restoration strategies should be local people and leaders centered. The role of stakeholders such as local administrators should be well defined to ensure there is sustainable restoration of mined land in Kakamega County .

5.4 Suggestion for further research

It was observed that the mining activities were not legally controlled in the entire County. This research therefore suggests that the Government through its agencies should do a research to find out other mineable minerals and find out a more suitable platform on which mining in the region should take place without endangering people, animals and the environment.

This study finds it viable for a further research to be done, to find out the possibilities of the county Government to use the mined pits for waste recycling and production of manure, to reduce the danger these mine pits pose to the community around them.

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APPENDICES

Appendix 1: Research permit

CONDITIONS

1. **You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit**
2. **Government Officers will not be interviewed without prior appointment.**
3. **No questionnaire will be used unless it has been approved.**
4. **Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.**
5. **You are required to submit at least two(2) hard copies and one(1) soft copy of your final report.**
6. **The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice**

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No. A 7481

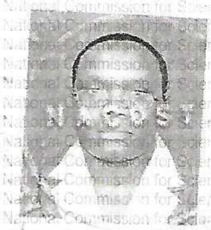
CONDITIONS: see back page

THIS IS TO CERTIFY THAT:
MS.RAMKAT RAEL JEPKEMBOI
of MASINDE MULIRO UNIVERSITY, 0-50135 khwisero,has been permitted to conduct research in *Kakamega County*

on the topic: *RESTORATION STRATEGIES AND COMMUNITY ATTITUDES TOWARDS MINE PITS IN KAKAMEGA COUNTY,KENYA*

for the period ending:
9th December,2016

Permit No : NACOSTI/P/15/95509/8856
Date Of Issue : 9th December,2015
Fee Recieved :Ksh 1,000



Applicant's Signature

Director General
National Commission for Science, Technology & Innovation

Appendix II: Research Authorization letter.

REPUBLIC OF KENYA

THE PRESIDENCY

MINISTRY OF INTERIOR & CO-ORDINATION OF NATIONAL GOVERNMENT

Telegrams
Telephone: 056-31131
Fax-056-31133
Email-cckakamega12@yahoo.com

COUNTY COMMISSIONER
KAKAMEGA COUNTY
P.O BOX 43-50100
KAKAMEGA

When replying please quote

DATE: 7TH APRIL, 2016

REF: ED.12/1/VOL.II/87

RAMKAT RAEL JEPKEMBOI
MASINDE MULIRO UNIVERSITY OF SCIENCE & TECHNOLOGY
P.O. BOX 190 - 50100
KAKAMEGA

RE: RESEARCH AUTHORIZATION

Following your authorization vide letter Ref: NACOSTI/P/15/95509/8856 dated 9th December, 2016 by National Commission of Science, Technology and Innovation to undertake research on ***"Restoration strategies and community attitudes towards mine pits in Kakamega County"*** for a period ending 9th December, 2016.

Iam pleased to inform you that you have been authorized to carry out the research on the same.

KANGETHE THUKU
COUNTY COMMISSIONER
KAKAMEGA COUNTY

COUNTY COMMISSIONER - KAKAMEGA Page 1

Appendix III: NACOSTI Research Field Dataization Letter

NACOSTI

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471,
2241349, 310571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/15/95509/8856**

Date:
9th December, 2015

Ramkat Rael Jepkemboi
Masinde Muliro University of Science
and Technology
P.O. Box 190 - 50100
KAKAMEGA.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Restoration strategies and community attitudes towards mine pits in Kakamega County, Kenya,"*** I am pleased to inform you that you have been authorized to undertake research in **Kakamega County** for a period ending **9th December, 2016.**

You are advised to report to **the County Commissioner and the County Director of Education, Kakamega County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

DR. S. K. LANGAT, OGW
FOR: DIRECTOR GENERAL/CEO

Copy to:

The County Commissioner
Kakamega County.

The County Director of Education
Kakamega County.

Appendix IV: Stakeholders Questionnaire

Introduction my name is Rael Ramkat, a student at Masinde Muliro University of Science and Technology doing a Master's Degree in Disaster Management and Sustainable Development. I am currently carrying out research on restoration strategies on mine pits in Kakamega County. You are invited to participate in this research by providing your views on restoration of Mine pits. Your contribution will help in completion of this study. Participation in this research is voluntary and your confidentiality will be preserved as the analysis will only focus on the patterns on the data over a number of respondents. The information you provide will only be used strictly for academic purposes. No names or information about any individual will be published.

(NB: Tick where applicable)

Name (optional) ______________________________

Organization ______________________________

Date of completion ______________________________

A Demographic Information

1. Gender: Male ☐ Female ☐
2. Age group 1. Below 18 years ☐ 2. 18-25 years ☐
   3. 26-35 year ☐ 4. 36-50 years ☐ 5. 50+ years ☐

3. Highest level of Education
   1. No schooling ☐ 2. Primary Level ☐ Secondary Level ☐
   4. Tertiary level ☐ 5. University level ☐

4. Occupation
   1. Unemployed ☐ 2. Self employed ☐
   2. Formal employment ☐ 4. Others ☐

1 Kindly list down the various types of mines you know

-------------------------- ------------------------------ -----------------------------

-------------------------- ------------------------------ -----------------------------

2 Are you aware of murram or Gold mining taking place in this county

Yes ☐ No ☐

3 Are you aware of any environmental problems caused due to Gold or murrammining

Yes ☐ No ☐

4a Are you aware of any restoration strategies against the environmental problems

Yes ☐ No ☐

b) If yes kindly list the restoration strategies ____

____

____

5a. Are these restoration strategies sustainable

Yes ☐ No ☐

6. If answer to Q 5 is No. kindly suggest sustainable restoration strategies

____

____

7. Are the slopes in the mine pits gentle (i.e. graded to a gentle slope) to ensure public and livestock safety?

Yes ☐ No ☐

8. Have you seen any backfilling done to ensure public and livestock safety? ______

____

____

9. Has construction and demolition debris been used as backfill in any Mine site you know? Yes ☐ No ☐

10. Is any mine site you know used as a dumping ground?

Yes ☐ No ☐

11a) Is there vegetation in any mine pit you know? Yes ☐ No ☐

b) If yes is the chosen vegetation productive and sustainable?

Yes ☐ No ☐

12a) Do the mine pits fill with water and flood?

Yes ☐ No ☐

b If yes are there chances of pollution due to the pit flooding

Yes ☐ No ☐

13a) Have you ever seen a safety or warning sign in the mine pits?

Yes ☐ No ☐

b) If yes are the signs maintained? Yes ☐ No ☐

c) Do you know of any mine area that is fenced? Yes ☐ No ☐

d) If yes, is the fence maintained? Yes ☐ No ☐

14a) Is grazing going on in any pit? Yes ☐ No ☐

b) If yes is it controlled? Yes ☐ No ☐

15a) Is there any murram or Gold pit that is natural and desirable to look at?

Yes ☐ No ☐

b) If any pit is natural and desirable to look at please name a few

--------------------------- ------------------------------- ------------------------------

--------------------------- ------------------------------- ------------------------------

16a) Are there signs of soil erosion in mine pits in Kakamega County?

Yes ☐ No ☐

b) If yes kindly suggest suitable restoration remedies ___________________________

____

17. How is the farm yield the farm yield when you compare between the time before mining activities started and after mining activities had taken place?-------------------------
----

18. Does mining lead to soil erosion? Yes ☐ No ☐

19a) Do you know of any Mine in Kakamega County with a post mine land use/rehabilitation plan? Yes ☐ No ☐

b) If yes kindly list a few of the mines ____

____

c) Is there any Mine you know of that has an after mine plan implemented

Yes ☐ No ☐

d) Kindly list the rehabilitation or after mine use implemented? ____________________

____

20. Kindly suggest other alternative Post-Mine land use that can be implemented in

a) Murram pits ____

____

b) Gold pits ____

____

Appendix V: Observation checklist

(To be used to observe the degradation and restoration of the murram and Gold pits)

Mine Pit Ref No./Name ______________________________

Location ______________________________

Approximate size ______________________________

1. What is the current land use (idle, Mining, grazing land, Dam etc)? ____________
   ____
   ____
   ____

2. Is there any sign of spilled fuel, oil, or solid waste? Yes ☐ No ☐

3. Are there signs of dumping in the pit? Yes ☐ No ☐

4. Has backfilling and grading been done? Yes ☐ No ☐

5. Has construction and demolition debris been used as backfill?
   Yes No ☐ ☐

6a) Has the site been revegetated? Yes ☐ No ☐

b) If yes what kind of vegetation (describe and approximate if trees)________________
____

7a) Are there signs of grazing going on? Yes ☐ No ☐

b) If yes is it controlled or allowed____

8 Are there signs of soil erosion? Yes ☐ No ☐

9 Is the site protected from run off (culverts, drainage pipes etc.)

Yes ☐ No ☐

10a Are there signs of pit flooding? Yes ☐ No ☐

b) If yes are there signs of pollution and property destruction due to flooding?

Yes ☐ No ☐

11a) Are there safety signs and fences around the pit? Yes ☐ No ☐

b) If yes are they maintained? Yes ☐ No ☐

12 Are the slopes gentle to provide a safe environment for users?

Yes ☐ No ☐

13 Is the landscape looking natural and visually desirable? Yes ☐ No ☐

14aIs there any other use the pit could serve? Yes ☐ No ☐

b) State the use ____________________________ (agriculture, reforestation, small park, building, recreation area etc)

Appendix VI: Focus Group Discussion Guide

1. What are the various types of mines in this area?
2. Is there any land degradation caused by mining in this area?
3. Are there dangers/risks caused by the mine pits?
4. What actions have you taken about the pit towards rehabilitating it?
5. Suggest future Post-Mining land use which are consistent with your expectations.

Appendix VII: Interview Schedule

Introduction My name is Rael Ramkat, a student at Masinde Muliro University of Science and Technology doing a Master's Degree in Disaster Management and Sustainable Development. I am currently carrying out research on restoration strategies on mine pits in Kakamega County. You are invited to participate in this research by providing your views on restoration of Mine pits. Your contribution will help in completion of this study. Participation in this research is voluntary and your confidentiality will be preserved as the analysis will only focus on the patterns on the data over a number of respondents. The information you provide will only be used strictly for academic purposes. No names or information about any individual will be published.

(NB: Tick where applicable)

A Demographic Information

1. Gender: Male [ ] Female [ ]
2. Age group 1. 18-25 years [ ] 2. 26-35 years [ ]
3. 36-50 years [ ] 4. 50+ years [ ]

Highest level of Education

Secondary [ ] Tertiary [ ] University [ ]

Organization ____

How long have you worked in this organization ________________________

1a) Are there any environmental problems caused by Gold Mining and murram extraction in Kakamega County? ____

b) If yes kindly name a few ______________________________

c How can they be addressed if not addressed yet? ______________________________

1 Are EIAs done before mining commences? ______________________________

3 Are after use plans part of the EIAs ______________________________

4 Approximately how many EIA reports have been received in Kakamega County or respective Sub-County in respect for murram and Gold Mining? ______________________________

5a) Is there any mine you know of that has an after use plan implemented or has been restored since enactment of EMCA 1999 ______________________________

b) If yes kindly give a few examples ______________________________

c) If NO give reason(s) ______________________________

6a) Is there a financial security posted for every miner/prospector to protect against the possibility that a miner may fail to restore the land? Yes ☐ No ☐

b) If yes. How much (approximate) is held for future restoration ______________________________

c) Are the funds held and security posted sufficient for restoration? ________________

____

____

d) If NO. Suggest how the same can be addressed ______________________________

____

7a)What are the various strategies you have used to restore mined land in Kakamega County or respective Sub-County? ____

____

b) Are there any challenges in restoring the mined land? Kindly state a few __________

____

____

c) How can these challenges be addressed? _____________________________________

____

d) Which are the most effective and sustainable restoration strategies? ______________

____

8a) Are members of the public willing to participate in mine pit restoration? __________

____

____

b) If yes, How can we enhance their participation? ______________________________

____

c) If No, suggest how we can involve them? ____________________________________

____

Appendix VIII: Questionnaire (For Community members)

Introduction My name is Rael Ramkat, a student at Masinde Muliro University of Science and Technology doing a Masters Degree in Disaster Management and Sustainable Development. I am currently carrying out research on restoration strategies on mine pits in Kakamega County. You are invited to participate in this research by providing your views on restoration of Mine pits. Your contribution will help in completion of this study. Participation in this research is voluntary and your confidentiality will be preserved as the analysis will only focus on the patterns on the data over a number of respondents. The information you provide will only be used strictly for academic purposes. No names or information about any individual will be published.

(NB: Tick where applicable)

Demographic Information

1. Gender: Male [ ] Female [ ]
2. Age group 1. 18-25 years [ ] 2. 26-35 years [ ]
   3. 36-50 years [ ] 4. 50+ years [ ]

Instructions

Please indicate what you think about restoration of murram or Gold pits by ticking one of the boxes to identify the statement that closely matches your desired response

1. The Mine pit is a hazard to the community

Strongly disagree [1] **Disagree** [2]
Neither agree or disagre [3] **Agree** [4] **Strongly agree** [5]

2. The community has forwarded complaints about the nuisance caused by the Mine pit

Strongly disagree [1] **Disagree** [2]
Neither agree or disagree [3] **Agree** [4] **Strongly agree** [5]

3. The community complaints about the nuisance caused by the mine pits have been addressed

Strongly disagree 1 **Disagree** 2

Neither agree or disagree 3 **Agree** 4 **Strongly agree** 5

4. I gave views in deciding the final land use after the mine is closed

Strongly disagree 1 **Disagree** 2

Neither agree or disagree 3 **Agree** 4 **Strongly agree** 5

5. The Post-Mining land use is consistent with our Community's expectations

Strongly disagree 1 **Disagree** 2

Neither agree or disagree 3 **Agree** 4 **Strongly agree** 5

6. The safety and warning signs around the Mine pit have reduced accidents in the area

Strongly disagree 1 **Disagree** 2

Neither agree or disagree 3 **Agree** 4 **Strongly agree** 5

7. The Community ensures that the fence around the Mine pit and the warning signs are not destroyed

Strongly disagree 1 **Disagree** 2

Neither agree or disagree 3 **Agree** 4 **Strongly agree** 5

8. The community participates in planting trees to restore the Mine pit

Strongly disagree 1 **Disagree** 2

Neither agree or disagree 3 **Agree** 4 **Strongly agree** 5

9. The trees that have been planted are well protected and will benefit the Community

Strongly disagree 1 **Disagree** 2

Neither agree or disagree 3 **Agree** 4 **Strongly agree** 5

10. The Community controls grazing of livestock in the Mine pits to ensure it is conserved

Strongly disagree 1 **Disagree** 2

Neither agree or disagree 3 **Agree** 4 **Strongly agree** 5

11. Once backfilling has been done, the community should ensure that it is not removed from the pits again

Strongly disagree 1 **Disagree** 2

Neither agree or disagree 3 **Agree** 4 **Strongly agree** 5

12. The Community should organize and participate in clean up exercises to reduce the solid waste in the Mine pit

Strongly disagree 1 **Disagree** 2

Neither agree or disagree 3 **Agree** 4 **Strongly agree** 5

13. The landscape around the Mine pit is natural and beautiful

Strongly disagree 1 **Disagree** 2

Neither agree or disagree 3 **Agree** 4 **Strongly agree** 5

14. The slopes are well graded, gentle and safe for all users

Strongly disagree 1 **Disagree** 2

Neither agree or disagree 3 **Agree** 4 **Strongly agree** 5

15. The Community is satisfied with the rehabilitation of Mine pits in this area

Strongly disagree 1 **Disagree** 2

Neither agree or disagree 3 **Agree** 4 **Strongly agree** 5

Appendix IXA: Degradation Assessment form

Site No---

Reclaimed ☐

Abandoned ☐

Owner --------------------------------------

Constituency -------------------------------

Area (approximate size) ------------------

Rating	Category	Description
0-20%	Trival	No damage or Negligible
21-40%	Minor	Minor impact
41-60%	Moderate	Moderate damage
61-80%	Major	Severe damage
81-100%	Massive	Massive damage

1. What % of vegetation has been cleared?

0-20% ☐ 21-40% ☐ 41-60% ☐ 61-80% ☐ 81-100% ☐

2. What is the level of tree root exposure due to soil erosion?

0-20% ☐ 21-40% ☐ 41-60% ☐ 61-80% ☐ 81-100% ☐

3. How bare is the land due to grazing?

0-20% ☐ 21-40% ☐ 41-60% ☐ 61-80% ☐ 81-100% ☐

Tree and Shrub Density

		Mined site		**Unmined site**	
Plots	Density	**No.**	**%**	**No.**	**%**
1	Tree				
	Shrub				
2	Tree				
	Shrub				
3	Tree				
	Shrub				
4	Tree				
	Shrub				

Measure the depth of the mine pits examined

Depth in meters	Frequency	Percentage %
0-0.9		
1-1.9		
2-2.9		
3-3.9		
4-4.9		
Total		

Appendix IX B: Restoration Assessment Form

1. What % of backfill material is available to restore the mine?

0-20%	21-40%	41-60%	61-80%	81-100%
Very little	**Little**	**Moderate**	**Much**	**Very much**

2. What is the % tree/shrub canopy cover?

0-20%	21-40%	41-60%	61-80%	81-100%
Very low	**Low**	**Moderate**	**High**	**Very high**

3. What is the % of pasture cover?

0-20%	21-40%	41-60%	61-80%	81-100%
Very low	**Low**	**Moderate**	**High**	**Very high**

Appendix X: Mining Sites in Kakamega County

	Constituency	Mine Sites
1.	Lurambi	Bukura, Lutonyi(2 sites), Bushiri, Eshisiru, Shimanyiro (2 sites), Emukaba
2.	Shinyalu	Ivakale (4 sites), Murhanda (3 sites), Rondo
3.	Ikolomani	Kilingili (2 sites), Eshangwe, Rosterman (2 sites)
4.	Malava	Malekha, Samitsi, Malava, Shikutse, KambiMwanza (2 sites)
5.	Navakholo	Lusumu (2 sites) Nambacha
6.	Matungu	Ikhonje, Ejinja (2 sites), Stone shine, Luanda, Ekamashia (2 sites)
7.	Mumias	Mayoni (2 sites), Mumia, Mayoni
8.	Khwisero	Khwisero (2 sites), Emasatsi, Mulwanda
9.	Butere	Emukhalwaye (2 sites), Sabatia, Marenyo, Shianda (2 sites)
10.	Matete	Matete (2 sites), Nabuyole (2 sites)
11.	Likuyani	Likuyani (2 sites)
12.	Lugari	Lugari (2 sites), Mugunga