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IMPACTS OF QUARRYING ON LAND USE AND POSSIBLE REHABILITATION MEASURES: A CASE OF ZOWERANI SUB LOCATION, KILIFI COUNTY, KENYA.

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DECLARATION

This research proposal is my original work and has not been submitted for examination in any University.

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DEDICATION

This work is dedicated to my family members for the support offered during my study period.

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ABSTRACT

Quarrying has been practised since pre-historic times and has been/is vital for the development of any society. Quarrying should be compatible with the neighbouring land uses and should be in harmony with their functionality. However, this has not been the case world over as large-scale mineral resource extractions continue to disrupt the existing neighbouring land uses and adjacent livelihoods. Contravention of the existing frameworks guiding mining has given rise to conflicts in the utilization of space and resources. The primary objective of this study was to ascertain the impacts of quarrying on land use in Zowerani sub-location in order to propose for possible rehabilitation measures. Specific objectives were: examining spatial changes overtime due to quarrying, social-economic & environmental impacts, roles & perception of stakeholders on quarrying and rehabilitation measures. Uncontrolled large-scale quarrying is practised in Zowerani which informed conducting the study in the area. The Functional Theory of Resources and Hoteling's Extraction Cost Rule theory informed this study. The study employed descriptive survey design including observation method. Data collected was in form of both primary and secondary data. Primary Data collection included interviewing, photography and observation. Questionnaires were administered as follows: 30 quarry workers and 6 quarry owners as respondents within the quarries, 6 key informants representing relevant authorities and 126 households abutting the quarries. Secondary data collection consisted of use of maps and study of literature relevant to the study area. Purposive sampling was used for the key informants while systematic sampling was used for selecting land uses abutting the quarry area. Convenience sampling was used to select the quarry owners while simple random sampling was used to select quarry workers. Spatial data analysis entailed the use of ArcGIS 10.5 and AutoCAD; descriptive analysis entailed literature review while statistical analysis entailed use of SPSS. Google earth images of the period between 2006 and 2019 revealed a great change in landscape due to quarrying in this area. Findings indicate prevalence of Ear Nose & Throat, malaria and bilharzia due to dust, noise and water filled up pits as confirmed by the Zowerani clinical officer compared to other areas with no quarrying activities. Most (76%) of respondents were unaware of the existing laws on quarrying and 53% suggested backfilling and tree planting for post quarried lands. The study recommends developing and enforcing proper rehabilitation measures to improve the livelihoods of residents, proper zoning guidelines to inform future development of

the quarries and creation of awareness to the residents abutting these quarries to ensure environmental sustainability, proper land use and sound economic growth in the area.

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LIST OF ABBREVIATIONS AND ACRONYMS

ASAL – Arid and Semi-Arid Lands

CIDP – County Integrated Development Plan

EA – Environmental Audit

EIA – Environmental Impact Assessment

EMCA – Environmental Management and Coordination Act

ENT- Ear Nose Throat

GDP – Gross Domestic Product

GIS - Geographic Information Systems

GPS - Global Positioning System

ILO – International Labor Organization

KNBS - Kenya National Bureau of Statistics

MCA – Member of County Assembly

NEMA –National Environment Management Authority

NGO – Non-Governmental Organization

PES – Payment for Environmental Service

SDGs- Sustainable Development Goals

SEA – Strategic Environmental Assessment

SPSS – Statistical Package for Social Sciences

TVET-Technical and Vocational Education and Training

UK – United Kingdom

UN – United Nations

UNEP – United Nations Environment Programme

CHAPTER 1

INTRODUCTION

1.1 Introduction and Background of the Study

Quarrying is a type of land use concerned with the extraction of non-fuel and non-metal minerals from rocks (Ukpong, 2012). It is normally done through open-cast method using rock drills, explosion of dynamite or by the use of other methods (Lad & Samat, 2014). Quarrying is a huge supporter of local economic growth; it promotes trade, creates employment for people yearly, creates new habitats and at times new infrastructure like roads are built to transport the machines and the extracted resources and thereafter left to be utilized by residents. Most people in quarrying areas wholly depend on quarrying for their livelihoods aside from additional economic activities (Eshawani, 2014).

Quarrying activities harbour significant effects on the environment, health and socio-economic well-being of people worldwide. The impact on the social economy can either be positive or negative (Lad & Samat, 2014). Numerous common stages or activities carried out during quarrying have potentially adverse impacts on the natural environment, society and cultural heritage, the health and safety of workers, and communities based in close proximity to quarries (Kitula, 2006) . Further, the operations in quarrying, whether small or large-scale, are naturally disruptive to the environment, producing huge amounts of waste that can have dangerous impacts for decades. The environmental deterioration caused by stone quarrying occurs mainly as a result of inappropriate and wasteful working practices and rehabilitation measures (Sati, 2015). Mining and quarrying are destructive enterprises (R. & M., 2000) and involve the complete destruction of the habitat of an area where they take place (Martínez-Rui et al., 2007)

In the process of development, human activities bore negative impacts on the environment; they range from over-exploitation of resources, destruction of ecosystem and pollution. Repeatedly exploitation of natural resources has been conducted in a manner that is not sustainable causing an increasing concern as this ultimately threatens human existence. One challenge faced by both developed and developing countries is the failure to ensure the lasting utilization of natural resources at the least possible environmental cost, while still assuring the socio-economic development (Klawitter et al., 2004). In most African nations, quarrying is not well managed for

environmental sustainability (Darwish & Odah, 2010) and the methods used are very poor with no order in resource extraction.

With the rapid economic growth and its high interdependence on the environment, the world has seen an increased strain on the environmental resources. The industries largely depend on earthly resources and minerals to establish and operate. This has raised public concern on the well-being of the environment thereby escalating conservation efforts to ensure sustainability of environmental resources and reduced depletion of certain resources especially the non-renewable ones.

In the wake of 2000, extractive commodities started to be discovered in Africa. Mining became a revolutionary in catalysing significant regional economic growth and improvement of the welfare of the domicile residents. It is also worth noting that the translation of revenues tapped from resource exploration into poverty alleviation has registered a slow progress in Africa compared to other developing nations. Researchers and policy makers have intellectually clamoured for renewal of the governance and macro-fiscal risks to redress the gaps of equity of resource consumption and most importantly the preferential compensation of the domicile community's proximity to the resource endowments.

There are numerous challenges that communities that live near the quarried land areas face (Bamgbose, 2014). The socio-economic impacts of quarrying determine the perception of people towards quarrying. Some of the positive impacts to the society include; increase of in income, upgraded infrastructure and creation of jobs (Chigonda, 2010) The negative impacts on livelihoods of people are associated to escalation in health risks from air and dust pollution such as pneumonia, eyes and ears infection and other respiratory diseases (Nartey et al., 2012) water source contamination, change in the social ethics and upsurge in conflict in the society (Lad & Samant, 2014).

In Kenya, environmental, socio-economic and health impacts are experienced especially due to the current rise in real estate businesses and road expansions. Kenya has over thirty thousand stone quarrying sites (Kenya Population and Housing Census, 2019) and although only those near Nairobi City such as Juja, Tala and Kitengela have greater impacts since they have access to largest market (Waweru & Mukundi, 2015) , Zowerani too has been a source of mining stone for

a long period now and hence the impacts on the environment and the social economy of the people around the quarries have been increasing day by day.

Despite efforts having been made in the past to ascertain and address the impacts of quarrying on land use and studies conducted to determine the possible restoration measures for post quarried lands, not much progress has been achieved. One of the studies that had been previously done on this topic was the one conducted by (Kindiga, 2017) of the University of Nairobi. His study focused on investigating the gains of quarrying, its impacts on land cover, land use and the environment taking a case study of Ngong' River in Embakasi. The study did not however include the aspect of restoration/rehabilitation of the post-quarried lands which is vital in ensuring sustainability of the environment and the neighbouring land uses.

Quarrying can lead to significant impacts to the environment but with the right planning and management, many of the negative effects can be minimized or controlled and, on several instances, there is great opportunity to protect and improve the environment. Discouraging total dependence in quarrying activities by the locals to sustain their livelihoods by suggesting alternative activities is one of the strategies that can be used to try and control the effects of quarrying on the environment. In order to attain the balance between natural ecosystems, project planning, formulation and implementation is required to avoid the effect of stone quarrying on the environment and community (Awoke et al., 2019).

This study therefore aims at investigating the impacts of quarrying on land use and possible rehabilitation measures in Zowerani sub-location; this is with the view of recommending viable socio-spatial strategies to resolve the problem.

1.2 Statement of the Research Problem

Urbanization in Kenya is increasing at the rate of 4.23% annually (Central Intelligence Agency (CIA) World Fact Book., 2018) and Kilifi County has not been left behind. KNBS Census report 2019 puts the rate of urbanization in Kilifi County at +2.72% per annum. The increase in urbanization is evident with many new buildings coming up in the main towns of Kilifi county like Malindi, Mtwapa, Mariakani and the sub-urban of main Kilifi town, this in turn has led to increase in the built environment demand for additional provision of building materials which has led to increase in stone mining. Zowerani is one of the areas within Kilifi County which has

continued to be a source of building materials within Kilifi and the neighbouring counties. However, quarrying in this area has escalated with lack of apt regulation and control of the location of quarries in relation to other land uses. No zoning plan or buffer has ever been prepared for the area to designate and put control on the spread of the quarries. Over dependence on quarrying activities to sustain livelihoods in Zowerani has also contributed to escalation of quarrying activities in the area.

The improper management of the quarry sites has caused harm to the environment and the people residing in the vicinity of these quarries. Since the commissioning of the quarrying activities in this area, most of the quarry sites have never been rehabilitated or restored despite different legislation being put in place to govern the quarrying industry. Mining falls under the mandate of the Ministry of Petroleum and Mining headed by the National Government and even though they have managed to enact laws like the Mining Act No. 12 of 2016, Local Content Bill and the Minerals and mining policy among others, quarrying has continued to undergo several challenges as witnessed in Zowerani. The National government which controls 70% of the mining operations has either failed to see to it that mining activities are conducted in a proper manner or has not coordinated properly with other key stakeholders including NEMA which is the body to ensure that the environment is managed properly during planning, exploration, mining and post-mining activities as per the mining regulations (2017); and the County Governments that play vital roles in the mining sector such as preparation of integrated development plans for specific zones, issuing of authorizations for permitting operations and surface rights, enhancing community participation in mining operations and choosing of the mining sector operators, coordinating artisanal mining efforts, developing formula for sharing mineral benefits as well as sensitizing communities on the same among others.

Quarrying has had notable impacts on the surrounding environment and livelihoods and they include emergence of deep quarries that pose serious risks to the residents, massive environmental pollution like air pollution as a result of dust and noise emanating from the quarries and lorries transporting stones, clearing of vegetation, loss of rich agricultural lands, loss of bio-diversity, reduction in aesthetic value, soil erosion, serious health related diseases like respiratory illnesses and on a positive end emergence of commercial activities such as kiosks,

and opening up of the area to the larger Kilifi county even though the developments are not in compliance with planning guidelines

This then becomes an entry point to examine the spatial changes over time, environmental, social and economic impacts of quarrying activities in Tezo Ward, Zowerani Sub Location, the people's perception on the quarrying activities and possible rehabilitation measures considering the fact that this area borders the ocean and therefore very ecologically sensitive. The findings of the study is intended to advice on better management of the quarry sites to curb social and environmental harm, curb haphazard growth in to agriculturally viable lands and most importantly propose better rehabilitation and restoration measures to the already abandoned quarry sites within this area.

1.3 Research Questions

1. What are the land uses in Zowerani Sub location and how have they changed over time as a result of stone quarrying?
2. What are the social-economic and environmental impacts of quarrying activities in Zowerani?
3. What are the roles and perception of stakeholders in quarrying activities in Zowerani?
4. What are the possible rehabilitation measures on the post quarried land?

1.4 Research Objectives

The specific objectives of the research were as follows:

1. To examine the land uses in Zowerani Sub location and how they have changed over time as a result of stone quarrying.
2. To assess the social-economic and environmental impacts of quarrying activities in Zowerani
3. To identify the roles and perception of stakeholders in quarrying activities in Zowerani.
4. To propose the possible rehabilitation measures to post quarried land.

1.5 Geographical Scope

Geographically, the research study covered the surrounding quarries in Zowerani sub location which is found in Tezo ward, Kilifi North Sub County in Kilifi County. The quarries lie on 3^0 32' 49''S and 39^0 54' 23''E. The sub location is approximately 20.71 Km^2 and has a population of 4575; 2252 male and 2323 female, 682 households and a total dependency ratio of 1.017 (Kenya National Bureau of Statistics (KNBS, 2014). It is important though to note that according to KNBS Census report released in 2020 the population of Zowerani currently stands at 6317 consisting of 3078 males and 3239 females with a total of 1062 households. The study was however conducted before the census exercise and therefore the statistics used was the most recent for the area by the time of study as per the records of KNBS. The area dominated by quarries is not in the best of state and the situation is worsening hence the choice of this location for the research work.

1.6 Justification and Significance of the Study

One of the major problems experienced in the coastal regions of Kenya is transformation and destruction of marine and coastal habitats that is caused by activities such as dredging of waterways, deforestation, over-exploitation of resources, diversion of freshwater flows, and construction. These activities lead to socio-economic impacts like reduced fish catches, increased coastal erosion, loss of aesthetic value, and reduced income from tourism. (Government of Kenya , 2009). Massive resource exploitation and subsequent haphazard practise of mining activities have led to challenges like destruction of marine and coastal habitats which have in turn caused serious socio-economic challenges in these areas with the main ones being negative environmental and health impacts to the coastal eco-system.

As the rate of urbanization continues to increase within Kilifi County, new settlements have emerged and especially in the wake of creation of municipalities like Malindi and Kilifi as well as massive infrastructural developments like Vipingo Investment Park under construction by Centum Company further increasing the demand for natural resources especially building materials. This has led to the encroachment, incompatibility and overexploitation of resources available for the building and construction industry in Kilifi County. Stone which is the major commodity for building in the county has therefore been largely mined in Zowerani sub-location

causing profound reductions in faunal diversity, as well as habitat degradation and transformation along the coastal strip where the mining activities take place. Indigenous plant diversity and ethno-botanical resources are majorly affected, since vegetation needs to be cleared before mining can commence.

Selection of this site was also because of the location of the quarries which is along the shore line of the Indian Ocean unlike many of the other quarrying sites within the republic, shorelines have delicate ecosystems and hence the need for proper management. Zowerani specifically hosts the major stone quarries within the County.

Findings from this study will provide policymakers and technical staff with the strategic vision, conceptual framework and guidance on some of the practical tools necessary for planning of the quarrying land and post quarried land in such a way as to reduce its overall impact on individuals, families, communities and flora and fauna in general. Moreover, this research will provide a yardstick when planning for quarrying areas in general.

1.7 Definition of Terms

Environmental Impact Assessment – Is the evaluation of the probable environmental impacts of a suggested project or development, taking into consideration both positive and adverse impacts.

Household - A house and its occupants regarded as a unit

Land use - A series of operations on land, undertaken by humans, with the aim of obtaining products and/or benefits through using land resources.

Non-Governmental Organization – A non-profit, citizen-based group that functions independently of government

Population - All the inhabitants of a particular place

Quarry – Oxford living dictionary define a quarry as a place, typically a large, deep pit, from which stones or other materials are or have been extracted.

Quarrying - Merriam Webster defines quarrying as the business, occupation or act of extracting useful material such as building stones from quarries (Webster, 1828).

Regeneration - Regeneration is the attempt to reverse the environmental degradation or decline by improving the physical structure of a previously degraded area (Weaver, 2001).

Restoration – It is the process of resting a building, work of art, etc. to its original condition.

Payment for Environmental Service - Are incentives offered to farmers or landowners in exchange for managing their land to provide some sort of ecological service.

Environmental Audit – The assessment of the degree to which an entity takes observes practices that reduce environmental harm.

Rehabilitation - The act of returning land to its former state, after some process has resulted in its damage (Schwencke, 2016).

Strategic Environmental Assessment – A process and tool for evaluating the effects of proposed policies, plans and programmes on natural resources, social, cultural and economic conditions and the institutional environment in which decisions are made

CHAPTER 2
LITERATURE REVIEW

2.1 Overview

This chapter presents the relevant concepts and theories and highlights on the procedures, methods, techniques and lessons learnt elsewhere that can be borrowed to enrich and fortify the research study. It also seeks to enlighten on the gaps, opportunities, constraints, and limitations experienced in other research expeditions so as to tailor the study to filling the information gap. Additionally, it also acknowledges relevant policies, legal and institutional frameworks that are affected by the research study. The structure of the literature review is also guided by the aforementioned problem statement, research questions and objectives. Cumulatively, reviewing literature informed the synthesis of an appropriate conceptual framework.

2.2 Quarrying Process

Quarrying alike several other man-made activities cause significant impacts on the environment. The process of extracting raw materials for processing often requires the use of explosives to disintegrate the rocks through blasting. This method of extraction leads to noise and air pollution, loss of biodiversity and habitat obliteration. Quarrying process undergoes different stages. First is prospecting an area to find an ore. This is done by going into the field to find the different kinds of indicators such as fossils and minerals that can give you a clue of where an ore body can be found. Thereafter the necessary permits and licenses are acquired from the relevant authorities.

The next stage is exploration of the area which entails determining the degree and worth of the mineral-rich ore through different means such as practical fieldwork, remote sensing, and drilling. The next step involves excavation of minerals from underground. This again is done through different approaches depending on the type of mine and the resources needed from the ground. Upon completion of quarrying operations, ecological reconstruction should be undertaken because the environment usually gets destroyed in many ways especially through land degradation which is rampant in cases involving quarrying. The reconstruction can be achieved through reclamation or rehabilitation of the quarries to restore the value of the lands to make them suitable for use again.

The magnitude of impacts can vary from barely noticeable to extremely destructive depending on several factors such as the type of mineral being mined, the method being used to extract the mineral and the features of the quarry sites and its environs. Among the most rampant complaints by the public is that blasting of stones within the quarries situated in close proximity to their homes generate a lot of noise. The exercise involving stone blasting may take place on a daily basis or occasionally like once or twice in a year. In the case of this study, it is due to the techniques employed during mining and the closeness of the quarries causing the effects that can be felt in different parts of the country.

2.3 Impacts of Quarrying

Quarrying activities often have long-term social, economic and environmental impacts in areas where it is undertaken. These impacts can be positive or negative depending on how the activities affect livelihoods in the surrounding areas. For instance, (Fellmann, et al., 2005) states that Even as agriculture remains the main strategy for reducing rural poverty, small scale mineral extraction is as well performing an important role in rural livelihood enhancement thereby creating additional job opportunity and helping to generate additional income. One of the main challenges associated with quarrying is that as the mining corporations and to some extent, the government acquire the principal share of the proceeds from quarrying; the local communities are left to bear the negative effects of these projects (Awoke et al., 2019). Below are the impacts of quarrying activities on the environment and society.

2.3.1 Social impacts of Quarrying.

Health and Safety Hazards

World Health Organization (2015) defines health as the state of complete physical, mental and social well-being of an individual and not simply the lack of disease and illness. People working and living around quarries are prone to respiratory diseases due to air pollution. According to (Langer, 2001) an estimated 4 million people pass away annually due to severe respiratory complications in developing countries, where most deaths are heightened by environmental pollution originating from quarrying, sandblasting and discharge of hazardous chemicals. In addition, additional health risks could be due to bad working conditions, noise pollution, minor and major physical injuries and accidents at work place, intense manual work, and long working

hours. Quarrying activities also lead to rise in stress levels as the tedious jobs, loud noise and the extreme weather conditions like high temperatures the workers are exposed to cause general fatigue. Also the amount of money they earn is not commensurate to the amount of work they handle which can be a cause of stress for many workers.

Plate 1: Massive air pollution at a cement quarry.

Source: Health and Safety Authority (HSA)

Job Creation

According to National Council of Bhutan (2013), job opportunities are created through quarrying activities for people and on top of that, quarrying contributes to the gross national product of a country through production for the local market and export trade. Stone quarrying is a major employer of people with low literacy level since it does not require complicated skills. The people employed in these quarries are able to earn a living to sustain them and their households (Sowers, 2016).

Opening up of Interior Places

The stone quarries in Kenya are mainly found in interior places. Most of the rural areas in Kenya are still rated behind in terms of development and activities such as quarrying help open up these places to the larger urban centres and catalyse development in these areas. When roads leading to the quarries are constructed for purposes of transporting the stones to major towns where the demand is high, the areas are opened up making accessibility of these areas easier and hence other relevant physical infrastructure like water, electricity and gas stations emerge thereby

attracting more investments in the areas further contributing to the development in the interior places.

Increased Social Harmony

Opened up areas have people from more than one tribe since some come to the quarries in search of employment, others come to purchase raw materials and others to transport the stones. This therefore leads to increased social harmony as compared to areas which are only inhabited by one tribe or community of people (Sowers, 2016).

Better Access to Social Services

Opening of rural areas increases the chance to access of better social services like hospitals and schools. Once the rural areas have expanded and the physical infrastructure like electricity and roads established, the social services like the hospitals are brought closer to the people and accessing them becomes much easier for the residents than when they are no proper accessible roads to use when going to hospitals and schools.

Influx in Population and Changes in Social Ethics

Quarrying activities tend to attract more people to the areas where they are being undertaken. In Zowerani for instance, the number of people in the area has increased over time between 2009 and 2019 (Kenya National Bureau of Statistics, 2019). In 2009, there were 4575 people in Zowerani and in 2019, the population rose to 6317 people. The quarrying activities in the area have been majorly attributed to the influx in population as more people tend to move to the area in search of employment opportunities within the quarries. The increase in population has further led to changes in social ethics as the area has expanded giving room to the emergence of social places like the entertainment joints especially pubs (*Mnazi* dens) popularly known as *Mangwe* which are hotspots for violence, theft and other society vices including prostitution and drug abuse. (Adjei, et al., 2008) Asserted that young women and girls move to mining areas with the aim of trading or look for employment and immediately they are not successful in this, they opt for prostitution which they view as being more profitable than trading. Consequently, he states that many youths use drugs as they view them as energy boosters and hence makes them stronger and able to work.

High Cost of Living

This majorly affects communities that reside around the mining zones. This is because most of the basic necessities including food, proper accommodation and clean water are costly to buy by ordinary people. The reasons for this are that mining corporations hire most of the community's strong men into the mining industry thereby snatching away the much needed labour from the farms that mining corporations take over the farmlands from communities. The outcome of this is reduction in food production prompting food to be acquired from other places at inflated prices (Adjei, et al., 2008). Also land viable for agriculture is quickly turned into mining grounds and hence less production

Other Social impacts of Quarrying

Other social impacts of quarrying may include displacement of communities, damage of cultural sites and blockage of free movement of animals (Awoke et al., 2019). Lands where quarrying activities take place are usually taken over by the investors or the government. In certain instances, they cover lands that are very sacred to the local communities and therefore once quarrying begins, the people are forced to relocate and their cultural sites destroyed which always lead to conflicts between the local communities and the quarrying company proponents. For instance, (Abugre & Akabzaa, 1997) stated that the initiation of large-scale open-pit gold mining with its resulting impacts such as massive land degradation and displacement of settlements is a key source of conflicts between locals and the mining companies. This is the same scenario with stone quarrying.

2.3.2 Economic Impacts of Quarrying

Loss of Agricultural Lands and Reduction in Agricultural Yields

While the demand for building stones increase, quarrying activities escalate. The building stones are excavated from underneath the earth surface and that means that soil has to be dug out first to expose the bare rock for mining. This interferes with the rich fertile soils thereby leaving the land bare and derelict after quarrying has ended. The land left behind cannot support any form of agriculture and hence lies fallow with no agricultural value to the residents as the soil has been completely degraded. Soil degradation caused by quarrying activities results into low food

productivity. The soil nutrients and the rich fertile soils are depleted leading to soil infertility hence no farming is possible. The soil is a natural resource which is not easily renewable, or expensive to reclaim or to improve, following erosion, physical or chemical damage (Stoops & Chevery, 1992).

Plate 2 Abandoned quarry land in Evros Region

Source: Bathrellos (MDPI)

Emergence of Small Economic Centres and Market Places

Quarrying activities have led to the emergence of small market centres which develop as a result of human traffic in the mining areas leading to demand of certain services for example eateries where the quarry workers can eat and refresh and small shops where they can buy necessities. This has opened business opportunities for certain members in the society and they are able to earn income to sustain them.

Source for Income Generation as Tourist Attraction Sites

As a tourist attraction and a strategy for earning both domestic and foreign income through tourism, post-quarried lands can be rehabilitated and turned into tourist attraction sites. For instance, Haller Park in Mombasa, Kenya which was a quarry for the Bamburi cement company Limited was rehabilitated by the industry after quarrying ended in the 1970s through reafforestation project (Soft Kenya) and today, it is a tourists' attraction site evidenced by the 90,000 visitors who visit per year. This provides economic benefit to the nation as it brings

revenues from the revenue collected at the entrance as well as from the sales of meat and plants sold from the park's nursery.

2.3.3 Environmental Impacts of Quarrying Activities

Quarrying potentially affects the environment and inevitably interferes with its sustainability. They have great impact on the environment with serious side-effects. (Wangela, 2019). Below are environmental impacts of quarrying.

Land Degradation

This is mainly in the form land structure alteration caused by excavation, heaping of top soil and loss of land due to disposal of quarry waste. According to the State of the Environment Report (2003), stone quarrying is responsible for property damage, depletion of ground water, destruction of forest land, wasting of fertile top soil, and adverse effects on the aquatic biodiversity. In areas where quarrying is being done, the vegetation cover and the soil are replaced by big excavated holes surrounded by huge heaps of after-quarry waste materials. This leads to gradual soil erosion that degrades the landscape and transport harmful substances to the ground water and aquifer. In a study undertaken in Ghana by (Nartey, 2012) he registers that the level of land degradation due to stone quarrying in the country is so huge that he posed questions as to whether the practise should go on or not.

Air Pollution

Dust from stone quarries is a key source of air pollution. However, the severity of the pollution depends on many factors some of which include; concentration of the dust particles, size of the dust particles and micro climatic conditions. Air pollution is a nuisance and has serious side effects on human and animal health as dust from the quarries lead to respiratory related ailments like flu, whooping cough, cold, chest congestion etc. Dust from quarries have effects on the physical surrounding where they are deposited as well, a good example is on the surrounding plants that remain stunted from the excessive dust pollution from the adjacent quarries (Gauch, et al., 2001) .

Noise Pollution

Quarries generate significant amount of noise especially when blasting method is used. Crushing the quarried stones to give them shape is another key source of noise pollution. The stones are

then transported using heavy powered vehicles to construction sites or to the industries which in most cases produce a lot of noise (Sowers, 2016).

Water Pollution

Man-made activities in the quarries produce a significant amount of waste such as sand, clay and silt. This waste is then washed away by rainy water during the rainy season to water sources causing water pollution (Wang & Shi, 2007).

Loss of Biodiversity

Biodiversity simply refers to the variety of living species. It is good to conserve biodiversity since all species are interdependent even if not visible. More important is that, the survival of human beings depends on the fine balance that exists within nature (Gauch, et al., 2001). Stone quarrying has the potential of destroying habitats and the species they support.

Plate 3 Contrast between a virgin land and a post-quarried land

Source : Author

Loss of Aesthetics

Most of the quarrying areas which make use of open-pit method of mining, leave the pits unrestored after mining is completed hence loss of aesthetics. The landscape thus remains bare, ugly and unattractive. During the rainy seasons they are filled with water and become breeding sites for mosquitos (Wangela, 2019).

2.3.4 Impact of Quarrying on Land Use.

The onset of surface mining in an area abuses the human rights of the locals and gives rise to land use problems. The mining corporations possess large chunks of land for their quarrying operations and other land uses such as agricultural land and residential zones are left to bear the burden of shortage of land. For instance, when minerals are discovered in an area, the land is taken over by the government or private investors. At times this is done without compensation which leads to conflicts between the community members and the mining companies. Farmers are not allowed to farm in the lands taken over by the mining companies unless given authorization by them. Quarrying therefore causes strain on land use as its activities take over very large spaces leaving other land uses including agriculture, forestry and housing to share very small pieces of land.

Consequently, a study by Fierer et al., (2005) to monitor the effectiveness of quarrying indicated that after quarrying activities open spaces are left, where ponds emerge due to stagnating waters. Most of the quarrying activities leave the lands barren with no value to undertake productive activities. This further reduces space for other land uses. In the event the post-quarried lands are restored, other land use practises like agriculture can no longer be viable as the soil quality are greatly reduced that they cannot support productive agriculture anymore an occupational activity that most rural communities depend on.

2.4 People and Quarrying Linkages

According to Bewiadz et al., (2018), both rural and urban dwellers have become concerned about secure and adequate livelihoods. In these areas, people have opted for alternative livelihood strategies due to economic hardship and poor agricultural yields arising from adverse effects of change in climate. There exist many linkages between people and quarrying activities in areas where it is being undertaken. Small-scale surface mining and quarrying has become one of the alternative livelihood strategies for more than 500 million people in developing countries (Wang & Shi, 2007). This is as a result of about 45% of the world's population not having access to land (Fellmann, et al., 2005). This has limited them from engaging in other activities like agriculture for survival. The World Bank (2001) indicates that over 40% of the world's population are poor and approximately 75% of rural inhabitants in developing nations undergo outright poverty. Poor rural residents are not as privileged as urban inhabitants when it comes to accessing socio-

economic benefits and hence they turn to primary and informal sectors of the economy more so in subsistence agriculture, small-scale mining and quarrying to seek livelihood opportunities in the (Birabwa, 2006). From the literature it is evident that quarrying activities have direct link to community livelihoods as most people in the rural areas depend on it as a source of employment to earn income since agricultural activities are not viable anymore.

Quarrying also has direct effect on human health and most of the people working within quarries suffer from different respiratory ailments and other diseases related to the mines. This definitely lowers their immunity levels thereby impacting on the rate of economic development since a weak workforce cannot meet the set economic targets and goals to stir upward economic development. Quarrying thus has direct linkages to people through the negative impacts on their heath.

Economic hardship, unemployment and rural-urban migration on the other hand are some of the reasons why rural and peri-urban inhabitants engage in quarrying activities (Bewiadz et al., 2018). Life in towns has continued to become unsustainable due to high inflation rates which have made people to migrate back to the rural areas due to economic hardships. People are therefore forced to engage in small scale mining and quarrying as a livelihood strategy despite the negative impacts it has on their health and environment.

2.5 Roles and Perception of Stakeholders in Quarrying Activities

According to the Oxford Dictionary, a stakeholder is any individual with an interest or concern in something, especially a business. Quarrying industry has got several key stakeholders who are considered important in the SEA process. All the stakeholders play critical roles in the shaping of the industry and have different perceptions with regards to the quarrying activities depending on their level of influence in the quarrying sector and depending on how they are directly or indirectly affected by the quarrying activities.

Below is a list of key stakeholders in the mining industry in Kenya and the general roles they play (UNDP SEA for the Mining Sector in Kenya).

1. **National Government Ministries -** Own the major stake in the quarrying industry. Provide strategic leadership, coordination including policy formulation and enactment of legal and regulatory frameworks. Vested with the duty of protecting the environment and people's rights.

2. **County Government -** holds a stake of investment and benefit sharing in mining sector. Some of the roles played by county governments include preparation of integrated development plans for specific zones, provision of consents for licensing operations and surface rights, promoting community engagement in mining operations and selection of the mining sector operators, coordinating artisanal mining efforts, developing formula for sharing mineral benefits as well as sensitizing communities on the same etc.
3. **Local Communities –** The stake of local communities in quarrying mainly touch on the effect of mining on them. These are the stakeholders who are directly affected by the quarrying operations. The local communities take the duty of ensuring effective defence of community interests in the quarrying sector.
4. **Civil Society** – These include the Environmental Activists, NGOs, and Environmental Rights Groups etc. This group mainly comes in to ensure environmental protection and guarding against violation of human rights. Their role is mainly in environmental and human rights advocacy.
5. **Professional Organizations** – This team of stakeholders ensure the maintenance of professional standards.
6. **Academic Institutions** – Responsible for providing the knowledge and skills applied in the quarrying industry. They play a major role of producing competent professional who work in the quarrying sector.
7. **Statutory Bodies/Institutions** – These are bodies created by specific acts of parliament that mandates them to play certain roles within the quarrying sector by supporting the mining operations. Some of the bodies include NEMA which is responsible for regulating environmental issues in the quarrying industry, Water Resource Management Authority mandated with the responsibility of water resources management and County Geologist responsible for handling mining issues at the county on behalf of Ministry of Mining.
8. **Mineral Prospectors** – Play an important role in mineral exploration and prospecting. They add value in the sector by providing mineral exploration experience.
9. **Other Stakeholders –** Other stakeholders that also have interest in the quarrying industry include large scale mining corporations, informal small-scale miners, dealers in minerals, research organizations, women, youths and opinion leaders.

Communities have diverse perceptions of the quarrying and mining activities and the post-quarried land use. Ndegwa et al., (2014) in a study on occupation health of quarrying discovered that the quarry workers and owners viewed the quarrying activities as a source of poor health conditions. Olusegun et al., (2009) Discovered that communities residing around quarrying areas were aware of the dangers associated with their quarrying activities. (Kaliampakos & Menegaki, 2001) recognized that perception of quarrying impact had the potential to influence halting of quarrying activities as it happened in Attica basin, Greece. Quarrying impacts the society positively too in various ways such as employment creation (Chigonda, 2010)and opening up of the interior places or rural areas. The environmental and socio-economic detrimental impacts of quarrying are the main source of conflicts between quarrying firms and the communities living around the quarrying zones (Lad & Samant, 2015).

Other stakeholders in the quarrying industry like the national government and county governments view quarrying as a source of earning income as the products have a huge turnover in terms of revenue collection. The civil societies e.g. the environmental rights groups view quarrying as a major source of environmental pollution and destruction since the quarrying activities involve clearing of vegetation and use of heavy machinery.

Understanding community perceptions on matters relating to quarrying and post-quarried land state is therefore very important as it influences their relations with other stakeholders in the quarrying industry (Lad & Samant, 2015).

2.6 Restoration and Rehabilitation Measures to Post Quarried Land

Post-quarried lands need concrete and comprehensive management systems so as to reduce environmental pollution and instead generate economic benefits for the landlords and the county at large. Tezo region of Kilifi County has experienced long term quarrying impacts for the benefit of contractors. However, the post-quarry sites have largely been neglected creating an environmental scar on the landscape. This has led to detrimental environmental problems to thrive in the Tezo region. Some of the grave environmental challenges that have been caused by the unattended post-quarried lands range from spread of different waterborne related illnesses like malaria and Bilharzia, accidents caused by dangerously hanging landscapes, pollution and complete obliteration of the environment and bare unproductive lands left behind to lie fallow among others.

These sites require a cost effect rehabilitation and restoration measures for effective post quarrying land use. Good rehabilitation and restoration measures require solid partnership among stakeholders, policies, ecology, research and community. Some of the best restoration and rehabilitation measures include: crop farming, fish farming, landscaping, sewer treatment works, recreational sites and planting trees.

Properly planned post-quarried sites bring forth positive impacts on the environment and the local communities. The benefits include: economic growth, Emergence of new habitats and decrease in dangerous nature of quarried land (Rushworth & Budnik, 2012).

According to Sutphin et al., (2001) there exist several instances in which quarried land has been successfully transformed to agriculture, forestry, nature conservation, urban or industrial land uses. In some of these examples the pre-mining land use was reinstated, while in others the land use was altered. Some of the transformed land uses were prudently planned and implemented, while others have changed, sometimes after the land has undergone a lengthy period as abandoned or waste land (Moffat, 2001). Mine restoration must therefore strive to turn the quarried lands into future valuable use and not rather leaving them in a worse manner than they existed before.

A good example of best practice on how to restore and rehabilitate a post quarried land globally include the case of the Shimao Wonderland Intercontinental hotel in China which is a unique construction in Songjiang, China, located at the base of Tianmenshan Mountain. The hotel is founded on an abandoned quarry that was characterized with stagnant water and has now been turned into a wonderful tourist destination site in the country promoting foreign revenue.

A simple rehabilitation process for a stone quarry can include converting the land into a forest after quarrying. This is done by filling up the pits with the debris and then covering the debris with fertile soil and thereafter planting trees with manure. The planted trees should be under the care of a professional who will closely monitor the progress of the growth of trees ensuring that they are constantly watered through irrigation and that no one encroaches into the forest land.

Plate 4: Post quarry land put into forest land use

Source: Author

In order to ensure successful rehabilitation of post-quarry lands, certain steps must be considered before implementation the rehabilitation plan.

1. Stakeholders – Are a very important part of the rehabilitation process. They must therefore be fully involved in the rehabilitation plans for post quarry lands. The relevant authorities come up with the regulations that guide the rehabilitation process of post-quarry sites. The quarry owners on the other hand implement the regulations and rehabilitate the lands after quarrying. The community acts as an oversight to the quarrying activities; this ensures the quarries are rehabilitated in the long run by the quarry owners.
2. Feasibility study – This involves conducting proper study on the land use that the post-quarry land will be put into to see if it will be profitable in the long run.
3. Natural environment – The natural environment of the place where the quarry site is located determines the post-quarry land use that the quarry will be put into after mining.

Source: Author

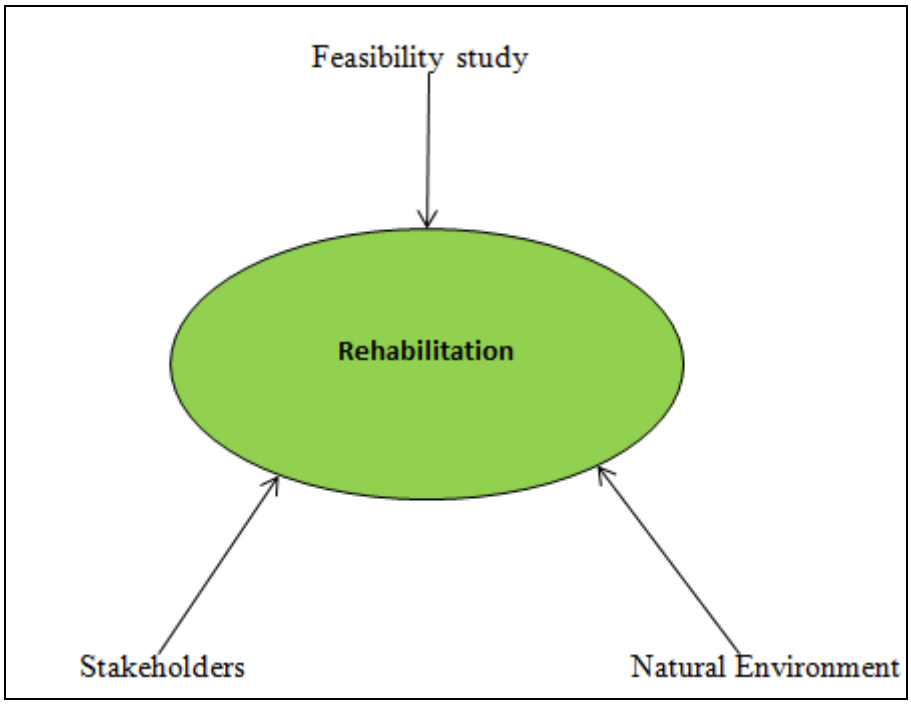


Figure 1: Diagram representation of rehabilitation steps for quarried lands

2.7 Theoretical Framework

2.7.1 The Functional Theory of Resources

This theory is a dynamic concept invented by Zimmerman (1933). It states that "Resources are not they become", which implies that resource derive their definition from the feasibility applying knowledge to exploit its potential (Zimmerman & Hitchcock, 1933). Minus the knowledge then resources do not exist. Zimmermann offered a synthetic assessment of the human, cultural, and natural factors that determine resource availability. These factors include but not limited to physical availability, time, technology, institutions, economic factors, government policy, culture and geopolitics. Resources are already in the realm of nature and are fixed or static. Zimmerman believes that resources are not fixed and that they are not made or created, only human appraisal turns the neutral stuff of the earth into resources and what are resources today may not be resources tomorrow. The building industry in Kilifi County has been sustained by building stones harvested from the quarries of Tezo and only the discovery of alternative sources of raw materials will shift the dependency on the quarries. Sound policies are therefore quintessential to ensure that the mining exploration and extraction is sustainable and

surplus revenue generated is diligently injected back to create a vibrant economy and multiplier effects (Hardin, 2009).

2.7.2 Hoteling's Extraction Cost Rule

Also referred to as the economics of exhaustible resources, stipulates that under competitive equilibrium the rent which is estimated as price of an exhaustible resource minus the net extraction costs must be increasing at the rate of interest. Harold emphasizes on the mining sector which is dependent on exhaustible resource. Mine owners profit depends on both current and cumulative rate of production. Extraction costs increases as mines go deeper and deeper while the demand for resources like gold and diamond is affected by increase stock in circulation

The uncertainty stimulates the accelerated depletion of known resources hence to ensure a sustainable regional growth; research needs to be conducted to invent alternative avenues of accruing the benefit of resources. Dependency on a fixed resource may cause strain and contention that stagnates regional growth. Tezo for instance, the dependence on stone for the construction industry consequently generate hazardous environmental conditions that have cost implications such as aesthetics, contestation for space etc. Insecure tenure on stone deposits such as high private discount rates also accelerates mineral resource exhaustion. Therefore, urgent need for the formulation and the execution of policies that would assure of equilibrium between the ambient systems of the environment against what man extracts.

2.7.3 Significance of the Theoretical Framework and How it Informs the Study

Both the Functional Theory of Resources and Hoteling's Extraction Cost Rule theories guide this study whereby the Functional Theory of Resources states the need to have alternative natural resources that can be used for the same purpose in order to ensure their sustainability. The building and construction industry in Kilifi County majorly depends on stones from quarry which in turn has led to the overexploitation of the resource resulting into detrimental environmental and health impacts in the quarry areas like Tezo. The assumption by Zimmerman therefore informs this study as there is need to have alternative sources for building and construction materials to cushion the negative impacts caused by overexploitation of building stones in Zowerani, Tezo.

Hoteling's Extraction Cost Rule explains the effects of overexploiting the existing natural resources for profit gains. It shades light on the importance of balancing resource sustainability and economic gains. Maximizing economic profits from natural resources without considering their sustainability has given room to over-utilization of the natural resources leading to extinction of non-renewable natural resources and serious environmental impacts. The lack of proper policy formulation and implementation to guide the utilization of some of these resources has given chance to investors to take advantage of the existing gaps to misuse the resources by practising unrestrained quarrying. The quarries in Zowerani, Tezo have been misused as there are no stringent policies to curb the over-exploitation of the building stones. Quarry owners are maximizing on profits at the expense of the surrounding environment and the residents of the area who are left to bear the consequences of their actions. This theory therefore informs the study as it touches on the importance of ensuring a balance in natural resource extraction by not only focusing on profit maximization but also considering resource sustainability.

2.8 Legal, Policy and Institutional Framework

2.8.1 Legal Framework

Instrument	Key Features	Relevance to Study
Constitution of Kenya	Articles 42 states that, every person has the right to a clean and healthy environment; 60 stipulates that land in Kenya shall be held, used and managed in a manner that is equitable, efficient, productive and sustainable; 69 encourages public participation in the management, protection and conservation of the environment and gives provision to ensure sustainable exploitation, utilization, management and conservation of the environment and natural resources, and the equitable sharing of the accruing benefits. The article also establishes systems of environmental impact assessment, environmental audit and monitoring of the environment; 70 states that a court of law may provide compensation for any victim of a violation of the right to a clean and healthy environment.	These acts dwell on the importance of protecting and conserving the environment by all citizens ensuring its protection for not only the current but future generations as well. They give emphasis on the right to a clean and healthy environment for all and allow victims of environmental violations to seek remedy for the harms meted upon them by any party or individual. These acts are relevant to the study as quarrying is notorious for environmental degradation and the constitution is a powerful tool that can be used by communities regulate quarrying activities in their areas and force mining companies to comply with set environmental standards and laws to ensure sustainability. Communities are also able to access information prior to the establishments of quarries in their area through public participation during EIA and get to

		know the impacts associated with quarrying before giving the go ahead for the projects to commence. Also the huge beneficiaries of benefits accrued from quarrying are always the company proponents and governments while the community remains with nothing. The constitution empowers communities and allows them to demand for their fair share of benefits accrued from quarrying within their communities as set in law.
County Government Act (2012)	Article 96(1) on access to information gives every Kenyan citizen the right to access information held by any county government or any unit or department thereof or any other State organ in accordance with Article 35 of the Constitution. Consequently in the same act in article 115(1) and (2) on public participation in county planning, it is stated clearly that public participation in the county planning processes shall be mandatory.	This act is able to regulate land use activities like mining through public participation and access to information which is also solidly guaranteed by the county authority i.e. the county assembly and hence through this the public has the right to ensure that post-quarried lands are restored and rehabilitated into meaningful use and that only sustainable quarrying activities and other land uses take place in their environment.
Physical and land	The act states that the county physical and land use	Mining is one of the most significant causes of land

use Planning Act (2019)	development plan shall be in conformity with the National Physical and Land Use Development Plan and any relevant Inter-County Physical and Land Use Development Plan and that each county government will prepare a county physical and land use development plan for its county after every ten years in Section 36; In section 37(f) the county physical and land use development plan identify the proper zones for industrial, commercial, residential and social developments	use conflicts within communities. Quarrying infringes on community space extending to undesignated areas and interfering with other land uses like agriculture and residential areas. This act promotes proper planning and regulation of quarries to ensure sustainable development. The act will see to it that the different land uses have clear cut zones to avoid any form of conflict thereby enabling easier and better regulation and monitoring of quarrying activities.
EMCA (1999)	Clearly outlines the general principles that guide the management of the environment. In article 3(1) every person in Kenya is entitled to a clean and healthy environment and has the duty to safeguard and enhance the same environment. In article 3(5), the EMCA act outlines the principles of sustainable development that provide guidance and coherence to good environmental management, ensuring that the rights of each individual to a clean, healthy and sustainable environment are respected. In article 42 (1) that all policies, plans and programmes for implementation shall be subject to strategic environmental assessment; in article 9 also states that	EMCA plays a big role in ensuring proper environmental Management. The EIA and the Environmental Audit and Monitoring processes are very important in ensuring that projects with high potential risks to the environment do not continue and therefore aids in conservation efforts towards the environment to achieve sustainability. The quarrying activities thus are monitored keenly with the above instruments through the Environmental Authority. EMCA also states that every citizen has the duty to protect the environment to ensure its

	environmental inspectors will be tasked with the inspection of the environment to determine degradation and also to carry out analysis and keep the relevant records; NEMA is mandated by this Act in article 68 (1) to carry out environmental audit and monitoring.	sustainability. This illustrates that if all citizens adhere to this provision of the EMCA Act, then we shall effectively control the negative impacts of quarrying and ensure only sound mining activities are permitted in our surroundings. The general principles of sustainable development also play a key role in guiding the management of the environment thereby regulating activities that have impacts on the environment such as quarrying.

The Mining Act, 2016	Article 20 (5) of the mining Act states that a person whose land or property is damaged as a result of the exercise of the powers of the Director of Mines is entitled to fair, prompt and full compensation for such damage in accordance with the Act. The Act established the Kenya Geology, Minerals and Mining Authority together with the Mining and Minerals Board and addresses grant of licenses and conclusion of mining contracts, condition for grant of exploration and exploitation of licenses and the offences prescribed in case of violation.	This act has helps reduce the violations of rights meted on innocent people by the quarrying proponents as they are fully aware that they will be held fully liable for their actions. Nobody in their right senses would wish to be penalized for causing harm to others; therefore they try so much to follow the set standard procedures for carrying out quarrying. It has also ensured that the people whose property is damaged by mining companies still have a source of livelihood after compensation. On the other hand the Kenya Geology, Minerals and Mining Authority together with the Mining and Minerals Board ensures that minerals and environment are protected and that health and safety of the miners is investigated and community development is given priority before any mining starts hence promoting sustainable mining and interests of the community as well.

Public Health Act 2012.	Section 136(a) on breeding places of mosquitoes to be nuisances states that all collections of water, sewage, rubbish or other fluid which permit the breeding or multiplication of animal or vegetable parasites or of insects which may otherwise cause or facilitate the infection of men or domestic animals shall be nuisances liable to be dealt with in the manner provided for the treatment of nuisances.	This provision in law helps to ensure that the quarry owners cover up the pits left behind after excavation to avoid breeding of mosquitoes when filled up with water. Failure to do this, the act can be used to ensure that the quarry owners answer for their negligence and pay hefty penalties for such acts of ignorance. This act thus helps in conservation of the environment through restoration of the landscape to its former state once quarrying has ended.

2.8.2 Policy Framework

Instrument	Key Features	Relevance to the study
Sustainable Development Goals (SDGs)	The following SDGs are relevant to this study. SDG6 – Clean Water and Sanitation, and SDG 15- Protecting, restoring and promoting sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss (ILO, 1996). SDG7 – Energy Access and Sustainability and SDG13 – Climate Action. SDG 8 - Promote sustained, inclusive and sustainable economic growth, full and productive	Through their direct operations, mining companies can generate profits, employment, and economic growth in low-income countries. At the same time, mining companies are expected to extract with responsibility to ensure environmental protection and conservation. SDG 6 and 15 – For mining operations to be possible, water and land have to be utilized which presents adverse impacts on lands and natural resources that can be mitigated or avoided. This research is centred on rehabilitation and restoration to avert land degradation. Quarrying leads to serious environmental degradation and loss of biodiversity hence SDG 15 works towards reversing this. SDG 7 and 13 -Mining activities are energy and emissions intensive, presenting opportunities for greater efficiency as well as increasing access to energy and combating climate change and its impacts. SDG 8 and 9 - Mining sector can catalyse economic growth and employment. It harbours potential opportunities in terms of economic opportunities for people. These can be in form of jobs, training, and

	employment and decent work for all and SDG 9 – Industrial innovation and infrastructure (Griggs, et al., 2013).	business development relating to mining operations and development of better infrastructure.
World Commission on Environment and Development (WCED)	Commonly referred to as the Brundtland Commission. It focuses on the environmental aspects of development; the emphasis of this commission is sustainable development that does not cause lasting damage to biosphere and to particular ecosystem. The key features associated to this is that it suggests the following: 1. Establishment of Environmental Goals, Regulations, Incentives, and	Quarrying activities causes damage to terrestrial and aquatic ecosystems. To realize environmental sustainability, both social and economic sustainability must be achieved. Economic sustainable development should progress towards environmental and social sustainability. WCED under the strategies for Sustainable Industrial Development dictates that resource and environmental concerns must be incorporated into the industrial planning and decision-making processes of government and industry. This will allow a steady reduction in the energy and resource content of future growth by increasing the efficiency of resource use, reducing waste, and encouraging resource recovery and recycling. Through the establishment of environmental goals, regulations, incentives, and standards, quarrying industries are able to operate in line with the set standards to minimize environmental harm and avoid contravening the

	Standards 2. Broaden Environmental Assessments - Major investments should be subject to an environmental impact assessment (Imperatives, 1987).	regulations. The incentives encourage the companies to do better each day which contributes immensely in controlling environmental degradation. The EIA's play a vital role in approving projects such as quarrying and it helps reduce impacts of such activities on the environment. With proper environmental assessments, the quarrying industry is regulated and its associated environmental risk identified early enough thereby assisting in environmental conservation and monitoring processes.
National Environmental Policy, 2013	The NEP stipulates the following on natural resource use and management: protection of environmentally sensitive areas such as water catchment, watersheds and ASALs, prevention of environmental degradation, promote integrated natural resource management, and adopt appropriate land use planning and management practices for sustainable development of ecosystems (National Environment Policy,	This policy seeks to ensure sustainable management of the environment and natural resources for national economic growth and improved livelihoods. Therefore the National Environment policy aims at regulating quarrying industry and its impacts on the environment through actions such as regular conducting of environmental audits, EIA's before commencement of projects and SEA's.

	2013).	
The National Land Policy, 2017.	This Sessional paper advocates for productive use all land on a sustainable basis by facilitating the implementation of key principles on land use, productivity targets and guidelines as well as conservation. It proposes a multi-sectorial approach to land use, provision of social, economic and other incentives and putting in place an enabling environment for investment, agriculture, livestock development and the exploitation of natural resources (The National Land Policy, 2017).	The formulation of the policy was geared towards guiding the country in its achievement of an efficient, sustainable and equitable utilization of land for prosperity and posterity. Quarrying leads to conflict in land use and causes strain on other land uses as its activities greatly interfere with the landscape and soil and covers large tracts of land. The policy helps in ensuring equitable and efficient use of land among different sectors such as agriculture, industries and housing.
The Kenya Vision 2030	It is premised on three pillars i.e. the economic, social and political pillar. The economic pillar aims at raising Kenya's GDP to a sustained growth	The Kenya Vision 2030 is a long-term development plan for the country that seeks to transform Kenya into a newly industrializing, middle income country providing a high-quality life to all its citizens by the year 2030. Mining contributes to GDP growth of the country. Through sustainable

	rate of 10% per annum. The social pillar targets at making the country a just and cohesive society with social equity, clean and secure environment (Government of the republic of Kenya, 2007).	quarrying, it will contribute in the realization of vision 2030 and help improve life for all Kenyan citizens.
Kilifi CIDP 2018-2022	It replicates the goals of the EAC Vision 2050, which sets out an all-encompassing view in which the region fully uses its resources to hasten productivity and the social security of its citizens (Kilifi CIDP 2018-2022).	Pillar six of this vision aims at achieving effective and sustainable usage of natural resources with enhanced value addition and management. This will ensure that the quarrying of building stones is done in a sustainable way that benefit both the economy, environment and the people abutting the quarry areas to create an thereby achieving a balance within the ecosystem.

2.8.3 Institutional Framework

Instruments	Key Features	Relevance to the study
The United Nations Environment Programme (UNEP)	UNEP's mission is -to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations. UNEP achieves this through some of the following actions but not limited to: i. Monitoring the status of the global environment and gathering and disseminating environmental information. ii. Catalysing environmental awareness and action to address major environmental threats among governments, the private sector and civil society. iii. Providing country-level environmental capacity building and technology support among other	The UNEP is vital in providing information related to sustainable protection of the environment. Through the UNEP's expert advice and capacity building programs on new technology, the quarrying industry is able to adopt better techniques of carrying out their operations hence minimizing harm to the environment. UNEP's policies which are anchored on environmental sustainability also help regulate quarrying activities and shield the environment from further damage as a result of such operations.

	actions.	
Kilifi County Government	Article 174 of the Constitution, states that the objectives of the devolved governments are to promote democratic and accountable exercise of power, to foster national unity by recognizing diversity, to give powers of self-governance to the people and to enhance the participation of people in the exercise of powers of the state and to make decisions on matters that affect them.	The County Government of Kilifi has a role in the sustainable management of quarrying areas within its jurisdiction and is mandated by the constitution to ensure that citizens have the chance to participate in making decision on matters that directly affect them for example establishment of projects such as quarrying within their communities which requires that EIA process be undertaken where the citizens should be involved and educated on the proposed projects

2.9 Case Study

2.9.1 The Chekka Quarry

Chekka quarry is a former active quarry owned by Holcim Lebanon, one of the leading cement companies in Lebanon. The quarry site spreads over an area of 4.62 ha. It was an abandoned and degraded site which was made available by Holcim Lebanon for ecological restoration purposes (Fenianos et al., 2017).

There were two restoration measures: from bare-land to structured-land and from nursery to site. Then from bare-land to structured-land included stone walls construction, gabion walls construction, substrate structures and embankment structures, open excavated ponds, compacted soil and soil amendment. From nursery to site was a tree planting initiative that the land is not left bare. It involved planting and sowing (Fenianos et al., 2017).

The following are objectives of the rehabilitation initiative in Chekka:

a) To show the difficulties experienced during rehabilitation of quarries in order to provide a chance for stakeholders to learn.
b) To demonstrate Holcim Lebanon's commitment and sincerity towards the local communities in solving environmental problems.
c) To affirm Holcim Lebanon's position as pilots in the sustainability commitment in the industrial sector in Lebanon.

Plate 5: Chekka Quarry

Source: Lafargeholcim Worldwide

2.9.2 Shimao Wonderland Intercontinental in China

The Shimao Wonderland Intercontinental hotel is a unique construction in Songjiang, China, located at the base of Tianmenshan Mountain. The hotel is founded on an abandoned quarry that was characterized with stagnant water. In 2012 reclamation plans started by clearing the contaminated water to allow fresh water to stream in the quarry which would be later used as a lake. Soon thereafter construction commenced by UK Company Atkins to provide a contemporary hotel for tourists (Sowers, 2016).

Atkins Company is using sustainable energy sources from the water collected in the quarry for thermal and electrical use. The hotel has 19 stories, 17 of which are below the ground level; two of the floors are above the 90-100M deep quarry. Re-vegetation approach was implemented to create visually appealing scenery. Geomorphic approach was used as the rock surface after mining and used as the foundation of the building which effectively reduced the cost of construction.

The hotel has a combination of indoor and outdoor recreation amenities. Recreation facilities include a restaurant, swimming pool, aquarium and rock climbing (Sowers, 2016).

Plate 6: Shimao Wonderland Intercontinental Hotel

Source: Atlas Obscura, 2016

2.9.3 Haller Park in Mombasa

Haller Park in Bamburi, Mombasa, is a transformation of quarry waste land which holds a variety of plant and animal species. This ecological area serves as a recreational spot for both foreign and domestic tourists. Haller Park was initially a cement production quarry which later became inhospitable arid waste land with brackish water. The Bamburi cement company then decided to hire Rene Haller to rehabilitate the quarries where he embarked on reforestation project in the 1970s (Soft Kenya).

The quarry did not have steep slopes; therefore, re-vegetation approach was viable. The stagnant water that filled the quarry was used as a lake for the hippos that live within the sanctuary. Millipedes and other life forms filled the rehabilitated area as a result of re-forestation. The most important animals were fruit bats and monkeys which acted as seed dispersers for plants and trees not initially planted. Three species of plants were found to survive in the saline conditions and they are: Whistling pine, Coconut palm and Conocarpus lancifolius (Sowers, 2016).

Today, it's a tourists' attraction site evidenced by the 90,000 visitors who visit per year. This provides economic benefit to the nation as it brings revenues from the revenue collected at the entrance as well as from the sales of meat and plants sold from the park's nursery.

Plate 7: Haller Park

Source: Adopted from Google Maps, 2019

2.9.4 How the Case Studies Informed and Contributed to the Research Project.

The Case studies enabled the researcher to have a holistic review of the research topic and provided an opportunity to develop a profound understanding of the topic and establish a credible platform to investigate the factors that affect the topic under investigation in extensive detail.

From the case studies selected, it is evident that massive quarrying was carried out in the areas show cased and therefore serious environmental degradation took place similar to what is happening in Zowerani. They are significant to this research as they demonstrate measures that were taken to restore and rehabilitate the post-quarried lands back to meaningful use. It shows that even after quarrying activities have ended, the lands left behind can be put even to other better uses to benefit the surrounding communities and conserve the environment. The case studies therefore were significant in drawing research recommendations on best practices that could also be replicated in Tezo-Zowerani to address the challenges posed by un-rehabilitated post-quarried lands.

2.10 Overall Information Gap

The reviewed literature gave details on social and environmental impacts of quarrying activities and possible restoration measures, policy and legislature in place regarding quarrying activities, some case studies for restoration and rehabilitation across the globe and in the country. However, the review did not discover existing write ups on the recommended buffer zone considerations for mining development in proximity to human settlements and especially when using explosives. Furthermore, there were no write-ups on any Kilifi county by-laws for management of quarrying activities within its jurisdiction.

2.11 Conceptual Framework

The building and construction industry in Kilifi County and its outskirts mainly depend on block stones for construction of houses. With the fast rate of urbanization in Kilifi County, the demand for the product has greatly increased thereby intensifying quarrying within the quarries of Kilifi County. The increased quarrying activities have had both positive and negative impacts in Zowerani one of the areas where the stones are mined. The impacts experienced are mainly in environmental and social and to a certain extent economic. These impacts depend on how the quarrying activities affect the environment and social life within the community. Generally the

quarrying activities have serious negative environmental impacts in places where they are undertaken as well as negative social impacts. Consequently there are some positive social impacts that are brought by quarrying such as employment opportunities among others. To ensure sustainability of the environment and livelihoods within quarrying areas, all the negative impacts need to be cushioned to minimize their effects. These can only be done through ensuring proper planning/rehabilitation and restoration measures for the quarries before onset of quarrying and after conclusion of the same. This will lead to long term solutions to the challenges caused by quarrying thereby giving room to well-planned post quarry land uses making the lands useful again and able to support practices like agriculture that could not be viable to carry out on post-quarried land before.

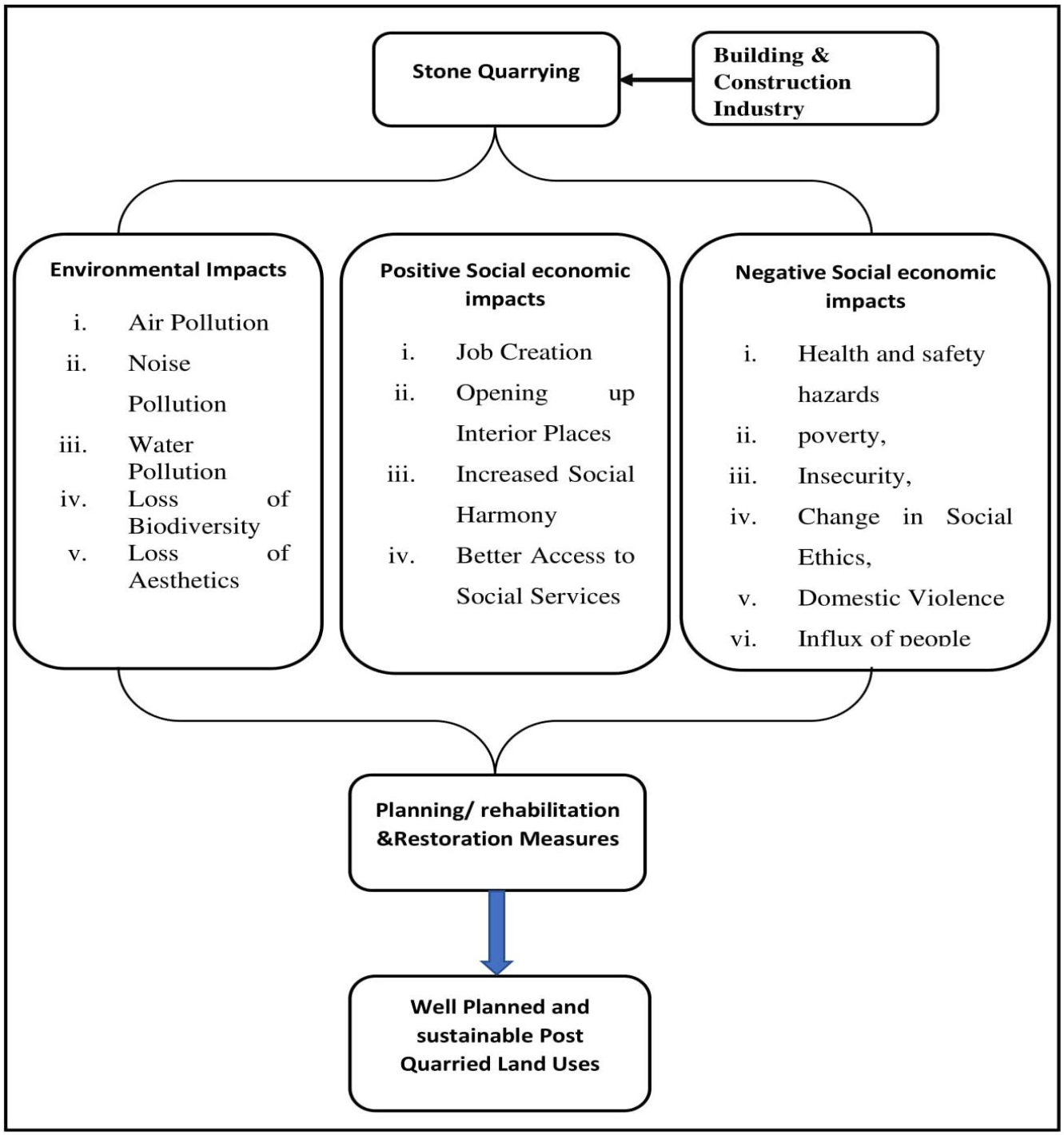


Figure 2: Conceptual Framework

Source: Author

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Overview

This chapter defines the methodology, procedures and how data for the research was collected and used throughout the study. It comprised of data type, sources, collection methods and tools used in the whole exercise. It entailed formulating a data needs matrix which is a summary of the data collection methods, instruments for collection, sampling design, data analysis techniques, data interpretation and presentation techniques.

3.2 Research Design

This chapter discusses the research methodology that was used in this research. It describes research design, study population, sample size and sampling design, data collection methods and data analysis methods that were applied for this study. The study employed qualitative and quantitative research methods. Descriptive survey design and mixed approach were employed to investigate and analyse the realities and facts of what was happening in the study area and used it to draw meaningful conclusions from the findings discovered. The qualitative methodology was used to describe information that could not be easily quantified. The quantitative method was used to assess and analyse the perception of participants alongside the negative and positive impacts of stone quarrying to the peoples' livelihood.

3.3 Target Population

Target population refers to the entire collection of elements about which the researcher wishes to make some inferences (Cooper et al., 2003). Target population in this study were the residents on the land uses adjoining the quarry sites, quarry workers, quarry owners and the key informants. According to 2019 census Zowerani recorded a population of 3078 males and 3239 females with a density of 342 and 1062 households though the study was conducted before the census exercise in 2019 and therefore applied the (Kenya National Bureau of Statistics (KNBS), 2014) statistics for Zowerani sub-location which was a total population of 4575 consisting of 2252 male and 2323 female with a household size of 682 and a total dependency ratio of 1.017. The key informants targeted by the study included: County physical Planning officer, environment officer, health officer, revenue officer, geologist and the area chief (to get history of the area). A total of six quarries were identified and the owners interviewed. From the reconnaissance of the

study area, the researcher found out that there was an average of thirty workers per quarry bringing the target population of the quarry workers to 180.

3.4 Selection of the Study Area

The study area was chosen through purposive sampling. This is because the area had substantive number of quarries with substantive impacts on land use and this is where the county government of Kilifi could try possible rehabilitation measures to reclaim back these quarry sites. Zowerani sub-location hosts several quarries compared to other quarrying sites within the county where stone mining takes place and hence it was purposely chosen for this particular study. Besides this, most of the already quarried lands are left unattended to posing danger to the surrounding land uses and/or people leaving close to the quarries.

3.5 Sampling Technique

Sampling involves the selection of a section of individuals within a population to measure the characteristics of the entire population (Kish, 1965). Sampling was therefore very important to give a representation of the entire population.

Different sampling strategies were employed to provide a representative view of the population so as to achieve the study objectives. In order to identify the land uses adjoining the quarry area i.e. the households, Spatial stratified sampling and systematic sampling were used. The spatial stratified sampling was used to map out households next to the quarry sites in the study area for the survey. The households were then selected through systematic sampling whereby by the first house from the edge of the study area was selected and thereafter the subsequent households for sampling were identified systematically after every three houses within a buffer of 3km from the highest watermark of the ocean.

The quarry owners were selected through convenience sampling. Zowerani area has got six main quarries and the study sampled those six main quarries as a representative of the whole study area. It was therefore convenient for the study to acquire information from the individuals who owned those six main quarries and hence six quarry owners were sampled in total. The quarry owners were samples as part of the respondents within the quarries. They were mainly targeted to provide information on impacts of quarrying with regards to environmental sustainability; the welfare/well-being of the quarry workers in terms of ensuring their safety through provision of

enough proper protective gears and payment of better wages; and the rehabilitation measures/techniques they employed to the post-quarried lands.

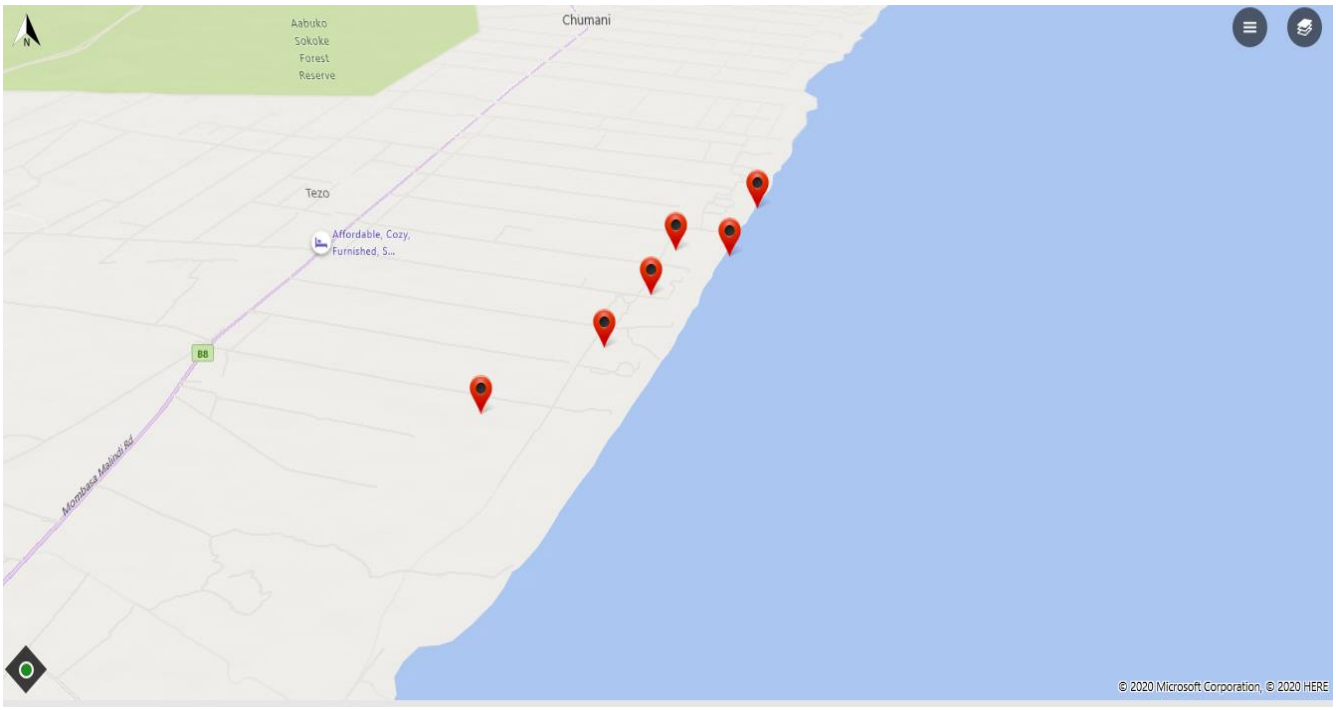


Figure 3: map showing the location of six main quarries picked by GPS in Zowerani.
Source: Google maps

Table 1: GPS coordinates of selected quarries

Site/Name	**Description/Features**	**XYZ Coordinates**	**Size / Area Covered**
Quarry 1	Situated next to Zowerani Primary School.	S03^{0}31.971' E039^{0}54.575 '	Covers 1.5acres and many multiple smaller quarries are located next to this particular quarry
Quarry 2	Located next to the sea shore East of Zowerani Primary School.	S03^{0}32.027' E039^{0}54.855'	Covers massive 5acres and other abandoned quarries surround it
Quarry3	Situated at the sea shore on the north eastern side of Zowerani Primary.	S03^{0}31.467' E039^{0}55.042'	Covers approximately 2acres
Quarry 4	Next to Zowerani Market Centre.	S03^{0}32.424' E039^{0}54.448'	Covers 3acres
Quarry 5	Situated by the roadside on the murram road connecting Zowerani to Bofa.	S03^{0}32.890' E039^{0}54.244'	Covers 2acres and other operational quarries are located nearer
Quarry 6	Located by the roadside as you leave Zowerani towards Tezo.	S03^{0}33.381' E39^{0}53.761'	Covers 2.5acres

Source: Author

The quarry workers were selected through simple random sampling from the six main quarries within Zowerani sub-location. In total, 30 quarry workers were sampled as respondents for the study. As mentioned in the section for target population, a reconnaissance study conducted by

the researcher showed that the main quarries had an average of thirty workers as stated by the quarry owners. This meant that the total target population for quarry workers was 180 as six quarries were sampled. The study therefore chose to sample 5 random quarry workers within the six quarries ensuring that every individual had the same probability of being selected during the sampling process. This sampling procedure assured that every quarry worker in the six main quarries had an equivalent opportunity for selection. It also guaranteed the absence of sampling bias making sure that the sample was a representative of the entire population.

Finally the key informants were selected through purposive sampling also known as judgmental, selective, or subjective sampling. The key informants were six in number and they included the County Environment Officer, County Geologist, Sub-County Revenue Officer, County Physical Planning Officer, Sub-County Health Officer and the Chief of Zowerani Sub-location. This method of sampling was used because the researcher had prior knowledge about the purpose of the study and therefore already knew the eligible key informants who would be relevant to the study so as to provide specific information that would aid in realizing the objectives of the study.

All the key informants had specific information to add in the study since they played important roles in the quarrying sector in Zowerani. The County Physical planning officer gave information on the zoning plans available for this area as well as whether the county spatial planning took into the consideration the quarrying activities within the county, the health officer provided information on the impacts quarrying activities in the area have on human health, she was able to give statistics of the common illness as reported in the area compared to other places where no quarrying was taking place , being a resident also she associated the commonly treated cases to the quarrying taking place, the chief of the area gave important information on public participation and whether the residents are always informed of the quarrying activities and their side effects, he also gave an in-depth history of the quarrying activities including the local knowledge on the maturity of the corals (how they are able to identify the mature corals for harvesting. The environment officer gave information on the EIA processes and whether the environmental regulations are being adhered to, the county geologist was concerned with providing information on the sustainability of the quarrying activities in the area and whether the activities were being conducted according to the mining laws. Finally the revenue officers gave

the information remittance of taxes by the quarry owners and whether the benefits accrued from the quarrying activities were being shared adequately in line with the existing laws.

3.6 Sampling Frame

This aims at choosing part of the population from which information will be drawn to form conclusions about the general population.

To determine the sample size for both the quarry workers and the households, the following formula by (Miller & Brewer, 2003) was used.

$n=N/ (1+N^{*}\alpha^{2})$

Where: α = the level of significance or margin of error

n =the sample size and

N = the sample frame.

In order to have a just representative sample size, the sample size for the households was determined at a significance level 0.08 while that of the quarry workers was at a significance level of 0.165.

Sample size for households: N=682

$$n= \frac{682}{1+682(0.08^{2})} = 127.12$$

n=127 households (Sample frame used was 126)

Sample size for quarry workers:

From the reconnaissance study conducted by the researcher in Zowerani sub-location before the actual study, it was evident that each of the six main quarries had an average of 30 workers throughout the year. The quarry owners noted that the number of employees was not consistent and that 30 quarry workers was the best average number of employees they could employ throughout the year. The study therefore used 30 employees for each of the six quarries since each the main quarries had approximately 30 workers.

N= 30x6 = 180

N=180

$$n= \frac{180}{1+180(0.165^2)} = 30.50$$

n=30 quarry workers

The sample size for the ***quarry owners*** who were categorized under respondents within the quarries ***was 6*** and they represented the quarries that were sampled while the ***key informants*** who were selected through purposive sampling were 6.

3.7 Distribution of Sample Size

Table 2: Distribution of Sample Size

	Sample Frame	Sampled Number
1.	Quarry owners	6
2.	Quarry workers	30
3.	Key informants	6
4.	Adjacent residents	126
	TOTAL	168

Source: Author

3.8 Types/Nature of Data Used for the Study

This study relied on both secondary and primary data as described below.

3.8.1 Secondary Data

This is information that was gathered through desktop research and literature review of past work relevant to the study. Some of the literature included relevant policies, laws and institutions influencing quarrying matters in Kenya. Secondary data was later corroborated by primary data collected during field work exercise.

3.8.2 Primary Data

It entailed the first hand data that was collected directly from the field. Primary data was collected by the researcher using tools such as questionnaires, photography interview schedules and observation checklists. This data verified the validity of the problem identified. An elaborate explanation on the primary data and where obtained has been given in the data collection methods section as well as in the section containing information on data needs according to the objectives.

3.9 Data Collection Methods

The study used several sets of data collection instruments to collect data for the study. They included:

1. **Literature Review**

It was used to gather secondary information for the purpose of conducting the study. Sources included; from published and unpublished office documents, articles, journals, reports, books, libraries, blogs, and online sources. The information sourced from these sources helped to explain impacts of stone quarrying on the environment and social economy and possible restoration measures of post quarried land. It entailed reviewing past work on the study topic from the sources mentioned to help identify research gaps, discuss conceptual framework, answer the research topic and make meaningful inferences and recommendations from the study.

2. **Instrument Administration**

Questionnaires were administered on the history of quarrying in the ward, how it had progressed over time and the impacts experienced due to mining, including the perception of the residents on the post quarried land use. They were used on the residents and those working on the quarry sites.

3. **Interview**

Interview is a structured face to face verbal communication between a researcher and the respondent (Ngau & Kumssa, 2004). The key informants included the Sub-county officials

namely the Environment officer, County Geologist, Sub-County Revenue Officer, County Physical Planning officer, Sub-County Health Officer and the Chief of Zowerani Sub-location. Interviews were accompanied with an interview schedule which included the list of questions mainly on how the ward was affected due to mining.

The information to be tapped from the chief and village elders included but was not limited to the impacts, challenges and opportunities experienced in their respective territories and recommendations to ameliorate the situation. The environmental officer and county geologists were engaged to tap the operational legislative frameworks that guided and safeguarded the exploitation of mining resources in the Sub- County. The county planner gave an overview of the suitability and compatibility of the land uses including whether the area was captured for proper zoning in the county spatial plan while the revenue office provided an account of the revenue generated by this industry including the measures the county had taken to improve the situation. They also informed on the most suitable approaches to redress the resource conflicts. Other interviews conducted were on the residents who had first-hand experience from the impacts, the quarry workers who were faced with enormous operational safety challenges as well as the quarry owners who also expressed their challenges.

4. **Direct observation, Photography and Sketching**

Observations were made systematically and the information recorded showed the present situation in the area in terms of the social, economic and environmental impacts experienced. This was done through the use of an observation checklist and form accompanied by photography and sketching.

5. **Mapping**

Maps were employed to illustrate the spatial distribution of the quarries within the study area (their sizes and location) and to spatially layout the land use change trends and patterns within the ward. Moreover, mapping was used in spatially delivering the discovered impacts of the quarries to Zowerani Sub location while photographs and sketches were taken to illustrate the existing scenarios on land.

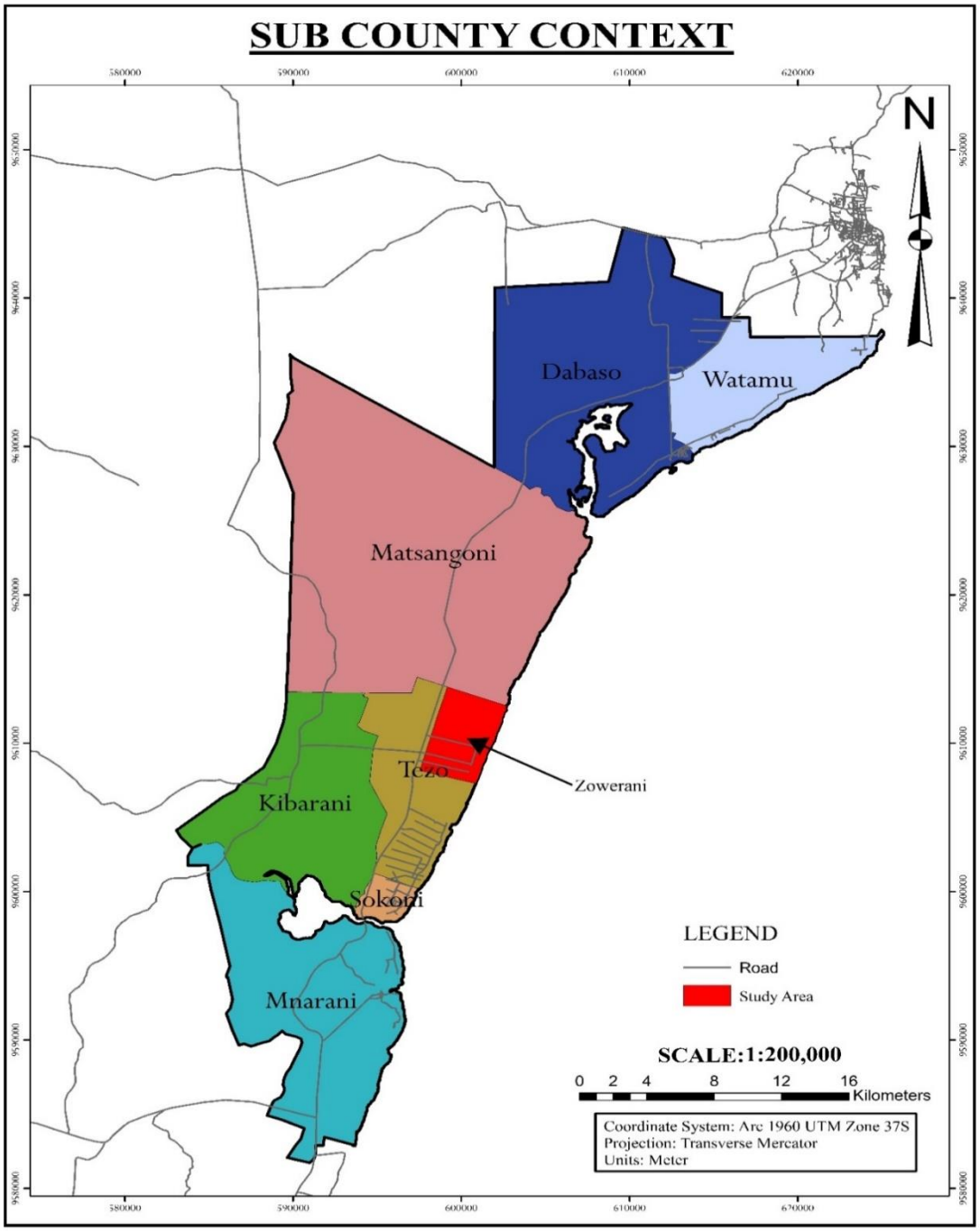


Figure 4: Map of the study area

Source: Author

3.10 Data Analysis Procedures

This study employed Miles and Huberman process in analysing the data that consisted of five phases i.e. data collection, data reduction, data display, conclusion drawing and verifying findings (Miles & Huberman., 1994).

i. Coding and Data Entry

The raw data from questionnaires, interview schedules and observations were checked and organized in a systematic way that enabled analysis. With regards to Quantitative analysis, the data was converted into numerical codes representing attributes or measurement of variables. A coding scheme was then prepared to ensure consistency in coding so that no details were omitted when entering the data into the computer. Data was then entered into the computer directly from the questionnaire.

ii. Qualitative Data Analysis

Qualitative data analysis here referred to non-empirical analysis. Examples here included content analysis and historical studies that was mainly done through systematic literature review and desktop research including some verbal accounts from the locals based on their historic experience. Qualitative data was useful in analysing information in a systematic way and helped to draw useful conclusions and recommendations especially on patterns, trends and relationships from the information gathered by comparing the research findings with the different case studies and the literature gathered. The spatial data generated through visual image interpretation and field observations were supplemented by GPS measurements, and later processed in GIS environment to facilitate spatial analysis and output display. ArcGIS 10.5 software was used to carry out spatial analysis, offer interface between spatial and non-spatial data and finally used to produce maps.

iii. Quantitative Data Analysis

This was useful in the meaningful description of distribution of scores or measurements using a few indices and statistics. Quantitative data was analysed using SPSS 2015 which proved valuable as it provided the researcher with an in-depth, faster and accurate statistical analysis, data management and data documentation. The software also had features that generate a wide range of graphs, methods and charts.

3.11 Data Presentation Plan

Analysed data was presented graphically for purpose of easy interpretation and consequent drawing of conclusions and recommendations. Tables, bar charts and photographs were some of the graphical presentation techniques applied for this study.

3.12 Ethical Considerations

Certain ethical principles were used in this research. Data used for this research was confidential and collected from a range of respondents whose identities were not revealed by not disclosing their names. Again seeking consent from the respondents before sampling for data was applied meaning only those willing to participate took part in the research.

3.13 Data Needs According to Objectives

Objective 1: Land uses in Zowerani Sub location and how they have changed over time.

Data Needs

Data here included form of land uses neighbouring lands occupied by quarry sites, land designated for mining, number of quarries and their sizes and other land uses neighbouring quarrying land within the study area.

Data Sources

Data was acquired through Google earth history, history from the land uses adjacent to the quarrying area and County Development plans. Other sources included review of literature and desktop research. The county department of environment and researcher's observations also provided data.

Objective 2: Social-economic and environmental impacts of quarrying activities in Zowerani

Data Needs

Data required to comprehend how quarrying activities have impacted Zowerani sub location in both social economic and environmental aspects included: - effects of quarrying activities on the other land uses, planning regulations governing quarrying activities, social economic characteristics and economic trends.

Data Sources

Data was acquired through, analysing history from the land uses adjoining the quarrying area, interviews from the local administration team, interview with the revenue collection officers and County integrated Development Plan. Desktop research and literature review were also incorporated.

Target Population

This section targeted the population that would assist in finding out the impacts of quarrying activities in Zowerani and it included the neighbouring land uses. The key informants included; Environment officer, County Geologist, Sub-County Revenue Officer, County Physical Planning officer, Sub-County Health Officer and the Chief of Zowerani Sub-location.

Objective 3: Roles and Perception of the Stakeholders in quarrying activities

Data Needs

Data here included the roles, views and behaviour of stakeholders. Views from the stakeholders who were affected directly or indirect by quarrying in Zowerani were captured for achievement of this objective.

Data Sources

Questionnaires administered to quarry owners, quarry workers, key informants, relevant secondary data and researcher's observation.

Target Population

Quarry workers, quarry owners residents and key informants.

Objective 4: Possible restoration and rehabilitation measures to post quarried land

Data Needs

Data here included the legal and policy goals from various sectors that affected quarrying activities and how they were regulated and review of the previous and present county strategies for ensuring sustainable quarrying activities.

Data Sources

Constitution of Kenya, NEMA policies, relevant acts of parliament, Kilifi CIDP and the Physical Planning Handbook

The respondents for this study were drawn from quarries in Zowerani. The sampling frame was inclusive of 6 main quarries in Zowerani Sub-location. Most of the quarries assumed similar characteristics and the same quality of stones were mined. The socio-economic considerations for all the quarries were assumed to be similar.

The socio-economic data was collected from quarry workers, quarry owners and people living within the quarries. The choice of the number of respondents was through convenience sampling and simple random sampling for the quarry owners and the quarry workers respectively.

An additional 126 respondents were interviewed for people living next to the quarry sites. The households next to the quarry sites were chosen because that was where residents were most likely to be affected by the quarrying activities.

Nevertheless, there are no documented recommendations on the buffer zones of a quarry which is using explosives to blast like the case for Zowerani Quarries. The quarries were located on individuals' land which was leased. Systematic sampling was used in selecting these respondents as the data used to determine the effects of quarrying on people living within quarry environs. Purposive sampling was used in administering interview schedules to the relevant key informants

Location and Temporal Data

Structured and illustrative analysis was employed in identifying the land uses in Zowerani Sub location and how they had changed over time. The structured analysis described the qualitative and quantitative aspects of quarries and the target location while the illustrative analysis involved photographic assessment of structural elements and features present in the target location. A spatial analysis using mapped sources such as Google earth was also conducted to synthesize data on land use changes in the area so as to understand the mining trends and how they affected a rural area like Zowerani sub-location.

Impacts

The analysis employed to synthesize the social, economic and environmental impacts of the quarries in Zowerani Sub location included; descriptive analysis, classification and tabulation, quantitative analysis, spatial analysis and illustrative analysis. Illustrative analysis of the study area was accompanied by using photographs taken during the field visits to create an image of the real problem faced in the area.

3.14 Data Needs Matrix

Data needed in identifying the effects of quarrying in Zowerani sub-location in Kilifi north sub-county was guided by the four objectives.

1. *The land uses in Zowerani Sub location and how they have changed over time.*

The data required to achieve this objective included; Land occupied by quarry sites, land set aside for mining and the number of quarries and their sizes. This information was obtained from review of county plans and from the field study undertaken.

Methods of data collection used included: administering questionnaires, interview schedules, direct observation by the researcher and drawing of sketches. Methods of data analysis were structured and illustrative analysis. The data was presented in form of maps, descriptive texts and graphs.

2. *To assess social, economic and environmental impacts of quarrying in Zowerani sub-location.*

The main goal of this objective was to understand the benefits and disadvantages accrued to Zowerani economically due to mining that was carried out. This was acquired through field study and interviewing key informants.

3. *To identify the roles and perception of stakeholders in quarrying activities in Zowerani.*

This objective aimed to identify the environmental impacts experienced in Zowerani sub-location through carrying out field survey. This information assisted in the development of site analysis maps and site suitability maps. The types of analysis employed included; quantitative analysis, spatial analysis and illustrative analysis. Finally, presentation was in form of maps, descriptive texts and photographs

4. *To propose the possible restoration and rehabilitation measures to post quarried land*.

The objective was set to guide the restoration of the quarried land. The data needed included measures that could be set for this objective to be achieved, how effective they were and the cost of implementing these measures. This was sourced from the findings during the field survey and review from secondary data.

Table 3: Data Needs Matrix

OBJECTIVE		DATA NEEDS	DATA FORM	SOURCES OF DATA	DATA COLLECTION METHODS	DATA ANALYSIS	DATA PRESENTATION METHODS
1.	To examine land uses in Zowerani Sub location and how they have changed over time.	Land occupied by quarry sites, land set aside for mining, number of quarries and their sizes.	Qualitative Quantitative	Review of existing county plans, policies and regulations. Field survey	Interviews Questionnaires Direct observation	Qualitative analysis, Quantitative analysis, Illustrative analysis,	Maps Photographs Descriptive texts

OBJECTIVE		DATA NEEDS	DATA FORM	SOURCES OF DATA	DATA COLLECTION METHODS	DATA ANALYSIS	DATA PRESENTATION METHODS
2.	To assess social and economic impacts of quarrying activities in Zowerani sub-location.	Socio-economic characteristics such as housing and income Economic trends over time.	Qualitative Quantitative	Field survey.	Interviews Questionnaires Direct observation.	Quantitative analysis, spatial analysis and illustrative analysis	Descriptive texts

OBJECTIVE		DATA NEEDS	DATA FORM	SOURCES OF DATA	DATA COLLECTION METHODS	DATA ANALYSIS	DATA PRESENTATION METHODS
3.	To identify the roles and perception of stakeholders in quarrying activities in Zowerani.	How has quarrying affected the other land uses? Has planning regulations been enforced?	Qualitative Quantitative	Field survey	Interviews Questionnaires Direct observation	Quantitative analysis, spatial analysis and illustrative analysis	Maps Photographs Descriptive texts

OBJECTIVE		DATA NEEDS	DATA FORM	SOURCES OF DATA	DATA COLLECTION METHODS	DATA ANALYSIS	DATA PRESENTATION METHODS
4.	To propose the possible rehabilitation measures to post quarried land.	What can be done to restore the already quarried land? What are the different alternatives in restoring quarried land	Qualitative Quantitative	Review of policies and regulations. Findings from precious objectives	Review of relevant secondary literatures	Descriptive analysis, classification and tabulation, opinion and comparative analysis.	Descriptive texts

Source: Author, 2019

CHAPTER 4
BACKGROUND OF STUDY AREA

4.1 Introduction

This chapter introduces the study area from the perspective of locational context, physiographic and natural conditions, population and demographic characteristics. It also accompanies the spatial inventories and descriptions with illustrations in the form of maps, tables and figures. Moreover, spatial information captured communicates of the spatial relationships among existing land uses and abutting land uses.

4.2 Geographical Location

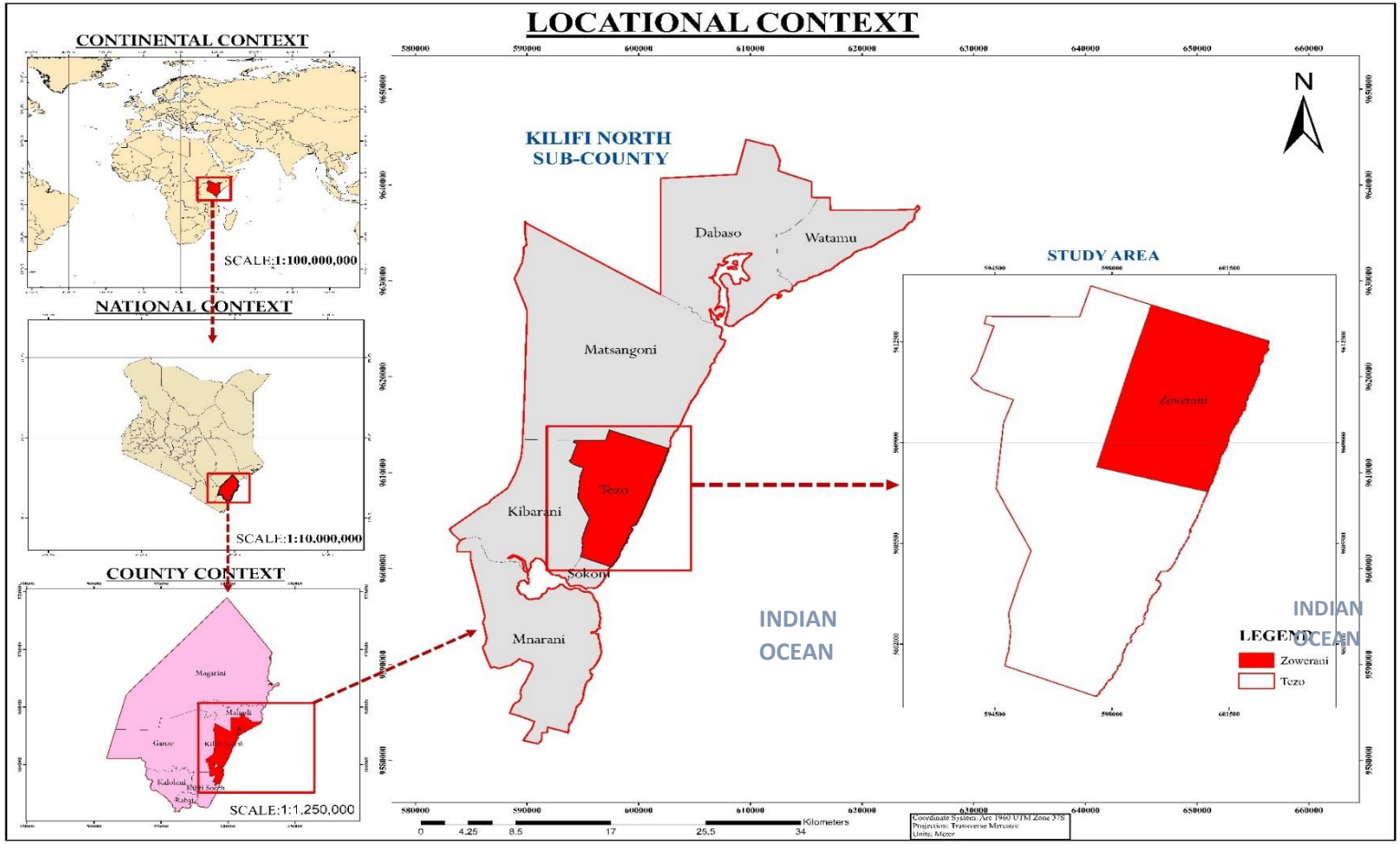
The study area is situated within the administrative confines of Tezo ward, Kilifi North Sub-county and Kilifi County. It also borders Matsangoni to the north, Kibarani to the west, Mnarani to the south and the Indian Ocean to the east. Zowerani sub location covers an area of is 2,069.852 Ha and is located 8 kilometres from Kilifi town. The study area is serviced by B8 Road, C115 road and Class E earthen roads. Zowerani area is also hub of mining activities and is populated by quarries along the shores of the Indian Ocean.

Table 4: Area Coverage

	Administrative Boundary	Area Coverage (Approximately)
1.	Kilifi County	1,264,384.01 Ha
2.	Kilifi North Sub-county	82,813.02 Ha
3.	Tezo ward	7,485.446 Ha
4.	Zowerani sub location	2,069.852 Ha

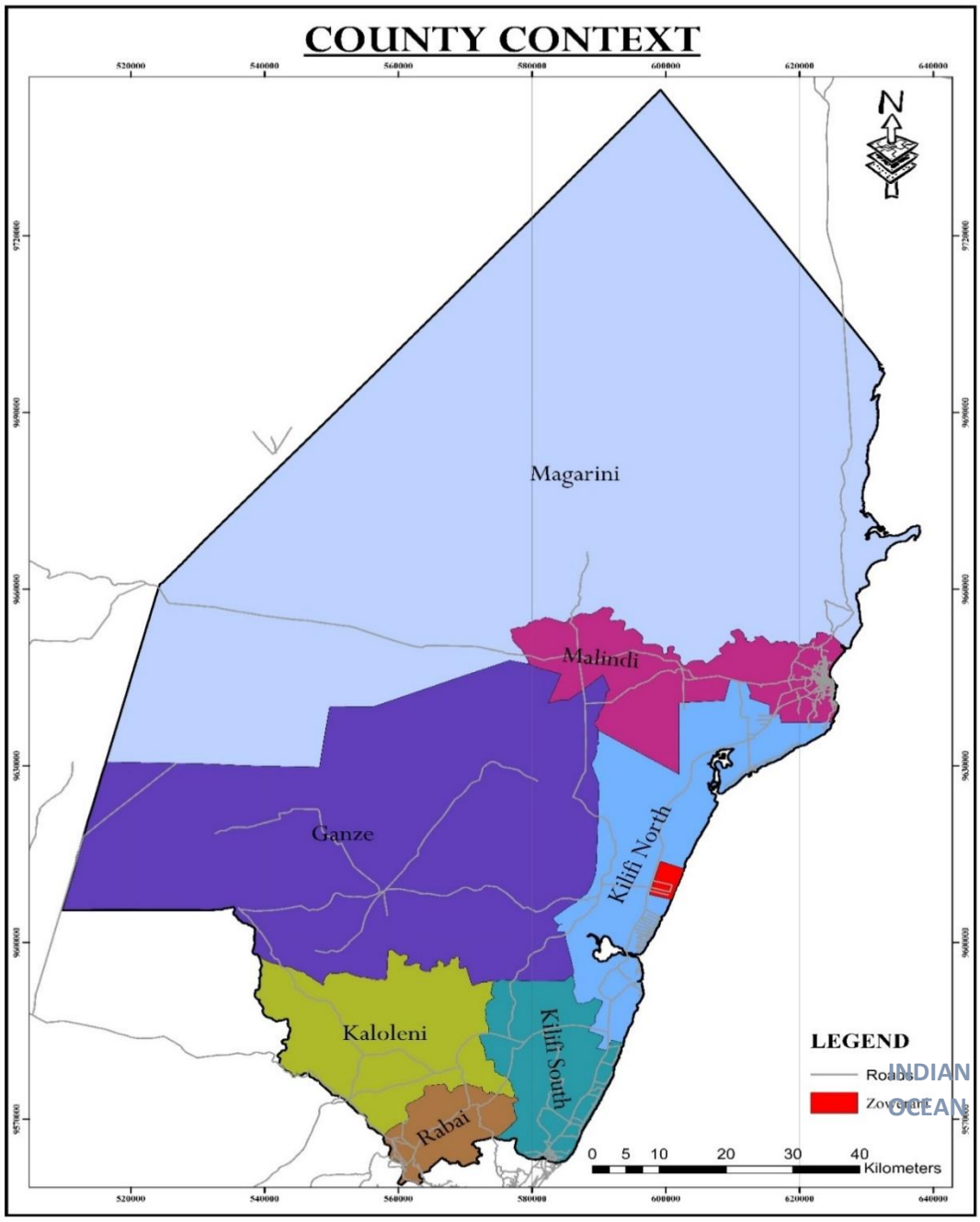
Source: (County Government of Kilifi, 2018).

Map 1: Locational Context



The first map shows the geographical location of Kenya in continental context and shaded in red, the second map shows Kilifi County in Kenyan context, the third map shows Kilifi north Sub-County in the county context, the fourth map shows Tezo ward within the Sub-county context and lastly Zowerani sub-location in the ward context.

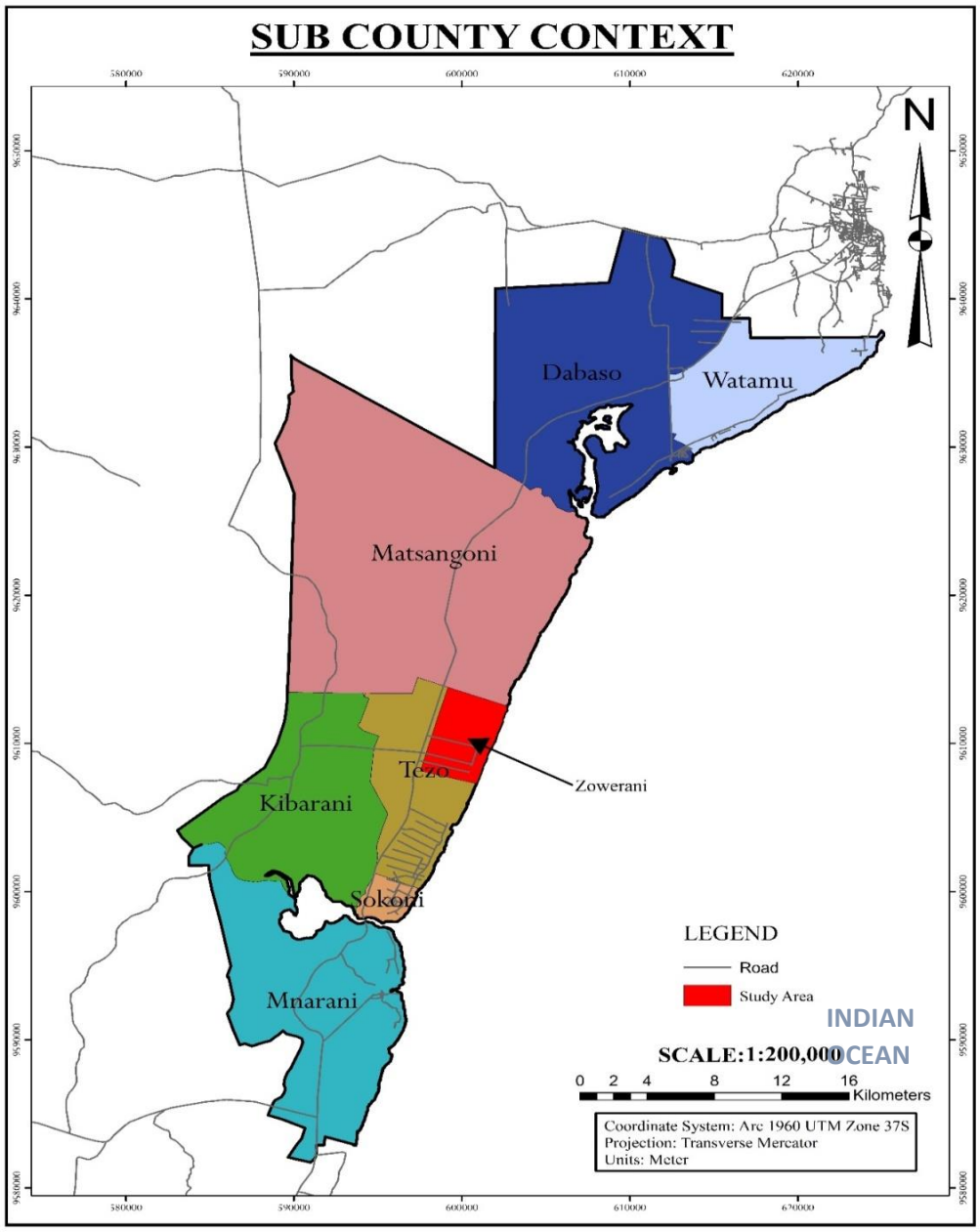
Map 2: County Context



Source: Author, 2019

The Map shows the location of Zowerani area in county context. Zowerani is located in Kilifi County that borders Mombasa County to the North and Lamu County to the south. It is found in the south eastern part of the county. The map shows different sub-counties in Kilifi. The area highlighted with the red colour represents Zowerani sub-location.

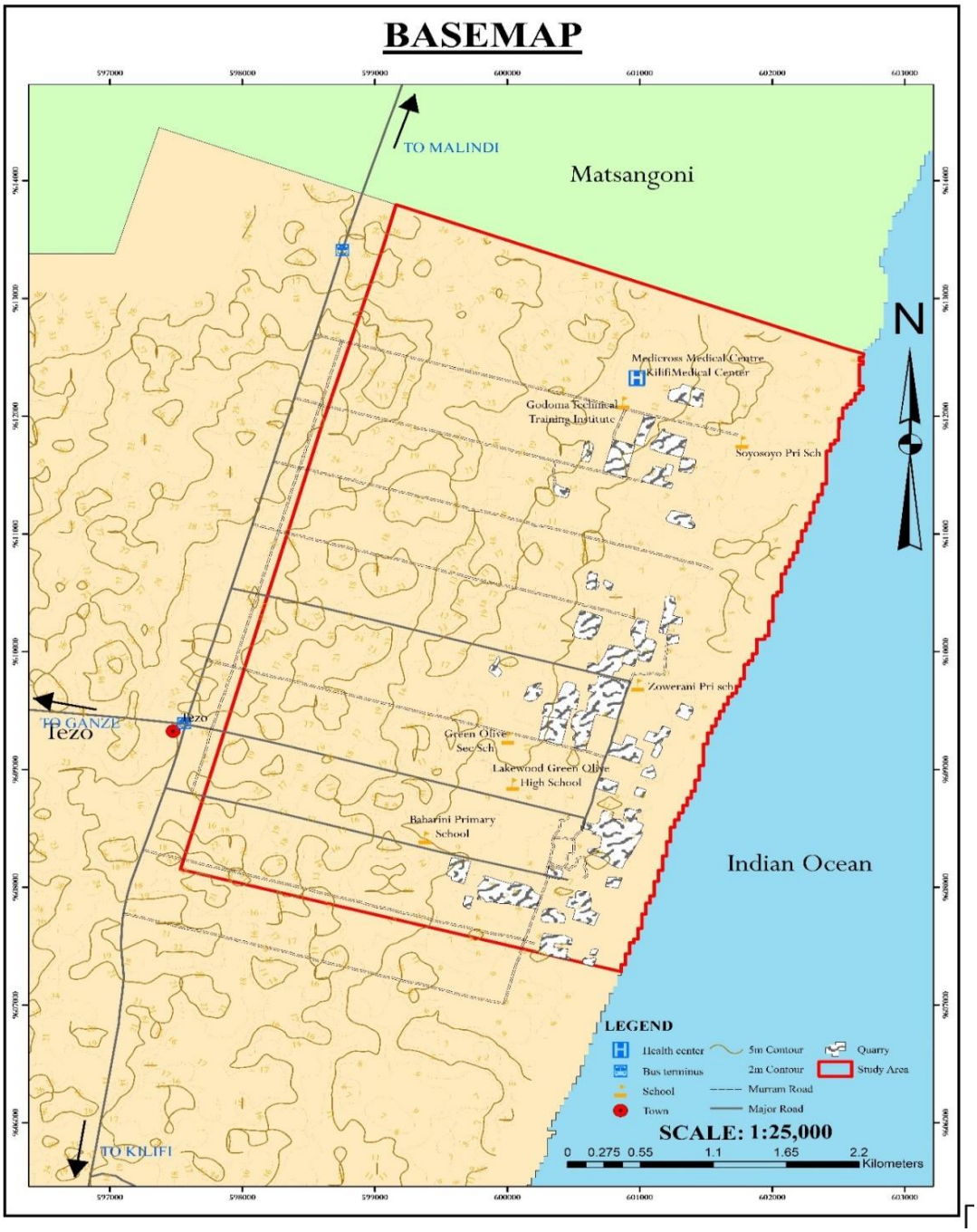
Map 3: Sub County Context



Source: Author, 2019

The above map shows the geographical position of Zowerani with regards to the sub-county context. The map clearly demarcates the different wards found in Kilifi North sub-county and Zowerani is found in Tezo ward.

Map 4: Base Map



Source: Author, 2019

Edged in red is the external boundary of the study area, the white and grey fields representing the quarried lands. The spacing of the contours indicates that the area is relatively flat.

Source: Google Maps

Plate 8: Google extract of a section of quarries in the study area

4.3 Demographic Characteristics

According to 2019 census Zowerani recorded a population of 3078 males and 3239 females with a density of 342 and 1062 households. This compared to the Kenya National Bureau of Statistics data for the same area in 2014 shows that Zowerani sub-location has a very fast growing population. Assuming a population growth rate of 3.1% of Kilifi County, the population projection would be as shown below:

Table 5: Population Projection

Year	**2019**	**2020**	**2025**	**2030**
Male	3,078	3,152	3,671	4,276
Female	3,239	3,250	3,786	4,410
Total	6,317	6,402	7,457	8,686

Source: (Kenya Population and Housing Census, 2019)

From the projection statistics, it is evident that the population in the area is exponentially increasing compared to the past years. This implies that more housing units will be needed to host the ever-swelling population in the area and hence the quarrying activities in Zowerani are expected to continue increasing with time.

4.4 Climatic and Physiographic Features

Zowerani sub location sits along the coastal belt and therefore receives an average annual rainfall of between 900mm to 1,300mm. Short rains are experienced in the months of October, November and December while the Long rains are experienced in the months of March, April and May (County Government of Kilifi, 2018). The average temperatures experienced ranges between 21^0C and 30^0C. These are relatively high temperatures and therefore the likelihood of most of the workers not able to put up protective gear while working the highest temperatures of 27.7 °C are experienced in March while lowest temperatures of 23.9 °C occur in July.

Accordingly, highest evaporation rates are registered during the months of January to March in all parts of the county. The study area also registers wind speeds of 4.8Km/h (Climate-Data.org, 2019). This is high speed and this accelerates dust pollution in the quarry adjacent land uses. *Source: Meteoblue 2013.*

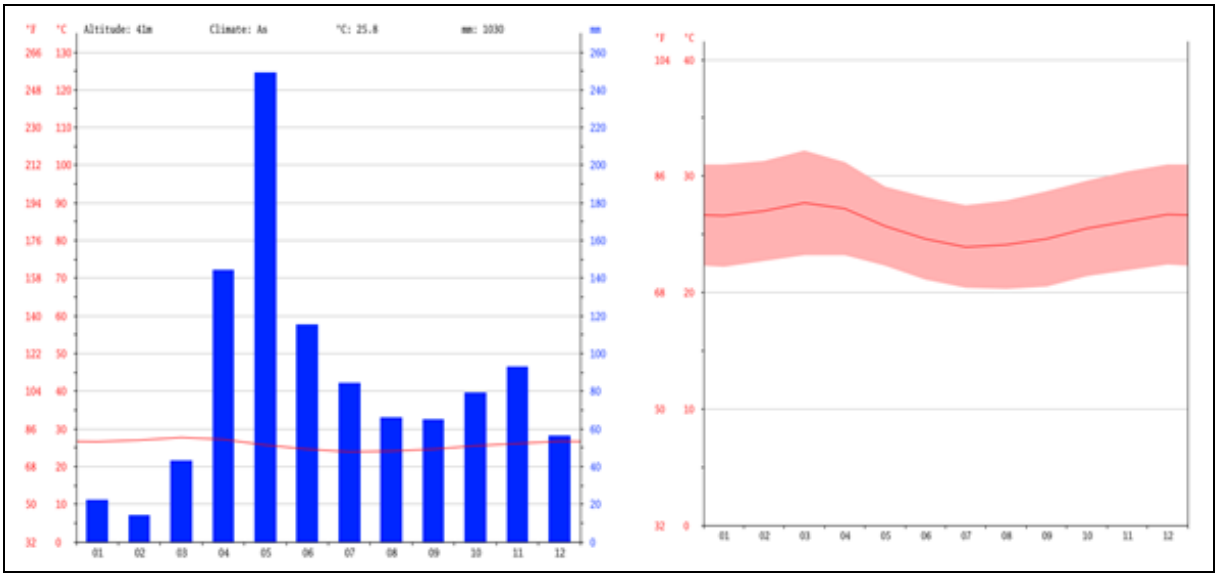


Figure 5: Temperature and Precipitation levels

Kilifi County is endowed by four main topographical features namely Coastal plains, Foot plateau, Coastal range and Nyika plateau. Zowerani is located within the coastal plains that are primarily composed of marine sediments, including coral, limestone, marble, clay stones and alluvial deposits and hence the suitability for stone quarrying (County Government of Kilifi, 2018). The area registers relative low slopes of (0-5%) with the lowest points and highest points being 1m and 53m above the sea level. Accordingly, the area generally slopes from the west to the east –shores of the Indian Ocean.

The climate and the terrain in this area favour quarrying. The relatively gently sloping terrain almost certainly flat makes it easy to mine stones and make access roads to the mines for transportation. The temperatures of between 20-30 degrees in the area also favour the formation of corals and that explains the availability of these rocks in this area which hugely attract and encourage quarrying.

4.5 Socio-Economic/Cultural Profiles

The available social amenities were schools and health centres only. Zowerani sub-location is served by six schools i.e. three primary schools, two secondary schools and a tertiary institution. They include: Baharini Primary School, Soyosoyo Primary School, Zowerani Primary school, Lakewood Green Olive High School, Green Olive Secondary School, and Godoma Technical Training Institute. It is also served by a clinic - Medicross Medical Centre, Kilifi Medical Centre and Zowerani dispensary. Soyosoyo and Zowerani primary schools have been adversely affected by the quarrying activities within this area.

Zowerani, Tezo is found in Kilifi North sub-county and according to the KNBS (2019) Census report Volume (IV), the total population in Kilifi North was 162,990 people. The number of school goers in the sub-county was 72,834 representing 44.7 % of the total population in the sub-county. Out of this, 40,268 left school after completion representing 24.7% of the total population while 24,984 left school before completion representing 15.3% of the total population. 23,855 representing 14.6% of the total population never went to school while 1040 residents representing 0.6% of the total population did not know whether they went to school.

In terms of education attainment, of all the 72,834 school goers, 17,073 people attained pre-primary education, 41,645 people attained primary education, 10,609 people attained secondary education, 1693 people attained TVET education, 1607 people attained university education, 34 people attained adult basic education, and 49 people attained *Madrasa/Dukai* while 124 people are not aware of the level of education they attained.

In terms of labour force, a total of 153,360 people in Kilifi North Sub-county are in the labour force bracket. Of this number, 68,410 are working, 9406 are seeking work/no work available, 75,535 are persons outside the labour force square while nine persons never stated whether they work or not.

In terms of distribution of households practising agriculture, fishing and irrigation as an economic activity, 298,472 households are involved in the activities in Kilifi County. Of this number, 35,912 households are from Kilifi North Sub-County with the distribution as follows: 18,690 farming, 17,085 crop production, 12,011 livestock production, 30 aquaculture, 1021 fishing and 386 practising irrigation.

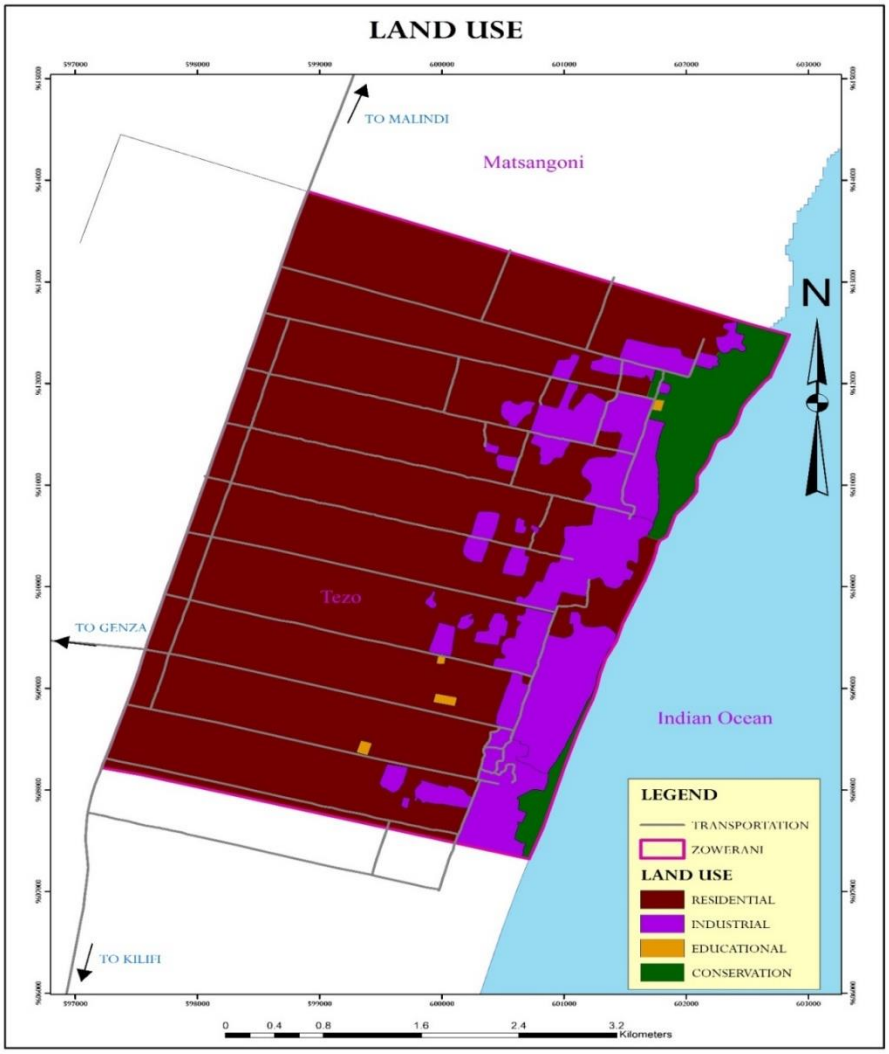
4.6 Physical infrastructure

Accessibility to and within the study area was facilitated by *B8 Road*, C115 *road* and *Class E* earthen roads. Only the *B8 Road is* tarmacked and connects Zowerani sub-location to Kilifi town and Malindi town. This made transportation of the quarry materials easy although on a negative side the sections of the road that the tracks used had been adversely affected and are constantly subjected to frequent repairs.

4.7 Land Use

The intensive land use exhibited in eastern part side of Zowerani sub-location is mining. The mining activities were facilitated by the availability of numerous quarries owned by the Coastal Development Authority among others along the coastal strip. Mining activities experienced in the area, involved harvesting of masonry stones which is lucrative for the ever-increasing demand for the building and construction industry. The abutting land uses were majorly residential and agricultural land uses. The study area also sits proximity to Tezo town.

Map 5: Land Use Map



Source: Author, 2019

4.8 Roles and Perception of Stakeholders in Quarrying Activities

The present-day concern world over is sustainable development that incorporates environmental concerns in sustainable exploitation of the natural environment. Quarrying activities exacerbates more impacts on the environment more than the economic benefits. These impacts on the environment and other socio-economic impacts form a solid foundation for conflicts between local communities and quarrying firms (Lad & Samant 2014).

The area along the ocean in Zowerani has for a long time been a source of building stone for areas surrounding the quarry areas. Therefore, the Quarried landscape increases each passing day and so does the impact on the environment and the society. This study was therefore able to

establish the perception of the people who live around the quarries in this area. The study captured people perceptions on the impacts of quarrying to society and environment, quarry rehabilitation methods and post quarry use of land.

4.9 Trend of Land Uses in Zowerani Sub Location

The quarrying area was initially covered with indigenous shrubs with minimal agricultural practices taking place. Most of the land is privately owned through an adjudication process. Due to the potential of the coral stone in this area and also increased demand of building material caused by the growth of urban centres within Kilifi county and by extension Mombasa county, people started quarrying coral blocks for construction in small scales using hand held devices. Gradually the land owners would be approached to lease the land for big companies whom would then use machine cutting devices to quarry in large scale. This trend has continued over the years with quarry owners moving from one site to another. The unfortunate occurrence is that once they exhaust one site, rehabilitation and or restoration is never carried out leaving large open pits which during rainy seasons are filled with rain water posing dangers to residents living near these quarry sites.

Plate 9:Un-rehabilitated Quarry Site

Residential Land Use

Residential land use in Tezo Ward primarily involves housing densities built within the township. They are a mix of low, medium and high-density housing. The low-density category allows traditional single-family homes, with one dwelling allowed per legal lot. Houses consist of single-family, detached houses with private yards.

The medium density category allows for moderate density housing either as attached or detached units at a density range of zero to 16 units per acre.

The high-density category allows an extensive range of housing unit types which may be attached or detached. They consist of apartments, condominiums, and town homes constructed at a density of 25 units per acre.

Plate 10: Residential houses built adjacent to quarry sites in Zowerani

Industrial Land Use

This is land allocated for industrial purposes. They can be used for manufacturing or mining, or used in the operation of factories, processing plants, and similar sites. It includes light industrial use and heavy industrial use. In Tezo Ward, the main industrial land use is the mining industry which is a heavy industrial use. This is the main industrial activity that is undertaken in the area and it involves extraction of building stones using heavy machinery that lead to the emission of a lot of dust and production of excruciating noise. There are other light industrial uses that mainly consist of petrol stations, fish storage facility etc.

Educational land Use

This refers to educational zones in Tezo Ward. They include: Ngala Primary School, Baharini Primary School, Soyosoyo Primary School, Zowerani Primary school, Lakewood Green Olive High School, Green Olive Secondary School, and Godoma Technical Training Institute.

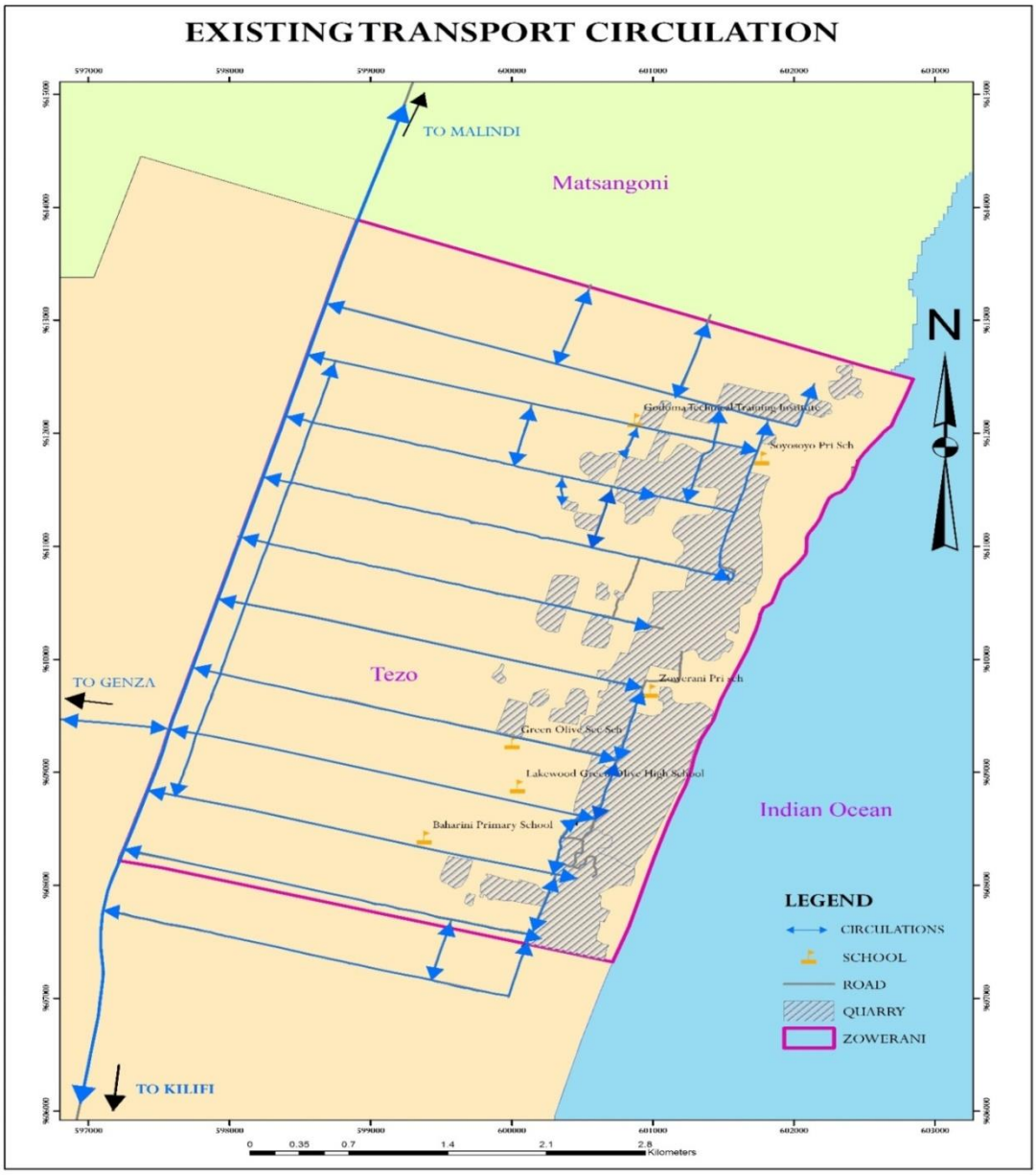
Plate 11: Zowerani Primary school

Transportation Land Use

These are zones apportioned for transportation need. Tezo Ward has various road types including: Class B, Class C and Class D roads.

B-8, Mombasa- Malindi Highway, is the main transport corridor in the study area.

Map 6: Traffic Circulation in the Study Area



Source: Author, 2019

The map above shows the existing transport network in and out of Zowerani sub-location. All the roads from the main highway of Mombasa-Malindi are Murram roads and they are mostly used by the Lorries to transport stones from the quarries to other areas of the county where the demand for the construction materials is high

CHAPTER 5

RESEARCH FINDINGS AND ANALYSIS

5.1 Overview

This chapter gives a descriptive interpretation and findings of the study. The data collected was analysed using SPSS to generate frequency tables, bar graphs, charts. Descriptive statistics was used to analyse the different variables. Data was collected through use of instruments like questionnaire and oral interviews. A total of one hundred and sixty eight (168) respondent questionnaires were distributed among all the respondents from 2nd June, 2019 to 9th June, 2019 for the study.

5.2 Respondent's Basic Information

This section provides a profile of the respondents who were part of the study. These respondents constituted area residents, quarry workers, quarry owners, health officer, revenue officer, physical planning officer environmental officer and area chief. This data is presented on a number of basic attributes including gender, age bracket, highest level of education and marital status. An analysis of these variables provides the socio-economic context within which other subsequent factors fall.

Table 6: Residents Basic Information

Respondents	**Category**	**Categories**	**N**	**%**
Household	Gender	Male	79	63
		Female	47	37
		Total	**126**	**100**
	Age	15-20 years	21	17
		21-30 years	52	41
		31-40 years	29	23
		41-50 years	9	7
		Above 50 years	15	12
		Total	**126**	**100**
	Highest Level of Education	Primary	54	43
		Secondary	41	33
		Post-Secondary	8	6
		None	23	18
		Total	**126**	**100**
	Marital Status	Single	30	24
		Married	88	70
		Windowed	6	5
		Divorced	2	1
		Total	**126**	**100**
	Period you have lived here	1-5 years	23	18
		6-10 years	25	20
		11-15 years	13	10
		16-20 years	8	6
		Above 20	57	46
		Total	**126**	**100**

Gender of respondents

Out of the 126 respondents, 63% were male while 37% were female. This implied that most of the residents in the households around the quarry mines were males and this explains why more

males were sampled than females. This finding also implied that more males resided around the mines than the females for obvious reasons like being closer to their places of work which in this case are the quarries. The finding did not however necessarily mean that there were more males than females in Zowerani as going by the KNBS (2019), there were more females than males in Zowerani. This was also in line with the population ratio both at the County and Sub-county levels. According to KNBS (2019), Kilifi County consists of 48.8% males and 51.2% females while Kilifi North Sub-county where Zowerani is located consists of 48.6% males and 51.4% females.

Age

Age determines a number of human factors that vary from perception to competitiveness. Most respondents (41%) were aged between 21-30 years, 23% were aged between 31-40 years. The remaining 17% were aged 15-20 years while 7% were aged 41-50 years. According to the KNBS (2019) census report KPHC Volume (III), the population of Kilifi sub-county consisted of more people in the age bracket of (21-30) than the other age brackets employed for sampling in this study and the same applied for the county age bracket population statistics. In Kilifi North sub-county, there were 32,799 people in the age bracket of (21-30) compared to 24,518 in the age bracket of (15-20), 20,540 in the age bracket of 31-40 and 14,208 in the age bracket of (41-50). This showed that the statistics gathered by the study were in line with that of the county and sub-county. This finding implied that there were more youthful people in Zowerani than the elderly and the younger age group. This was attributed to the fact that the quarry operations are labour intensive and hence required labour force from the youthful generation who are considered more energetic as compared to the elderly and the children hence the reason more youths resorted to staying in Zowerani closer to their source of employment.

Level of Education

The findings revealed that 7% of the respondents had attained post-secondary education as their highest level of education, 33% had attained secondary education, and 41% had attained primary education while 19% had not attended any educational institution. This finding reflects the same situation at the sub-county level in terms of education attainment as there exists more people

who have primary education as the highest level of education at 57.17% of the total people who went to school, with the least people attaining post-secondary education at 4.5%. This implied that most residents had not gotten past the primary education and therefore had no sufficient academic qualifications that could get them formal jobs to earn reasonable income to ensure sustainable living. With at least a secondary certificate qualification, one is always assured of fitting somewhere within the Kenyan job market. Since the education literacy levels are so low in the area, more people are readily available to provide casual labour in the quarries in order to earn a living. This encourages quarrying in the area as cheap labour is readily available.

Marital status

From the households sampled, 71% of the respondents were married, 23% were single, and 5% were widowed while 1% divorced. This finding compared to the county statistic which shows that the population density and distribution in Kilifi County stands at 129 persons per km^2 (Kilifi CIDP, 2018-2022) while the average household size stands at 5 people (KIHBS, 2016) suggests that the population of Zowerani is likely to continue growing as more people were living as couples and hence the fertility rate was assured. This is so considering the fact that currently the fertility rate of Kilifi County stands at 4.8% higher than that of the national fertility rate at 3.57% (Kilifi CIDP 2018-2022) hence an assurance that the population will continue going up. With an increase in population, it means that the abandoned post quarried land will be required to be put in to use to support the growing population and therefore rehabilitation maybe inevitable. Demand for housing in the larger extend will also be required and hence more quarrying activities in this area.

Another perspective for explaining the high number of respondents being married is that many of them dropped out of school to get married. From the data of cross tabulating education level and marital status, it is evident that most residents who were married never went past primary school. This implied that the low literacy levels in Zowerani played a role in early marriages in the area. The table below shows the statistics of level of education and marital status compared to each other in a tabular form.

Table 7 Level of education cross-tabulated against Marital Status

	Marital Status	**Total**

		Single	Married	Widowed	Divorced	
Level of education	Primary	12	40	1	0	53
	Secondary	13	27	2	0	42
	Post-secondary	2	5	0	1	8
	None	2	17	3	1	23
Total		29	89	6	2	126

Source: Author

Period of residency in study area

A sizeable portion of the respondents (46%) had stayed in Zowerani for 20 years and above, 6% had lived there for a period of 16-20 years, 10% had lived there for 11-15 years while 19% had lived in Zowerani for 6-10 years and another 19% for a period of 1-5. The Kilifi County Government Department of Water, Environment and Natural Resources, states that mining has been going on in the area for last 15-25 years now but was not intense at that time as it is now. This finding from the study implied that quarrying activities have escalated over the years and more so in the recent years. From the study which shows that 38% of the residents moved to this area in less than 10 years is a clear indication that they were pulled by a certain socio-economic factor to move into this area. The main economic activity in Zowerani over the years has been quarrying and has since attracted more people to settle in this area to benefit from the activity. This has led to the escalation of quarrying activities in Zowerani further intensifying the practice.

Table 8: Quarry Workers Basic Information

Respondents	**Category**	**Categories**	**N**	**%**
Quarry Workers	Gender	Male	27	90
		Female	3	10
		Total	30	100
	Age	15-20 years	8	27
		21-30 years	12	40
		31-40 years	7	23
		41-50 years	2	7
		Above 50 years	1	3
		Total	30	100

	Highest Level of Education	Primary	20	67
		Secondary	5	17
		Post-Secondary	2	7
		None	3	9
		Total	30	100
	Marital Status	Single	13	43
		Married	13	43
		Windowed	2	7
		Divorced	2	7
		Total	30	100
	Period you have been engaged in the quarrying activities	1-5 years	15	50
		6-10 years	7	23
		11-15 years	2	7
		Above 20 years	6	20
		Total		100

Gender, age and education

From the findings, Majority of the quarry workers at 90% were male while the remaining 10% were female. Majority (40%) of those workers were aged between 21-30 years, 28% were aged between 15-20 years, 23% were aged between 31-40 years, and 7% were aged 41-50 years while the remaining 3% were above 50 years. In terms of education attainment of the quarry workers, 64% attained primary level, 18% attained secondary school level, 7% of the workers attained post-secondary education while 11% had not acquired any formal education.

The findings implied that more male workers between the ages of 15-40 years who had not attained education past the primary school level were employed in the quarries to work as casual labourers as compared to the females and older males above 40 years. The explanation for this would be that at the age of 15 years after completing primary education, more males between 15-40 years who constitute the huge percentage of quarry workers dropped out of school and hence could not attain sufficient education past the secondary level which is a basic standard for getting formal and decent jobs. They hence had to provide casual labour in the quarries to earn income

to fend for themselves and their families for those who already had. Again, the quarrying industry is extremely labour intensive and therefore they prefer a workforce constituting of a much youthful energetic generation to keep the industry moving something which the male gender between the ages of 15-40 years are known to wield as compared to the ones above 40 years and the female gender. These findings from the field study are consistent with the observations made by (Togunde & Carter, 2006) and (Osiruemu, 2007)who stated that formal education is an important tool for human capacity development. Consequently, people with low or no education tend to engage in informal economic activities such as quarrying which was the same case in Zowerani as that majority of the respondents were drop-outs while others had no formal education.

Marital status

From the survey, 45% were married as 41% were single. Of the remaining 14%, 7% were widowed workers and an equal 7% of these workers were divorced.

Different workers have been involved in the quarrying business for different timespans. This implied that more single and married people opted to provide labour in the quarries. The married worked in the quarries to earn income to sustain their families back at home while the single ones did the same to earn a living and also maybe support their parents and other siblings. The fact that more married and single people were willing to work in the quarries showed that labour was readily available thereby promoting quarrying in the area.

Period involved in quarrying

From the study, 50% of the respondents had worked in quarrying for between 1-5 years while 23% had been in quarrying for 6-10 years. Another 7% of the workers had worked in quarries for between 11-15 years while 20% had worked for over 20 years. By this trend, it is evident that most of the workers which translated to half of the workers joined the quarrying industry recently i.e. in the last five years. This is a clear indication that quarrying activities have increased in recent years in the area leading to higher demand for labour in the mines. The fact that the quarrying industry is lucrative and has maximum profits has attracted more investors to venture into the business hence increasing quarrying in the area which explains the much labour registered in recent years.

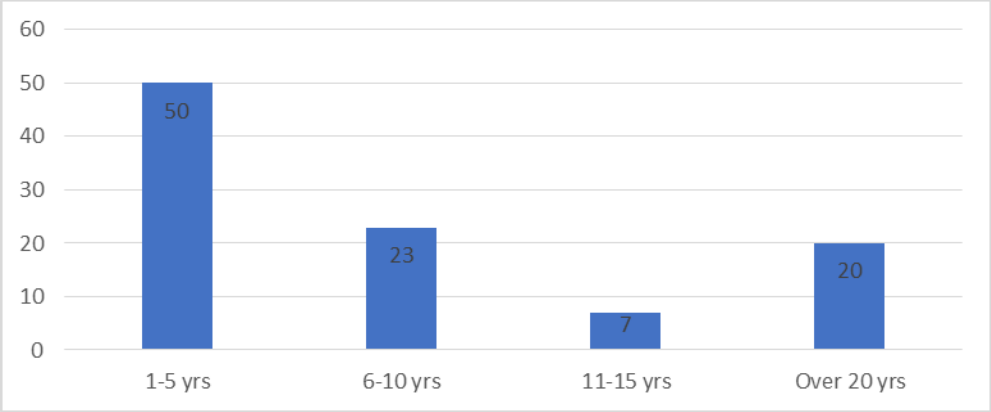


Figure 6: Period Involved in Quarrying Activities

5.3 Land Uses in Zowerani Sub-Location and how they have changed over time

The study realized that land use in Zowerani had greatly changed over time from agricultural and forest land use to industrial land use. The quarrying activities taking place in the area caused strain on the land use systems and had greatly affected the environment and the area's landscape. Below are the respondents' views on change in landscape in the area over time.

5.3.1 Distance to the Quarry

Table 9: Distance to the Quarry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	500m-1km	2	1.6	1.6	1.6
	1km-2km	89	70.6	70.6	72.2
	2km-3km	34	27.0	27.0	99.2
	Above 3km	1	.8	.8	100.0
	Total	126	100.0	100.0	

Source: Author

Cumulatively, you can note that 72.2% cover a maximum of 2km from their residence. While 27% cover a distance of 2km-3km, 0.8% covers a distance of above 3 kilometers. This implied that most of the residents preferred to establish close to the quarries because of the closeness to

the quarrying sites which were their places of work. It was therefore affordable for the people to rent houses next to the quarries as it saved them transport and time to get to their places of work Consequently, the houses next to the quarry sites were cheaply available as the rents were not charged as much as for other areas in the study area.

5.3.2 Quarrying Activities Taking Place in the Area

The findings revealed 65% of respondents found quarrying taking place in the area while 35% of the respondents stated quarrying activities started when they had already moved into the area. These findings compared to the findings on the years of residency in the area which showed that only 46% of the respondents had stayed in Zowerani for more than 20 years while the remaining 54% had stayed for less than 20 years. This implied that more people moved to the area after quarrying began most probably to look for employment opportunities and provide labor in the quarries or establish their own quarries as corporates to begin mining and earn profits. This indicated that quarrying activities attracted more people into the area further escalating it.

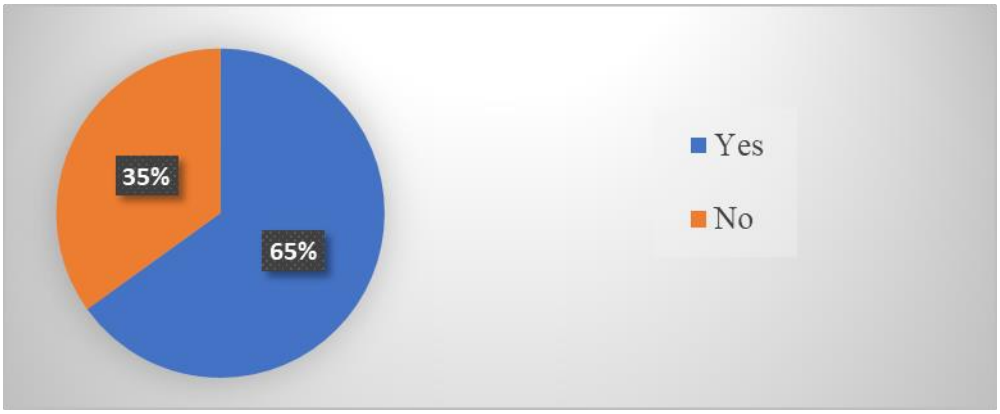


Figure 7: Quarrying Activities Taking Place in the Area

The pie chart shows the percentage of people who found quarrying taking place in Zowerani versus those who established in the area before quarrying began.

5.3.3 Landscape in the Area in the Past Few Years Compared to Currently

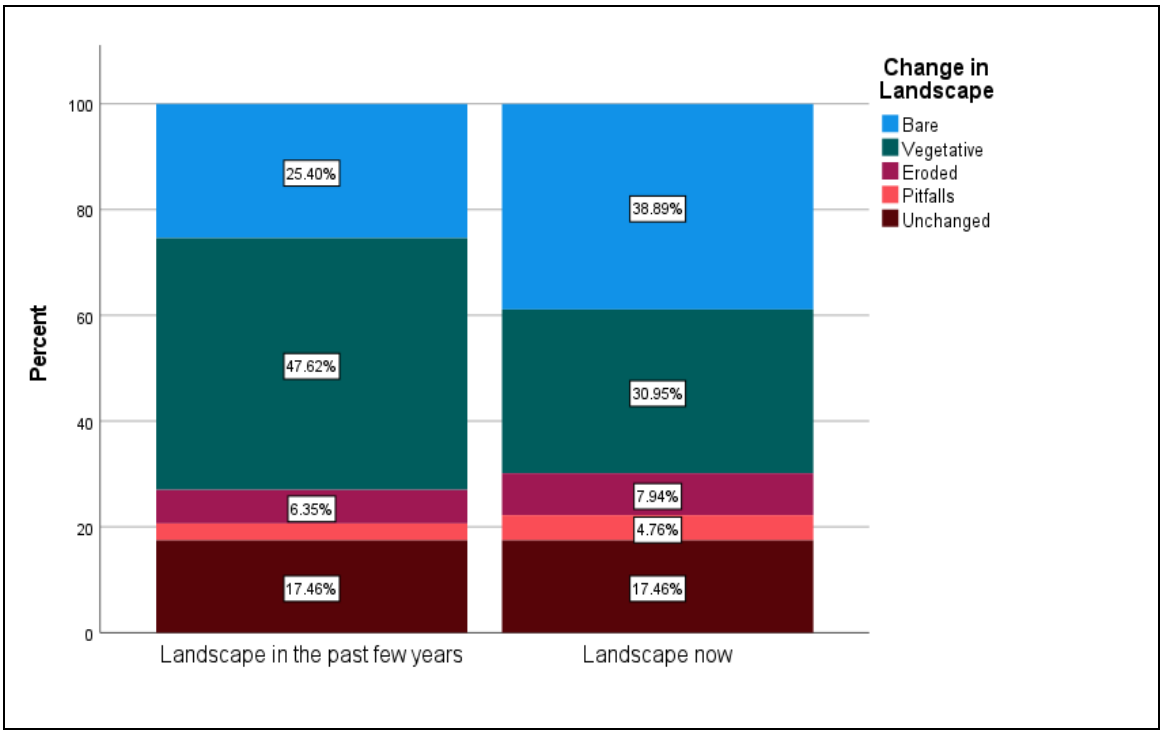


Figure 8 Graphical Comparison of change in landscape

From the survey on the question regarding landscape in the area in the past, 47.6% of the respondents saw the landscape in the area change to vegetative, 25.4% of the respondents had seen the landscape become bare while 6.3% stated erosion took place. 17.4% witnessed no change in the landscape while 3.3% have seen the landscape get filled with pitfalls. Regarding their response on the landscape currently, 30.9% of the respondents have seen the landscape in the area change to vegetative 38.9% of the respondents have seen the landscape become bare, with 7.9% stating erosion occurred in Zowerani. 17.5% of the respondents witnessed no change in the landscape while 4.8% have seen the landscape get filled with pitfalls. This implied that in the past years before mining became so intensive, the landscape had vegetative cover and only the few areas where quarrying was taking place were experiencing soil erosion and degradation of ground cover. With the reduction in vegetation cover as found by the study and increase in erosion and formation of pitfalls, it is evident that the environment has changed over the years and continues to degrade further due to increased quarrying. The conclusion drawn is that quarrying activities lead to environmental degradation and especially when it is intensified over time with no interventions. The findings are consistent with the assertions of (Nartey, 2012) who stated that stone quarrying causes land degradation. (Mouflis, Gitas, Iliadou, & Mitri, 2008) Also

asserted that quarry activities result in the permanent alteration of original land form and the destruction of original vegetation cover which was the case in Zowerani.

Table 10: Cross tabulation of Landscape now against Landscape in past few years

		Landscape in this area in the past few years					
		Bare	Vegetative	Eroded	Pitfalls	Unchanged	Total
Landscape in the area now	Q16	32	60	8	4	22	126
	Q17	49	39	10	6	22	126
Total		81	99	18	10	44	252

From the cross tabulation in table nine on the two variables of landscape in past few years and landscape now, it is evident that there has been a change in the area. The vegetation cover continues to dwindle and more harsh conditions like dry weather set in. This shows that the quarrying activities taking place in Zowerani impact the environment and the clearing of the vegetation is not controlled at all.

Plate 12: An eroded landscape after quarrying activity

Source: Author

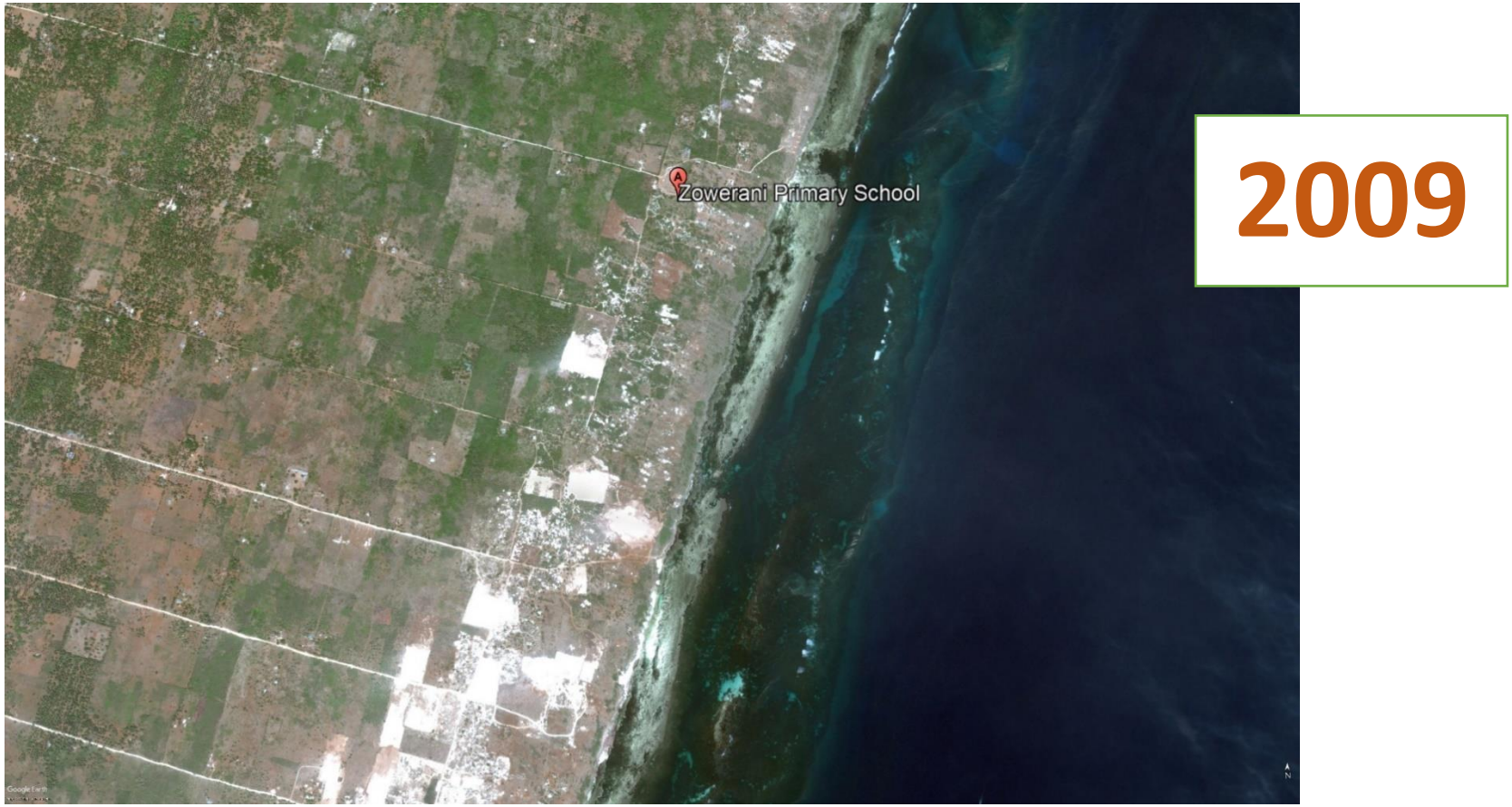
Image evidence on the change on landscape in Zowerani adopted from Google Earth. The images show the distinction in the land scape for the past fifteen years and it is evident that in 2006 the ground cover was mostly vegetative. This change in 2009 as quarrying increased but in 2019 the ground mostly covered by quarries and the vegetation has been completely destroyed illustrating very clearly the negative impacts quarrying has on the environment.

Plate 13: Overall Change in Landscape (2006)

Source: Author, 2019(Adopted from Google Earth Photos)

The Google map image above shows the landscape in Zowerani area as at the year 2006 and it is evident that the landscape was covered by green vegetation. Though mining activity had commenced, the damage on the landscape was barely noticeable.

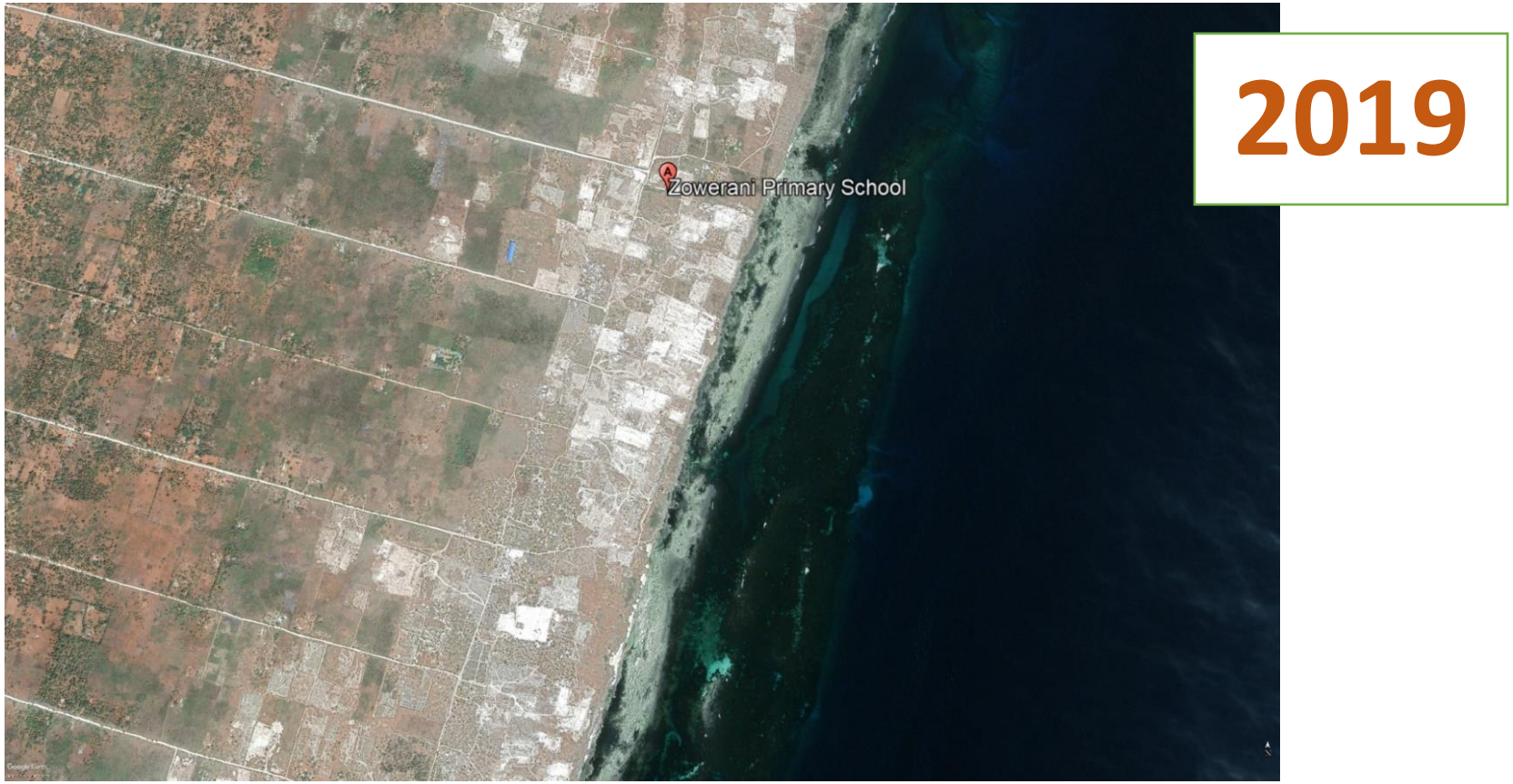
Plate 14: Overall Change in Landscape (2009)



Source: Author, 2019(Adopted from Google Earth Photos)

The image above shows the landscape in Zowerani sub-location as at the year 2009. This was just three years from 2006 and already the vegetation cover on the landscape was already diminishing. This is a clear proof that sound quarrying of the building stones was not taking place in the area. It meant that if the same was to continue, then in the next few years the ground would remain bare. Already the mined grounds that have been exhausted and left un-rehabilitated are clearly visible from the aerial images.

Plate 15: Overall Change in Landscape (2019)



Source: Author, 2019(Adopted from Google Earth Photos)

The image above shows the landscape of Zowerani as at 2019. There exists a huge contrast between the images retrieved for 2006 and those of 2019. It is visible that the environment has been completely destroyed within a timespan of just 13 years due to intensive quarrying going on. It is enough proof that unsound and unregulated mining can have detrimental impacts on the environment and the surrounding livelihoods. It goes therefore without saying that mining in Zowerani has caused more harm to the environment in the area more than it has conserved it basing on the Google earth images retrieved over time for the area.

5.4 Social-Economic and Environmental Impacts of Quarrying Activities in Zowerani

Quarrying activities have got various impacts on the environment and socio-economic livelihoods of communities. From the study findings, one of the most significant social impacts of quarrying on the community was the negative effects it had on health. Most of the respondents stated that they had suffered different ailments which were directly caused by the activities in the quarries. These findings coincided with the findings by Langer (2001) who stated that an estimated 4 million people lose their lives yearly from severe respiratory complications in developing nations, whereby most of these deaths are intensified by environmental pollution originating from quarrying; sandblasting and release of dangerous chemicals. The following represent findings of those impacts in Zowerani as from the study.

5.4.1 Social impacts of quarrying in Zowerani

5.4.1.1 General views of the residents on impacts of quarrying effects on their health.

Figure 9 shows the findings in relation to the human health in the area. The findings on health in Zowerani were compared to that of Kilifi county hospital to offer a clear picture of the health situation in the area. The findings have been explained for the most significant key emerging issues as shown below:

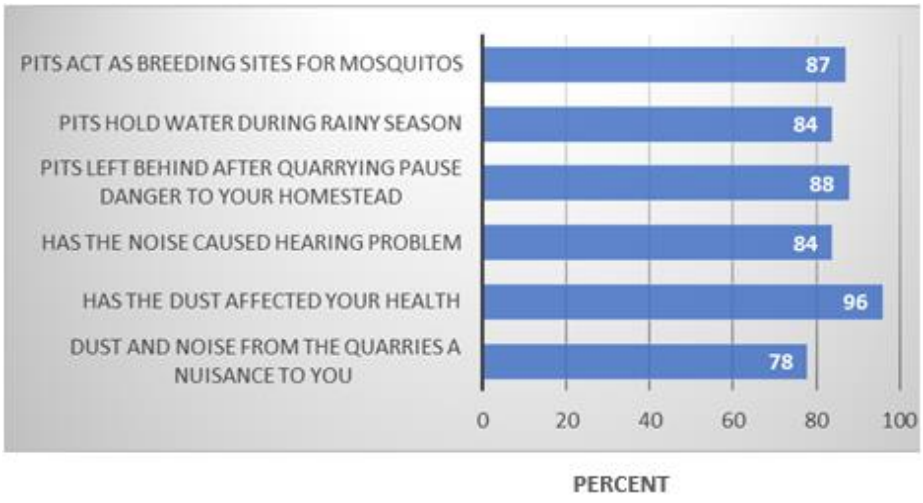


Figure 9: Human Health

As can be observed in the figure 9 above, most (87%) of the respondents confirmed that the bare pits left behind after quarrying acted as breeding sites for mosquitoes. This implied that quarrying contributed to the spread of malaria in the area since mosquitoes spread the disease. The post-quarry lands left unattended were favorable sites for mosquito parasites to breed when

filled with water. This posed a serious danger to the homesteads located around the quarry sites as the mosquitos could easily spread malaria disease to the residents.

Noise emanating from the quarries also significantly affected the residents by causing serious hearing problems. A majority (84%) of the respondents experienced hearing problems as a result of noise from the quarries; this was also confirmed by the health officer based on the ENT cases she received at the dispensary. This implied that the side effects of the noise from the quarries were far reaching and very intensive. This implied that there were no proper safety measures in place like distribution of protective gear to the workers and residents or issuance of prior warnings before blasting was conducted hence most people were exposed to impacts of noise pollution from the quarries. On the same scale, most of the respondents (96%) had been affected by the dust pollution from the quarries. Almost all the respondents reported that they had suffered from dust related health complications. This implied that dust had a huge negative health impacts on the residents and posed a risk of emergence of unhealthy community in Zowerani. The dust therefore was obviously a nuisance to the residents going by the response rate.

5.4.1.2 Dust and Noise Related Disease

These are the residents' responses on dust and noise related disease they have suffered due to the quarrying activities in this area.

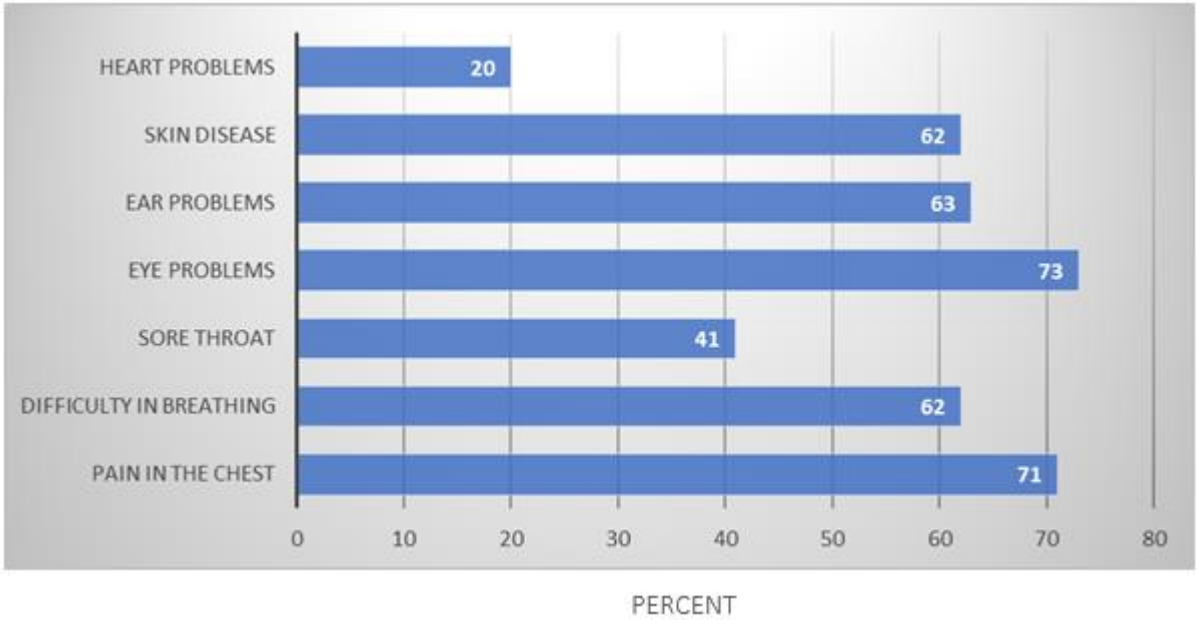


Figure 10: Table showing the respondents views on dust and noise related diseases

In figure 10 above, Chest pain, eye problems, ear problems and difficulty in breathing seems to be the most significant issue affecting the area residents as per the findings of the study. Majority (71%) of the respondents confirmed that they experienced pain in the chest due to the dust emanating from the quarries while another 73% reported that they had eye problems due to the dust. The dust also affected their breathing capability and more than half of the respondents (62%) stated that they experienced difficulty while breathing. This implied that quarrying activities had adverse effects on residents' health especially due to the massive dust emissions that were released from the quarries. As a result of ailments like chest pain their working ability was slowed down thereby rendering them vulnerable to handling heavy jobs especially for those within the quarries.

According to Langer (2001) 4 million people suffer from and die annually due to severe respiratory complications in developing countries. He goes ahead to state that these deaths are intensified by environmental pollution originating from quarrying and release of toxic chemicals. The findings in Zowerani corroborate the findings of Langer and prove that indeed quarrying affect human health.

5.4.1.3 Water-borne Related Diseases Suffered

These show the findings on water-borne related diseases that residents of Zowerani have suffered due to the quarrying activities in the area.

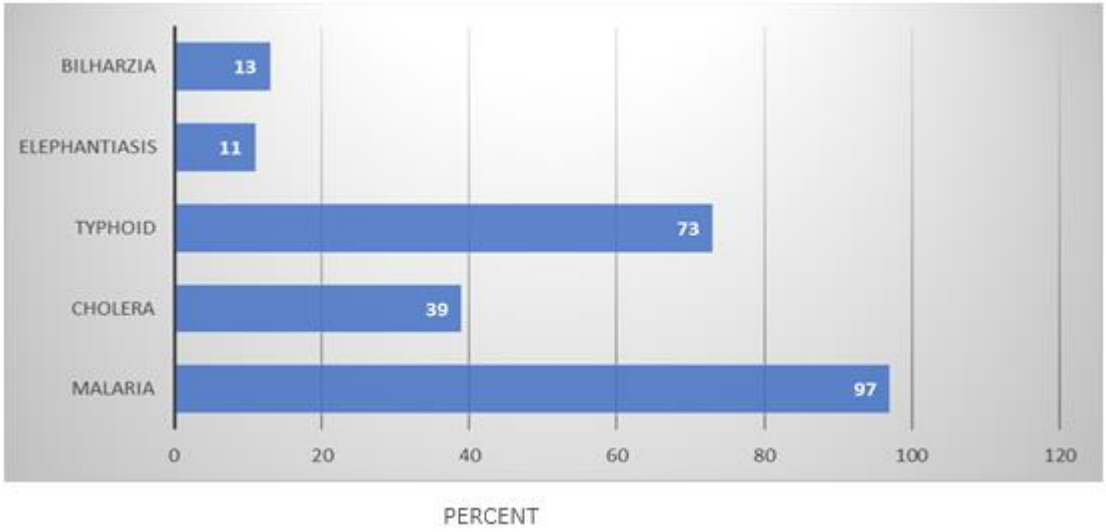


Figure 11: Water-borne Related Diseases Suffered

From figure 11 above, it is evident that the prevalence rate of waterborne related diseases like typhoid and malaria is greatly significant than that of Bilharzia and Elephantiasis. Majority (97%) of the respondents confirmed that they were prone to malaria attacks as a result of the bare pits left behind after quarrying which acted as mosquito breeding sites. They further stated that this situation was being escalated by the ocean waters since this area was along the shores of the Indian Ocean. Malaria therefore was one of the most chronic ailments in Zowerani and quarrying played a huge role in spreading it. Rehabilitation of the quarried land was therefore very necessary.

Other waterborne diseases like typhoid and cholera had endangered the lives of 73% and 39% of the respondents respectively. This was as a result of some residents utilizing the water in the filled up quarry pits for domestic purposes. These findings implied that water borne diseases was an impending threat to the health of the residents. This was likely to escalate in the area if uncontrolled quarrying was to continue. Since there is a higher potential index that that the disease would spread further in the future if the status quo remains, the only solution is to curb the problem by putting in place measures for rehabilitation of the post-quarry sites.

5.4.1.4 Occupational illness/ condition

The following section reflects the views of the quarry workers on occupational illnesses/conditions.

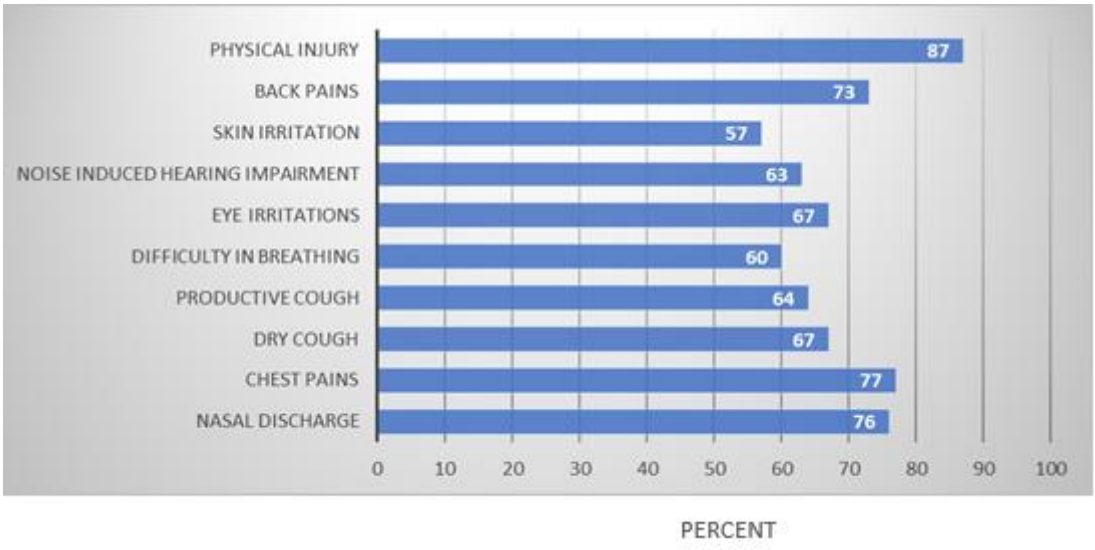


Figure 12: Analysis presentation of occupational illnesses by respondents

Figure 12 above shows the occupational illnesses suffered by the respondents as realized by the study. Significantly from the findings, physical injury emerged as the key occupational concern for the respondents as most (87%) had in one way or the other experienced physical injury as a result of the quarrying activities. This implied that the respondents were prone to occupational accidents which indicated that they never had sufficient protective gears to put on during working hours at the quarries. During the fieldwork, the researcher realized that most of the workers worked with bare hands, open shoes and no head gears nor overalls which are the basic protective gears for such kind of work. This meant that the workers at the quarries were exposed to accidents at any time which actually endangered their lives. The quarrying activities were therefore death traps to the workers in case fatal accidents occurred. The findings on physical injuries from this study echoes the sentiments of Abate (2016) who also identified physical injuries, respiratory problems and fatal accidents as some health challenges that confront workers in the quarry industry.

Plate 16: Non-rehabilitated post-quarry land that poses danger for accidents

Source: Author

Other significant occupational complications for the quarry workers included pain in the chest (77%) and back pain (73%). This implied that the workers were handling heavy duties that resulted into chest pains and back aches. Stones are very heavy and cause strain in the muscles of the body. It was therefore clear that the working tools in the quarries were not up to standard and equipment like trolleys should be introduced to help transport the stones to loading areas instead of workers carrying the stones and walking for long distances with the heavy stones to load onto the trucks. Also a significant number (76%) of the respondents confirmed that they experienced nasal discharge which implied that quarrying caused air borne diseases like flu and common cold

among others. Quarry owners are therefore expected to employ best quarrying practices when venturing in the industry to protect the workers and provide better medication in times of need for the workers.

5.4.2 Environmental Impacts of quarrying in Zowerani.

Quarrying activities are associated with several negative impacts on the environment. From the study, it was evident that quarrying has affected the environment in Zowerani to a large extent. These findings are substantiated by other works related to the topic such as the research by Sati (2015) who alluded that quarrying, whether small or large scale, is naturally destructive to the environment. The major impacts of quarrying to the environment in Zowerani were associated with generation of dust and noise as well as land degradation. These findings were consistent with the sentiments of Langer et al., (2004) assertions that quarrying gives rise to various environmental concerns such as land disturbance, emission of dust, noise, and ground vibrations which occur due to movement of the heavy machinery and rock blasting. Below are the outcomes from the study on the environmental impacts of quarrying in Zowerani.

5.4.2.1 Air Pollution

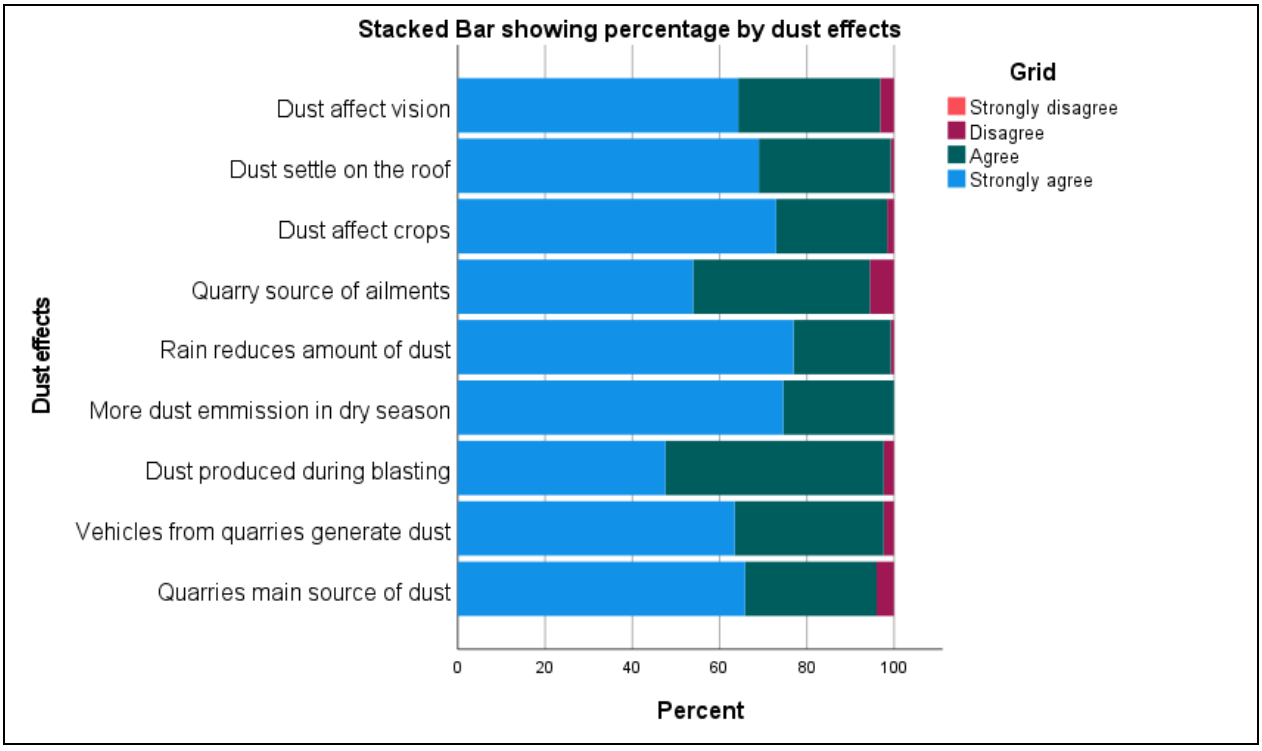


Figure 13: Findings on air pollution

From the findings, it was evident from the analysis that the residents strongly agreed that the quarries in the area produced a lot of dust. This obviously affected their livelihoods in many ways especially on their health. Majority (66%) of the respondents strongly agreed that the main source of dust in their surrounding came from quarrying. This implied that unsound quarrying was taking place in Zowerani hence the activities were not environmental friendly.

Cumulatively, 96% of the household respondents were of the opinion that dust generated from quarrying activities contributed to contraction of different respiratory ailments in the area. This according to all the respondents occurred during the dry season as 75% and 25% strongly agreed and agreed to that fact respectively. These findings implied that most of the residents were facing a higher risk of continuing to suffer from respiratory ailments. Many of them stated that they had previously suffered from diseases like whooping cough, flu and common cold as a result of inhaling the dust.

The failure by the quarry owners to employ simple precautionary measures like sprinkling water on roads to moderate the dust led to more cases of illnesses being recorded at the local dispensary. According to most of the respondents' (77%) opinion as shown in figure 13, water reduced amount of dust and measure like sprinkling of water would go a long way in controlling dust emissions by the quarries. The findings above was also an indictment on the local authorities for failing to enforce the necessary regulations to control the dust emitted from the quarries.

Cumulatively, 97% of the respondents agreed that vehicles transporting stones from the quarries generated a lot of dust. This implied that despite massive quarrying taking place in Zowerani, it had not brought forth better infrastructural development in the area. Most of the roads were dusty murram roads that posed serious danger to school going children and the homes next to the road as the dust could settle on the roofs of the houses as noted by the majority (69%) of the residents. The drivers of the lorries as stakeholders in the sector registered their opinions and stated that even though quarrying had opened up Zowerani to the larger Kilifi county, the infrastructure needed to be improved and better roads be constructed to reduce the losses they incurred on regular maintenance of their vehicles.

The residents also stated that dust concentration in air is mostly during blasting. Cumulatively, 98% agreed to this sentiment. All together another 97% of the respondents agreed and strongly agreed that the too much dust generated from the quarries obstructed their vision during the day.

This implied that during blasting there was excessive air pollution due to the dust that resulted into eye problems to the residents. This implied that the quarry owners and the relevant authorities failed in their duties to follow the guidelines and enforce the policies respectively thereby denying the residents their right to a clean and healthy environment enshrined in articles 42 of the Kenyan Constitution (2010).

The above findings on air pollution are corroborated by the works of (Mengesha & Bekele, 1998) who affirmed that breathing in of the dust particles can lead to serious health issues including respiratory and lung problems. On the same breadth, they stated that dust deposition causes skin and eye problems. This is true to Zowerani case as well since most workers were unable to see clearly during quarrying due to much dust.

Plate 17: dust generated by moving Lorries to and from the quarries

Source: Author

5.4.2.2 Noise Pollution and Vibrations

The following are quarrying effects related to noise pollution according to the residents of Zowerani sub-location.

The main source of noise is from the haulage, blasting, excavation and machine cutting of the stones

Cumulatively, a whopping 96.8% of the respondents stated that the main source of noise was from the haulage, blasting, excavation and machine cutting of the stones at the quarries with the

other 3.2% reporting that the main source of noise was not from the haulage, blasting, excavation and machine cutting of the stones within the quarries. This implied that the quarrying activities generated very loud noise in Zowerani that interfered with the peaceful environment of the area. Loud noise has its side effects like headaches, loss of concentration and development of hearing problems among others. (Gale & Groat, 2001) Argued that stone quarrying contributes to noise pollution and vibration thereby supporting the findings from the study area. The people were therefore exposed to these side effects which would result into a non-vibrant society hence slowing down the economy of the area as residents would concentrate on treating noise ailments related instead of growing their economy.

Table 11 showing main source of noise

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	122	96.8	96.8	96.8
	No	4	3.2	3.2	100.0
	Total	126	100.0	100.0	

Source: Author

The picture below shows a quarry worker using small scale quarrying stone cutting machine. The machine produces very loud noise which is very irritating to the ears.

Plate 18: Stone cutting machine that produces very loud noise

Source: Author

5.4.2.3 Views of residents on environmental impacts of quarrying associated with water

Quarry pits get filled up with water during rainy season

Table 12: quarry pits fill with water

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	106	84.1	84.1	84.1
	No	20	15.9	15.9	100.0
	Total	126	100.0	100.0	

From the study, 84.1% of the respondents stated that the quarry pits fill with water when it rains due to poor drainage while 15.9% disagreed. This implied that the establishment of the quarries was not done according to planning requirements for their development. If done accordingly, it would mean that the quarry owners construct proper drainage systems around the quarries to allow for easy transportation of storm water from the pits during and after quarrying has ended. The failure by the quarry owners to properly establish the quarries and the concerned authority to enforce the policies and regulations meant therefore that the residents were exposed to environmental and health hazards. Pits filled with water acted as breeding grounds for mosquitoes that spread malaria and also posed huge risks of accidents such as drowning as one could easily fall into the pits.

Plate 19: Abandoned pit filled with water after quarrying.

Source: Author

Does the water ever get drained?

Table 13: Quarries get drained

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	87	69.0	69.0	69.0
	No	39	31.0	31.0	100.0
	Total	126	100.0	100.0	

From the study, 69% of the respondents indicated that the quarries that get filled with water do get drained mostly by drying up on their own and in certain cases by the quarry owners themselves while 31% stated that the quarries that get filled with water do not get drained easily and hold water for approximately 3-4 weeks and in certain instances where the rains fall over a longer period of time, they also take longer to dry up. The reason for this was that the surface of the pits left behind is rocky and hence seepage of water in to the ground is extremely slow. This implied that when it rains for a long time without sunny conditions, the people of Zowerani are left at a high risk of falling sick from mosquito bites or having accidents like falling into the pits.

5.4.4 Breeding of Mosquitoes as a Result of Water in the Pits

Table 14: Mosquitoes breeding

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	100	79.4	79.4	79.4
	No	26	20.6	20.6	100.0
	Total	126	100.0	100.0	

Overwhelming majority (79.4%) of the respondents believed that breeding of mosquitoes was as a result of water in the pits. This implied that the pitfalls were the main cause of malaria cases registered in the area. Since most post-quarry lands are left unattended, the mosquitoes perfect breeding ground when the pits fill with water increasing the spread of malaria in the area.

From cross-tabulation of two variables of pits acting as breeding sites for mosquitoes and the number of respondents suffering from malaria, it was evident that the pits that were filled with

water contributed to the spread of malaria. From the table below, most of the people who consented to pits acting as breeding sites for mosquitoes had suffered from malaria which confirms the views of the researcher.

Table 15 Cross-tabulation of pits acting as breeding sites for mosquitoes and Malaria disease

Count				
		Malaria		Total
		Yes	No	
Do the pits act as breeding sites for mosquitoes	Yes	106	3	109
	No	14	3	17
Total		120	6	126

5.4.2.4. Views of quarry workers on environmental impacts of quarrying

Noise levels at the quarry

Quarry workers had different views on the noise levels at the quarries. 47% of the respondents were of the opinion that the noise levels were tolerable while 33% were of the view that the noise levels were deafening and another 20% opinionated that the noise from the quarries was not audible. This implied that many of the quarry workers had adapted to the noise and did not feel the effects, some also had protective gear to block the noise and that is why they were not seriously affected by that noise while those who did not have the protective gear felt the noise was too much and hence they could not hear sound well.

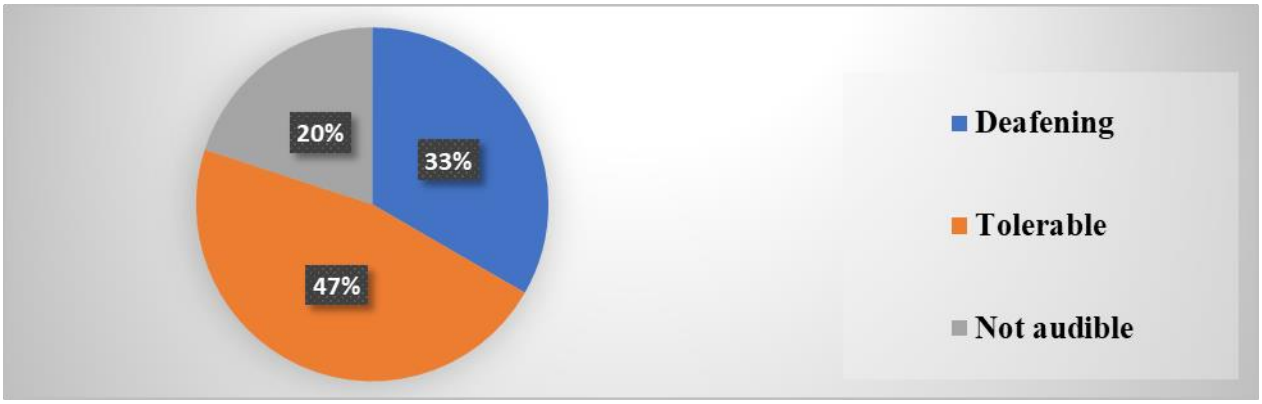


Figure 14: Opinions by respondents noise levels at the quarry

Causes of noise at the quarries

Majority (76.7%) of the respondents reported that stone cutting machines were the main cause of noise at the quarries while 16.7% stated that the major cause of noise was from vehicles while 6.7% were of the view that detonators were the main cause of noise. This implied that the cutting machines were so irritating to the ear and hence there was need to get machines that would produce lesser noise. Again the quarry workers did not have proper protective gears to protect them from the intense noise. They were exposed to noise related side effects and were likely to suffer from health problems like constant headaches and hearing problems.

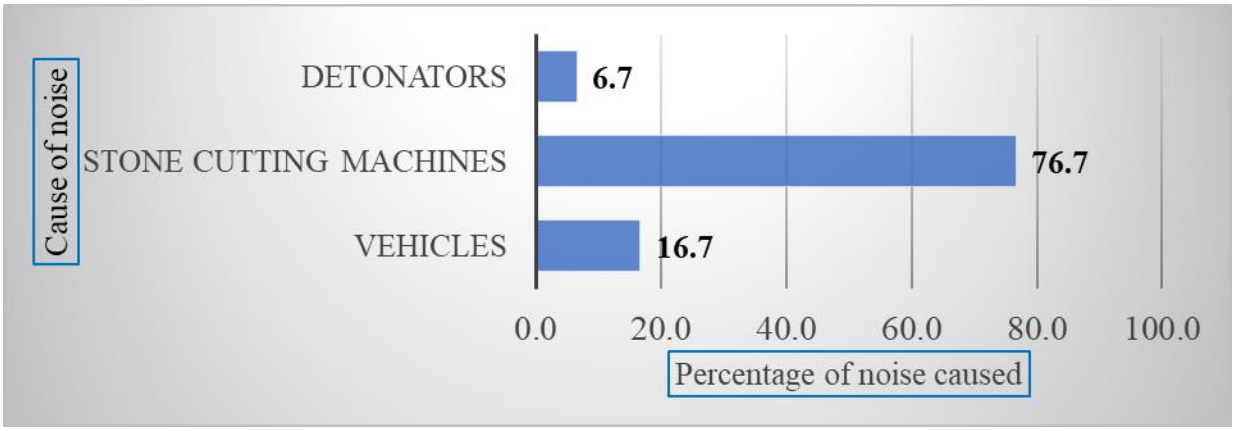


Figure 15: Causes of noise at the quarries

Dust emission at the quarry

From the findings, 87% of the respondents confirmed that there was dust emission from the quarries while 13% reported that there was no dust emission from the quarries.

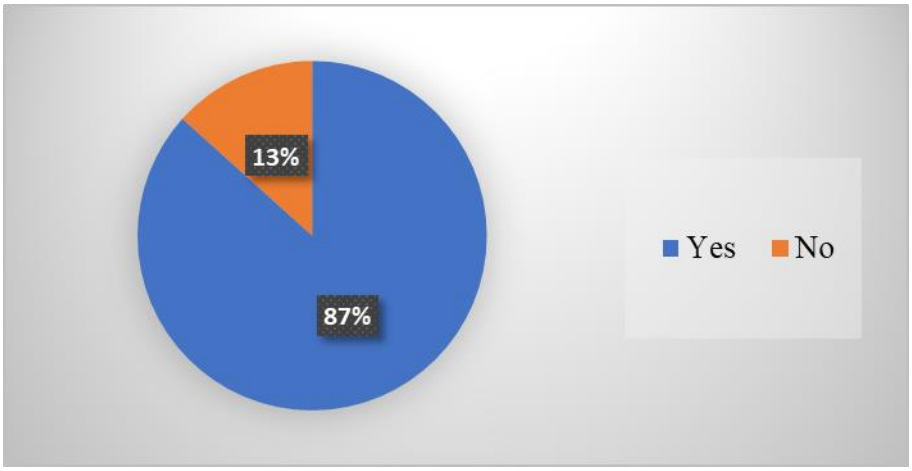


Figure 16: Dust emission at the quarry

This implied that the quarry workers worked in a very toxic environment full of dust which was very harmful to their health hence they were at a greater risk of contracting respiratory related ailments like whooping cough and common cold. The quarries were therefore a huge source of air pollution going by these findings.

Plate 20: Dust emissions during cutting of stones using machine

Source: Author

5.4.3. Economic Impacts of quarrying activities in Zowerani.

Quarrying is a source of employment to many residents of Zowerani sub-location. It is the main source of income in the area according to them. From the verbal narrations of the residents and quarry workers, most of them registered that quarrying boosts economic development of their community in terms of influencing new developments like road infrastructure and electricity which was not a common thing in the area in the past years. The quarry workers noted that quarrying helps them to support their families and afford a living even though the wages were not enough to sustain all their needs. These were the same sentiments given by majority of the household respondents who felt that the income earned from the quarries was very minimal and could only sustain a part of their basic needs. The county Revenue Officer in his views recognized that the wages offered to the casual workers were very little to sustain all their needs and that most of them were extremely strained financially as the income was not enough to support their livelihoods. He further noted that even though the quarries were a good source of employment for the residents, the remuneration needed enhancement so as to aid in improving the livelihoods of the residents and foster economic development. The assertions by Wang et al, (2010) that over 500 million people in developing countries involve in jobs such as small-scale surface mining and quarrying for existence corroborates the study findings and affirms that quarrying is a source of employment to not only Zowerani residents but to many other people all over the world.

The residents noted that they were involved in small income generation activities like hotel businesses to feed the many quarry workers and hence quarrying helped in improving the economy of the area through business.

The residents also narrated that quarrying had affected them by interfering with some activities they used to undertake in order to earn income like agriculture. They stated that farming next to the quarries was close to impossible and that the quarries took very huge tracts of land which later became fallow after quarrying ended and could not support sustainable agriculture therefore most of them resorted to work in the quarries to earn income.

The quarry employees and residents who live next to the quarry sites also registered that they use a lot of money in buying drugs and paying for treatment for dust and noise related diseases caused by the quarrying activities. From the findings on health effects of quarrying in Zowerani, more than 80% of respondents had suffered from quarrying related diseases meaning that the

amount of money spent on treatment was very high. The respondents hence remained in a stressful economic condition with faced with financial constrains to fend for themselves and their families.

5.4.4 Impacts of quarrying on land use in Zowerani.

Quarrying activities lead to significant impacts on existing land uses in areas where it is practised. More often than not, it leads to conflicts resulting into change in land use within communities. A good example is that quarrying affects agricultural land use and this is supported by Zo (1997) who states that quarrying brings different problems about land use and interferes with indigenous community rights. Below is an impact of quarrying on land use and how it has affected the residents.

Residents able to farm near quarry sites

Table 16 showing findings for able to farm near Quarry Sites

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	42	33.3	33.3	33.3
	No	84	66.7	66.7	100.0
	Total	126	100.0	100.0	

Sizeable (66.7%) of the respondents are not able to farm near quarry sites while 33.3% of the respondents are able to farm near quarry sites. The reason for this was because most of the lands left behind after quarrying had taken place were unproductive and only underlying bare rocks were left exposed with all the top soil gone. The lands that could have otherwise been used for agricultural purposes were left derelict and not able to support plants growth. This implied that quarrying activities in the area interfered with fertile agricultural lands and hence shifted land use patterns. The very few residents who were able to practice agriculture stated that the farms were not very productive and the yields they got from the crops were very insufficient.

Plate 21: Agriculture taking place next to quarry site

Source: Author

5.5 Community and Key informants' perceptions on quarrying.

The following section outlines the research findings on the perceptions of the residents of Zowerani and other key informants interviewed of quarrying on quarrying in the area and how to further improve the activities to minimize its impacts on the environment and livelihoods.

5.5.1 Residents views on cracks developing on the walls of buildings from quarrying activities

Concerning cracks developing on the buildings around the quarries, 15.87% of the respondents agreed that these cracks were as a result of the vibrations and noise from the quarries while 84.13% had not experienced cracks in their houses. This implied that quarrying activities had negative impacts on the earth's crust and that is why houses that were built next to the quarries developed cracks on the walls and foundations. This was as a result of vibrations and noise that emanated from the quarries during blasting and haulage of stones. Some of the residents stated that during some blasting and haulage, there were tremors that were felt as the blasts were very loud and they could see building shaking. From the previous finding on how far people lived from the quarries, most residents stayed more than 2km away and this explained why most houses do not have cracks due to the vibrations from quarrying as they were located a bit far from the quarries. From the findings however, by virtue that some residents' houses had cracks interferes resulting from foundations of houses being weakened by quarrying activities illustrated clearly to a large extent how the residents were affected by quarrying.

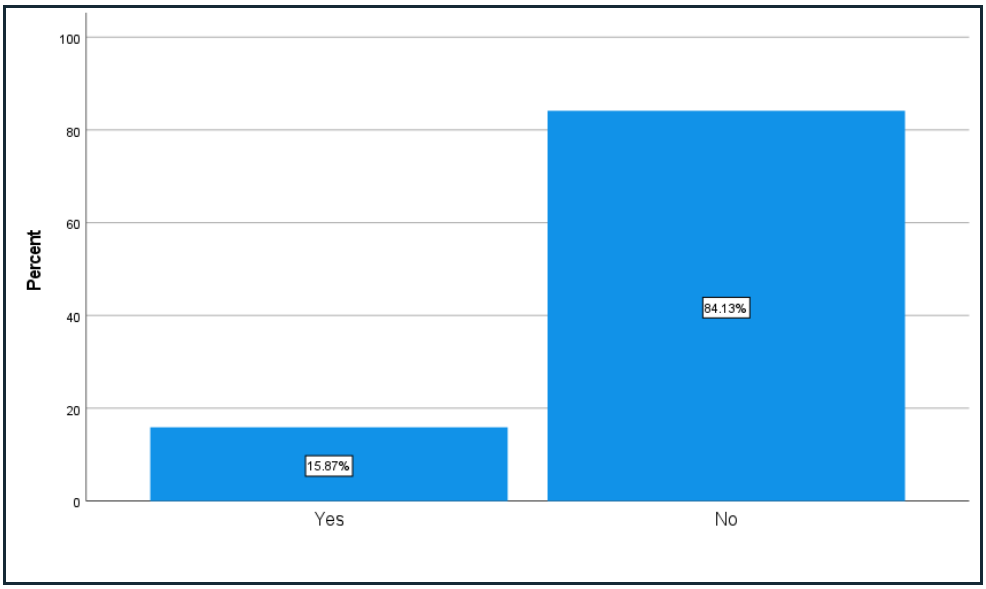


Figure 17: Findings on walls developing cracks.

Of those who had experienced cracks develop in their houses, 57.14% had observed buildings that formed cracks collapsing as a result of the vibrations and noise from the quarries while the remaining 42.86% had not observed the same. From their accounts no one was hurt in these incidents as the occupants of these houses took precautionary measures and evacuated once the cracks began forming to avoid any injuries/deaths in case the buildings collapsed. This finding implied that quarrying activities weakened the foundations of houses that were situated next to the quarries eventually leading to their collapse. The disturbances to the earth's crust caused by the explosions interfered with the stability of the ground causing cracks on houses weakening them and causing huge losses to owners once they collapsed. Quarrying was therefore a cause of heavy losses in terms of property to some of the residents and most of them stated that no compensation has ever awarded by either the quarry owners or by the government.

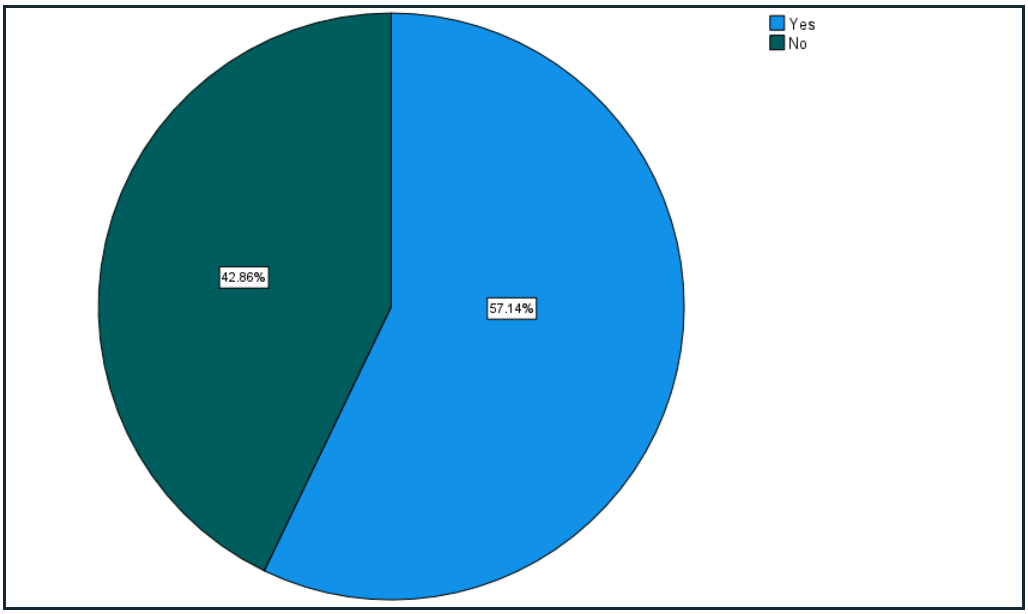


Figure 18 Showing results on buildings collapsing

5.5.2 Perception of residents on precautionary measures to take on quarrying

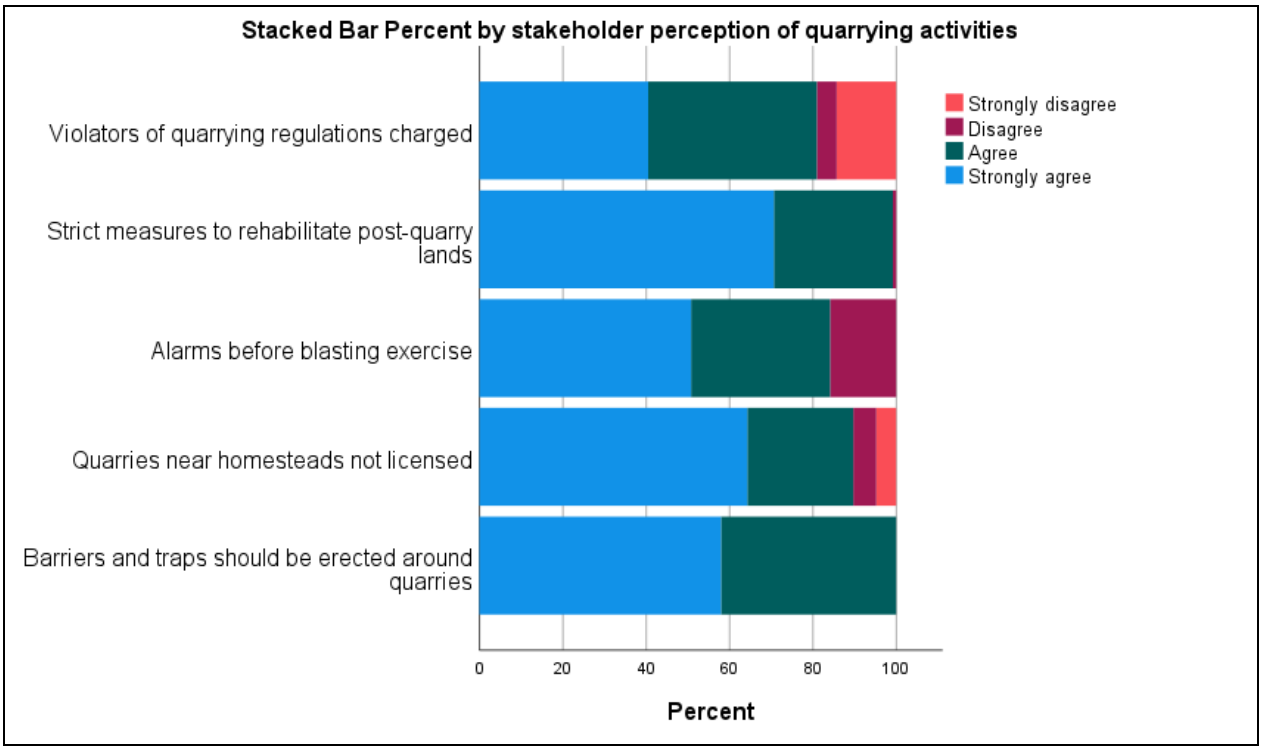


Figure 19: Perceptions of stakeholders on quarrying

From the analysis, all the respondents strongly agreed and agreed that barriers should be erected around the quarry sites in order to prevent accidents around the quarries. This was mainly because almost all the quarries were located next to the residents' homesteads. This created a very dangerous situation as most of the residents were openly exposed to the dust and noise emanating from the quarries. By erecting barriers around the quarries, it meant that the residents would be shielded from some of the negative impacts of quarrying like air pollution through dust. The implication of this was that the people in the area were hugely affected by the quarrying activities and they longed for the situation to be improved. It also revealed laxity on the part of the authorities to regulate mining activities as they are the ones who are supposed to ensure these measures are in place.

On the same note, most of the respondents (64.2%) strongly agreed that quarries next to their homes should be banned and not licensed while 25.4% agreed to the same. The law on mining does not allow for the establishment of quarries next to residential areas as the impacts of quarrying are detrimental to livelihoods. The law separates land uses like industrial zones from residential zones and states that each land use should be established in its zone. The fact that the

quarrying industry was being licensed to operate in the residential zones was therefore not in line with the law. The household respondents were right in their sentiments that quarries next to their homes are not supposed to be licensed. This finding as well implied that the authorities failed in their mandate to coordinate as a team and that there were contradicting views that existed among the different stakeholders in the quarrying industry. The fact that there were different views clearly explains why other authorities went ahead to license quarries around homesteads and institutions while others refused, it all depended on which license/permit had more weight to allow one operate quarries in undesignated areas. In this case it implied also that corruption played a significant role in allowing such quarries operate in undesignated areas in complete contravention of the existing laws governing mining activities. The key stakeholders mandated to regulate quarrying activities were therefore not combating haphazard mining practices through unscrupulous licensing.

Quarrying activities produce a lot of noise and to control the impacts of noise emanating from quarrying, 50.7% of respondents strongly agreed to notices being issued to those around the quarries before blasting exercises while another 33.3% agreed to the same. This implied that no precautionary measures were in place to alert the residents next to the quarry sites during blasting exercise. This showed negligence on part of the relevant authorities as they were well aware of the effects stone blasting had on environment, adjacent land uses and livelihoods of the residents. From the residents accounts they registered that they had complained about the issue to the area chief who was supposed to pick up the matter with other stakeholders on their behalf but nothing had been done yet as the quarry owners continue with blasting without warnings given. This revelation meant therefore that the law could be invoked to hold those quarry operators who blasted stones without prior announcement accountable for their actions as they were interfering with the residents' livelihood but that had never been done.

In order to improve the quarrying activities in the area and reduce their impacts, 70.6% of respondents strongly agreed that strict measures should be taken to rehabilitate post quarried lands while another 28.5% agreed to the same. Consequently 40.4% strongly agreed that violators of quarrying regulations should be charged while 40.5% agreed to the same. This implied that there was an urgent need to rehabilitate the quarrying sites that had been abandoned to reverse their negative impacts to the residents as observed in this study. It also showed that quarrying had negative effects on the community that even the relevant authorities were aware

of. This suggested for tougher measures to be imposed to ensure that quarry owners restore back the quarries to their former state after they are done with quarrying to help avoid the effects they have on the environment. It also implied that the one of the most effective ways the negative quarrying impacts could be reduced is through prosecuting those who engage in haphazard quarrying activities and putting in place stringent measures that would see the quarries that do not follow the law being completely shut down and their owners tried and made to pay for the damages. This would see to it that the environment is protected and its sustainability ensured.

5.5.3 Residents Knowledge on Policies or Legal Frameworks Governing Quarrying Activities

Out of the total respondents, 76% were not aware of any policies and legal frameworks governing quarrying activities while 24% were aware of policies and legal frameworks governing quarrying activities. This implied that the residents of Zowerani were not privy of their environmental rights and the few who had some knowledge did not know how to pursue the challenges legally. It showed that most of the residents of the area would not easily know when an illegality is being committed by the quarry operators which in turn gave room to unsound quarrying activities in the area further increasing the negative impacts of quarrying on the livelihoods of the residents.

On the government side and from the key informants, the revenue officer stated that there exist legislation to mining and quarrying activities within the county which are the Quarry Act and the Finance Act of Kilifi County. The finding from the study and the revelation from the key informant indicated clearly that access to information in Kilifi County especially in areas where mineral resource extraction is being conducted is very poor. For this reason most residents of these areas would not stop any haphazard quarrying activities as they are not privy of the laws to challenge such acts thereby promoting unsustainable quarrying in the area.

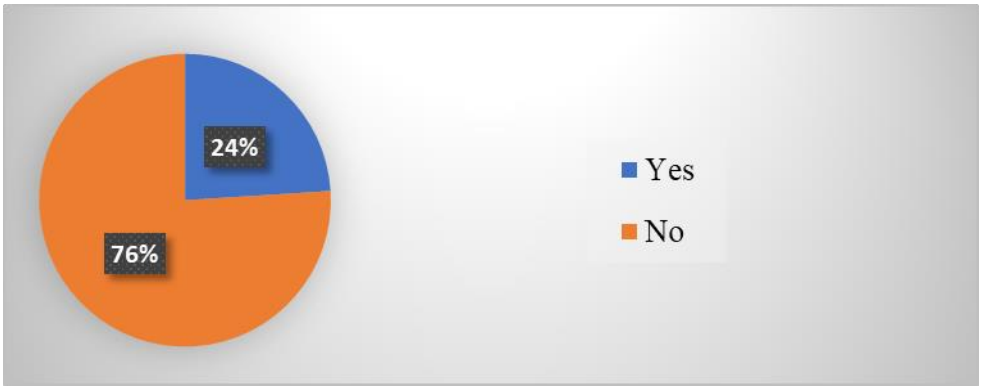


Figure 20: Policies or Legal Frameworks Governing Quarrying Activities

The figure above shows the findings from the study on whether the residents are aware of the policies or legal frameworks governing quarrying activities.

The low levels of education also played a critical role in the residents not being aware of the existing policies or legal frameworks that govern quarrying activities. This meant that the county government needed to put in place robust community sensitization programs to educate the residents of Zowerani on these policies. The table below shows the Level of education cross tabulated against the level of awareness on policies or legal frameworks governing quarrying activities and it shows the ripple effect of low literacy levels on the residents' knowledge on these policies.

Table 17 Level of education tabulated against policy and legal framework awareness

		Policies or legal frameworks governing quarrying		
		Yes	No	Total
Level of education	Primary	6	47	53
	Secondary	14	28	42
	Post-secondary	5	3	8
	None	6	17	23
Total		31	95	126

5.5.4 Residents views on immediate Restoration Measures.

Table 18: Restoration measures necessary

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	117	92.9	92.9	92.9
	No	9	7.1	7.1	100.0
	Total	126	100.0	100.0	

Out of all respondents, 92.9% felt immediate restoration measures are necessary in the quarry sites while 7.1% believed restoration measures can be implemented later on. This implied that the residents are not contented with the way quarrying activities are being carried out in the area. By the fact that an overwhelming majority felt that the quarries should be restored shows that they had experienced the negative impacts caused by quarrying and would want the effects to be reversed through restoration measures.

5.5.5 Perception of the other key stakeholders interviewed.

The County Geologist felt that prospecting of the stone mines was not scientifically done and that most of the quarry owners/miners relied on just direct observation of mineralization in rock outcrops and for this reason, quarries were developing haphazardly. He stated that Kilifi County government had not developed a policy on control of quarries within the county which posed a challenge in regulation. He went ahead to state that the county is planning to come up with a policy on control of quarries to try and control the haphazard exploitation of building stones.

The Environment officer felt that most of the quarry owners were dishonest businessmen and women who were very adamant on following the environmental management plans depicted in the Environmental Impact Assessment reports licensed by NEMA. This she said was a major challenge and noted that in as much as the Department of Environment and Natural Resources was responsible for guiding the quarry owners, inspections and conducting sensitization drives on quarrying, they were short of officers considering that the county hosted several quarries including ballast and sand quarries. They also had inadequate tools to fully execute their mandate in terms of laws and policy in this area. In order to address these challenges, he stated that they

are in consultation with the county leadership to increase the number of officers in their department to help with the work. He also stated that those who neglect the environmental operation guidelines stipulated in the EIAs will have their operation licences revoked.

The county planner alluded that the county spatial plan, which is still a draft will capture this menace and propose some strategies to curb the haphazard spread of the quarries as well as minimize the incompatibility with other users as depicted in the current situation. In addition The County Government of Kilifi was proposing to develop a concept for the Revitalization of the shore line beginning with the Kilifi Waterfront (Kilifi Creek). The concept is deemed to provide the basis for attracting funds for the development of a Master Plan for the Revitalization of the shoreline and subsequently attract investments for the development of tourist infrastructure at the shoreline to transform it into a premier tourism attraction Centre for the county. This will attract both domestic and foreign tourists. Quarrying in Zowerani is mainly practiced along the shores and if the above concept materializes then it is likely to improve the situation for better management of these quarries.

The revenue officer considered the quarrying activities as major revenue source with over 60% of the county's revenue being realized through quarrying. The roads officer noted that roads within the quarry areas needed constant repairs due to overloading by the transporters. He also noted that the wages offered to the quarry workers was not sufficient to sustain their livelihoods and that the quarry owners should consider increasing the wages of the quarry workers. He further suggested that the County Government should set laws on remuneration for casual workers within the quarrying industry.

The health officer at Zowerani at Zowerani dispensary stated that they were acutely understaffed and that the doctor patient ratio was way below the recommended levels by World Health Organization. The health officer also noted that from time to time they experienced shortage of hospital equipment and drugs to cope with high numbers of patients registered in the dispensary especially during the hot season. He stated that most of the patients in the hospitals suffered from respiratory related ailments like common cold and flu closely followed by malaria and waterborne related diseases like typhoid. When asked on why this was so, he stated that this was mainly attributed to the quarrying activities taking place in the area that generated a lot of dust and in turn affected the health of the residents and the post-quarried lands that got filled with water and acted as breeding grounds for mosquitos that spread malaria. The health officer

suggested that sound quarrying practices be adopted in the area to curb some of the health problems related to quarrying in the area and that all the quarry workers be provided with protective gear to shield themselves from the noise and dust they are exposed to at the quarrying sites.

The area Chief noted that much of the revenue collected from quarrying according to the recommended percentage does not often get back to develop the community. He blamed this on laxity by the offices mandated to control and manage the quarrying activities within the county.

He further noted that inadequate public participation before quarrying activities commence was responsible for some of the challenges experienced once quarrying commences like conflicts between the quarry owners and the locals. He suggested that proper public participation drive should be conducted prior to commencement of any quarrying activities in Zowerani so as to make the residents part and parcel of the quarrying projects.

5.6 Summary of Impacts and Outcomes of quarrying in table format.

Negative impact = -VE

Positive Impact = +VE

Activity /Impact on	Description	Water	Air quality	Human Health	Soil	Animals	Agriculture	Vegetation cover	Employment source	Neighborhood
Stone cutting and haulage	This happens at the quarry sites during blasting and cutting of the stone. A lot of dust and noise is produced during this exercise and huge volumes of soil excavated.	**-VE**	-VE	**-VE**	**-VE**	-VE	**-VE**	**-VE**	**+VE**	**-VE**
Transportation	This is mainly during transportation of stones from quarries to the market by lorries. There is emission of too much dust and loud noise.	**-VE**	**-VE**	-VE	-VE	**-VE**	-VE	-VE	+VE	-VE
Vegetation Clearing	Vegetation is cleared during start of quarrying to expose the bedrock. This interferes with the soil structure and bio-diversity forcing species to	-VE	**-VE**	-VE	-VE	-VE	**-VE**	**-VE**	**+VE**	**-VE**

	relocate their habitats.									
Commercial Activities	These are economic activities that emerge as a result of quarrying taking place in the Zowerani e.g. eateries, shops and market centers.	+VE	-VE	+VE	-VE	+VE	+VE	-VE	+VE	+VE
Physical infrastructure development as roads, electricity etc.	These are infrastructural developments that emerge due to the quarrying undertakings in the area. Roads have been constructed to transport stones to the market among other infrastructural developments.	-VE and +VE	-VE	+VE	-VE	-	-VE and +VE	-VE and +VE	+VE	+VE
Housing Development	As more people move into Zowerani to engage in quarrying activities housing infrastructure and other social emerge like hospitals.	-VE and +VE	-VE	+VE	-VE	-VE and +VE	-VE and +VE	-VE	+VE	+VE

5.7 Possible Restoration Measures to Post Quarried Land

5.7.1 Quarry Rehabilitation Measures

According to the residents views on the possible restoration measures that could be employed to rehabilitate the quarries, majority at 53% felt that the most viable quarry rehabilitation step was to refill the bare quarries within the study area while another 15% were not aware any viable rehabilitation measures. 5% suggested that proper roads needed to be constructed within the study area and another 5% were for the opinion that the government should intervene and regulate the mining activities while another 5% suggested that the quarry perimeters should be erected in order to prevent accidents around the quarries. 3% were of the view that mining should be abolished within the study area while another 3% suggested that corruption should be addressed within the quarrying sector. Another 5% suggested that trees should be planted in the abandoned quarrying pits with 2% suggesting that quarries should be generally utilized even after mining is over and another 2% were of the opinion that provision of health services should be incorporated in the management of the quarries. The remaining 2% suggested that skilled labor should be employed in quarries so that proper dues are paid to the laborers.

All the above findings implied that for there to be a fully successful rehabilitation of the post-quarry lands in Zowerani, many factors had to be considered. It was therefore important to note rehabilitation did not just involve filling the pits but went as far as incorporating other vital factors like ensuring that the right expertise conducted the exercise. It also implied from the views of the residents that even the lands that are undertaking quarrying activities currently needed to do it in a sound manner to ease the restoration of the quarried lands. The residents were therefore for the urgent rehabilitation of the post-quarry lands in Zowerani to aid in normalizing the environment in the area and make the lands useful once again.

5.8 Summary of findings and planning implications

From the analysis of the research findings on the impacts of quarrying on land use and possible restoration measures, it was evident that;

1) **Land uses in Zowerani sub-location have changed over time, with quarrying being the most dominant land use.**

From the study, it was evident that quarrying has been undertaken in the sub-location for a period of more than ten years, as per the respondents of the residents and the area chief who have

lived here for a longer period of time. Consequently, majority of the residents cover a distance of 1-2 and 2-3 kilometres to access quarries. This implies that the quarries are located quite close to the residential neighborhoods in the community. In addition, quarrying has influenced landscape change in Zowerani especially form vegetative to bare and eroded land. Therefore, quarrying activities have negatively impacted on the aesthetics of the area. Majority of the respondents, who took part in the survey, responded to not being aware of any policies or legal frameworks governing quarrying activities. This has resulted to the continued degradation of the locality since the residents do not have any form of reference to control the mining activities which have been affecting them. Interview from the county physical planning officer indicated that the county spatial plan had not clearly zoned the area including the extent into which quarrying should occur and therefore the trend of haphazard quarrying was likely to continue despite all the challenges depicted by this study

2) **Quarrying activities have caused more negative than positive social-economic and environmental impacts.**

Quarrying activities taking place in Zowerani sub-location have in the long term resulted to dilapidated state of not only the social-economic lifestyle of the residents and quarry laborers but also the environment at large. In this regard, the study witnessed that quarry pits get filled up with water during rainy seasons as a result of poor to no drainage in the site. This poses a hazard to the residents as accidents have occurred due to uncovered pits. Moreover, the pits act as breeding grounds for insects especially mosquitoes and other waterborne bacteria, endangering the health of workers and residents as some have contracted; malaria, typhoid, cholera, bilharzia and elephantiasis. The disease preference was also affirmed by the clinical officer interviewed at Zowerani dispensary.

Run-off water form quarries during the rainy seasons tend to drain into the ocean and at times carry impurities that are transported along into the water bodies causing water pollution. Air pollution has been a menace in the sub-location, resulting from the accumulation of dust in the atmosphere and the major causes include; heavy vehicles transporting materials in the site and blasting exercises. The dry seasons intensifies the pollution levels compared to the rainy seasons. This has adversely affected both the residents and workers through, ailments such as; heart problems, chest pains, breathing difficulties, eye irritation and skin irritation. The clinical officer confirmed that nearly 80% of the cases treated at Zowerani dispensary were as a result of the

quarrying activities in the area, additionally, the presence of dust has led to poor vision especially during the day and poor aesthetics as the dust tend to settle on the roofing structures of the households.

Noise pollution and vibrations experienced in buildings on the other hand has been caused by; blasting, excavation, machine cutting and haulage activities. This has resulted to presence of cracks on buildings which lead to instances of collapsing of structures, hearing problems especially among workers who spend a significant amount of hours working there and nuisance at nearby homes since the heavy noise hinders hearing. Quarry workers pointed out that the major cause of noise in quarries was from; stone cutting machines, heavy vehicles and detonators.

On the positive side of the quarrying activities and for economic gain the revenue officer indicated that 60% of the total county revenue came from stone quarrying activities within the county and that 50% of this revenue is again reverted back to the community through road servicing and management

3) **The roles and perception of stakeholders point out the need to develop and enforce measures to mitigate the negative impacts.**

The affected stakeholders pointed out their concerns which when taken into consideration will improve their communities. These include; firstly, erecting of barriers and traps around quarry sites which will reduce the occurrence of accidents, secondly, quarries that need to be set up near homesteads should not be licensed (proper buffer zones should be stipulated). Thirdly, the mining companies should issue notices in the form of alarms before commencing blasting exercises. Fourthly, strict measures should be developed by the relevant authorities and adhered to by mining companies in order to rehabilitate post-quarried land and finally, heavy penalties should be charged to violators of quarry regulations.

4) **Need for rehabilitation of post-quarried lands in Zowerani.**

From the research study, it was evident that quarrying activities in Zowerani sub-location have had huge impacts on the environment over time. The continued intensive mining of building stones in the area without following the set out regulations for mining operations have caused complete obliteration of the ground cover thus giving room to desert like characteristics to set in. Furthermore the destroyed environment and un-rehabilitated quarry sites have had serious effects on people's health thereby impacting the economy of the area.

The lack of quarrying rehabilitation plans for Zowerani means that the environment in the area cannot be conserved properly. It is hence very critical to have such plans in place and enforce the existing rules to the latter to help salvage the situation. For instance the law on polluter pays principle states that anyone who pollutes the environment in any way has the responsibility of restoring that land to the previous state or be liable to face jail term.

The residents of Zowerani as evidenced by the study results felt that the post-quarry lands required immediate rehabilitation in order to remedy the already damaged environment and area's landscape. This they said will also help prevent some of the health impacts that arise from such quarries. They further stressed that there is need to enforce regulations available to guide the quarrying activities as the foremost measure to preventing haphazard stone quarrying which has been witnessed in the area.

The post-quarry lands in Zowerani therefore need to be immediately rehabilitated to allow the environment in the area to flourish again. After backfilling trees should be planted in the sites where quarrying is complete to reduce the dust, accidents and respiratory illnesses. Other measures may include teaching the residents on alternative uses they can put the post-quarry lands into, this will help prevent wastage of space and enhance the utilization of lands that would have otherwise been left to lie bare. With proper rehabilitation measures employed, the environment in Zowerani will definitely once again flourish and its sustainability will be assures.

5.9 Institutional Dynamics

Quarrying industry in Zowerani has got a significant number of key stakeholders who play critical roles in shaping of the industry. This study sampled some stakeholders who were considered crucial in understanding the research topic as they were directly linked to the quarrying activities in Zowerani. The following are the institutions and stakeholders in the quarrying sector of Zowerani, their roles and how they have contributed in shaping the practice in that area.

The County Government of Kilifi

Among the roles undertaken by the County administration include issuance of consents for licensing operations and surface rights; promoting community engagement in mining operations and selection of the mining sector operators; coordinating artisanal mining efforts; developing

formula for sharing mineral benefits as well as sensitizing communities on the same; preparation of integrated development plans for specific zones etc. The county government has though failed in its mandate as they have not sensitized the community members in Zowerani on sharing of mineral benefits and hence the community does not benefit fully from the natural resources available in their communities. Through the county officers, licenses for quarry operations have been issued through unscrupulous means to investors who do not meet the laid down criteria for licensing thereby contributing greatly to unsound quarrying hence negative environmental health impacts are experienced. The county Government has therefore greatly contributed to the haphazard mining in Zowerani.

Statutory Bodies/Institutions

These are bodies created by specific acts of parliament that mandates them to play certain roles within the quarrying sector by supporting the mining operations.

In this case NEMA and office of the County Geologist were targeted. NEMA is responsible for regulating environmental issues in the quarrying industry while County Geologist responsible for handling mining related matters at the county on behalf of National government i.e. Ministry of Petroleum and Mining. Before quarrying takes place, approvals must be gotten from these two offices. However, through dubious means and corruption, the quarry owners were able to get approval to mine in areas that were not even designated for quarrying. This showed that the important processes like EIA which should be undertaken before issuance of approvals were overlooked by these officers and hence, they were part and parcel to the unsound quarrying patterns that were taking place in Zowerani. NEMA again failed to check the quarrying activities regularly to ensure that they are adhering to the environmental standards and regulate their operations thereby giving room to the quarry owners to continue working unperturbed with the deleterious impacts of quarrying.

Local Community

These included the residents and the quarry workers. They are the stakeholders who are directly affected by the quarrying operations in their areas.

The local community in Zowerani should play a crucial role in ensuring effective defense of community interests in the quarrying sector like environmental protection and land rights.

However, a large percentage of the residents are not aware of the legal instruments to use in undertaking such defense and hence they are left to bear the consequences of haphazard quarrying practices. Most of them are not aware of their rights with regards to the environment and so they have done so little to protect their environment. They greatly appreciate the jobs created by the quarries but are also lamenting the negative impacts they have brought without knowing how to control them. Advocacy campaigns, environmental awareness programs and public education on the environment should therefore be conducted in the area to help improve the situation.

National Government Ministries

Own the major stake in the quarrying industry. They play a role in providing strategic leadership, policy formulation and enactment of legal and regulatory frameworks. They are also mandated to protect the environment and people rights'. This has however not been the case for Zowerani as the local community land rights have been abused. At the end of quarrying, most quarry owners leave the lands unattended to rendering them useless with no benefit to the owner. This also leads to further degradation of the environment something which the National government has failed to control through her officers.

CHAPTER 6:
SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Overview

This chapter is focused on summary of the study, recommendations to be considered to solve the impeding challenges and conclusion of the research project.

Summary

The overall aim of this study was to ascertain the impacts of quarrying on land use and propose possible rehabilitation measures taking a case of Zowerani sub-location. Specifically, it aimed at; examining the land uses in Zowerani Sub location and how they have changed over time due to quarrying activities; assess the social-economic and environmental impacts of quarrying activities in Zowerani and proposing possible restoration and rehabilitation measures to post quarried land. The study also explored perceptions of respondents with regards to the impact of quarrying activities on the environment and local community health and safety.

Findings of the study established that quarrying activities in Zowerani have not been properly regulated in terms of the existing related legal frameworks neither have they been practiced in an environmentally sound manner that could promote economic stability and at the same time assure environmental sustainability and proper use of land as a resource. There was no proper enforcement of mining regulations that could control haphazard quarrying in the area. In most cases quarries were established without proper plans like constructing enough drains leading to detrimental resultant impacts that directly affected the neighboring residents and largely contributing to environmental degradation in the area as shown in the change of landscape over time.

Quarrying activities in the area has also affected the natural environment through altering the land use, land cover and the surface landscape. The bulk excavation of rocks caused loss of viable agricultural land. The presence of abandoned post-quarry lands and heaps of quarry wastes incorporated with lack of quarry rehabilitation plans degraded the lands to a huge extent.

The study also found out that quarrying activities in the area contributed to a number of health issues in the area which was as a result of the state of environmental pollution. The quarry workers and the adjacent communities were at risk of suffering from a range of diseases like respiratory ailments and hearing problems which was as a result of inhaling dust particles from

the quarries and being exposed to loud noises that the machines produced respectively. The workers at the quarries had poor safety procedures and rarely had protective gear on them while working which exposed them to accidents and serious ailments. Other health risks comprised of for example, during the rainy seasons, the pits left behind after quarrying formed breeding grounds for parasites like mosquitoes and larva that transmit malaria and other related water borne ailments. The dug pits posed a great risk of accidents like drowning to the residents.

The literacy level in Zowerani sub-location was very low as compared to that of Kilifi Township Sub-location which implied that education in this area was not considered a priority by the residents despite the presence of government owned schools that provide free education like Zowerani primary school and Green Olive secondary school. Very few people managed to go beyond the primary level of education. Most of the quarry workers consisted of the male younger and middle-aged generation of between 15-40 years who most of them had not attained education past the primary school level. This illustrated how quarrying operations in the area affected the education of most teenagers as several preferred dropping out of school at 15years to provide labor in the quarries. To some extent, poverty as well pushed the residents to drop education and opt to working in quarries in order to earn income to sustain their needs and those of their families. Since most of the residents in Zowerani did not attain education past the primary school level, they were therefore unable to find good employment as the Kenyan job market is very demanding and gives priority to education attainment.

Another intriguing revelation of this study was that most of the residents of Zowerani were unaware of the policies and legal frameworks that govern quarrying activities. This attested to the fact that they lacked the knowledge and power to challenge and hold to account the quarry owners who practiced haphazard quarrying in the area. The lack of awareness about these laws by the residents enhanced uncontrolled quarrying activities that further exacerbated the negative effects of stone quarrying in Zowerani. The residents were therefore left to bear huge losses like the loss of agricultural lands that resulted from post-quarry lands not being rehabilitated after quarrying was complete so that they could be put back into other uses like agricultural or forestry among others as seen in the case studies.

The study also revealed that quarrying was the main source of employment for residents. It created employment opportunities for the people of Zowerani especially the youths and middle-

aged people who had young families to take care of. It affirmed therefore that the residents of Zowerani took part in quarrying activities in order to earn income to earn a living.

Spatially, the area had not been zoned for quarrying activities as revealed in the draft county spatial plan for the county, thus therefore meant that no proper guidelines on the expansion of the quarries leaving the fate to the developers whose aim was to attain maximum profit with no regards to the outcome of the current and post quarrying challenges.

6.2 CONCLUSION

Quarrying plays an important role in the development of communities and the society in general. However, continued quarrying without proper management and regulation poses more negative than the positive impacts. In ascertaining the impacts of quarrying on land use and possible rehabilitation measures in Zowerani, the following conclusions are drawn.

- Quarrying in Zowerani sub-location that has taken place over a long period of time has led to significant change on the landscape in the area which has continuously degenerated over time from majorly vegetative to bare land. This demonstrated that sustainable quarrying was not being practiced in Zowerani which in turn contributed to the deleterious impacts on the environment as shown by the study.
- Quarrying in Zowerani has led to negative socio-economic and environmental impacts ranging from health complications such as respiratory related ailments and waterborne diseases, noise and air pollution which has greatly impacted the residents livelihoods. Most of the quarry workers and the residents have suffered from health issues related to quarrying activities in the area. The social, economic and environmental well-being of Zowerani has hence been affected by quarrying in the study area.
- The quarrying procedures in Zowerani were not conducted in a proper manner as evidenced by the study. The responsible authorities either failed to fulfill their mandate in one way or the other or were just negligent of the negative impacts of quarrying in Zowerani. The views of the stakeholders on quarrying in the area like enforcement of stricter measures for rehabilitation of quarried lands and imposing of heavy penalties to violators of quarrying regulations suggested that they were aware of the issues that affected the industry but were doing very little to improve the situation. This therefore called for the authorities to take their roles seriously and see to it that the laws and

regulations guiding quarrying were being strictly implemented and adhered to by the quarry owners to ensure environmental sustainability and wellbeing of the residents in the study area.

- Quarrying activities in Zowerani exposed the residents to risks of getting involved in fatal accidents, increased disease prevalence and loss of agricultural lands among others. These effects were found to have significantly affected the livelihoods of the residents and reduced the rate of economic growth in the area.
- Quarrying principally served as source of employment and livelihood for the people of Zowerani who are entirely living in a rural area. It enhanced development of other services like physical infrastructure where murram roads were constructed to open up the area and give access to the quarry mines. This therefore helped open up the area to the outside neighboring towns like Kilifi.

Developing and enforcing proper restoration and rehabilitation measures will not only improve the livelihoods of quarry worker and residents but it will also ensure environmental sustainability and sound socio-economic growth in the area. This will in turn attract major developments in the sub-location especially after restoration of the post-quarried lands just as it has been demonstrated in other case studies

6.3 RECOMMEDATIONS

From the study, possible rehabilitation measures should be incorporated in order to ensure sustainable development of post-quarried lands, zoning of the prospecting areas with quarrying materials should be done prior to any quarrying activity, Kilifi county should zone and prepare master plans for areas deemed to have quarry materials so as to avert the haphazard growth of the quarries as witnessed in Zowerani, the land use policy should consider and recommend a buffer zone that should be maintained to separate quarrying zones from other uses more so residential areas based on effects caused on people by the quarries located in cross proximity as witnessed in Zowerani, this is clearly missing through the literature review contacted for this study. Specific recommendation shall include;

1. **Reclamation of Bare Quarries**

i) Vegetative Restoration

Mine wastelands can be restored using manufactured technosols which are mine wastes modified with organic materials like manure, sewage sludge, paper mill wastes, or green waste compost. The use of this method is recommended since microbial activity decreases the concentration of toxicity in the soil and enhances plant growth thereby controlling soil erosion.

This method is non-destructive and cheap. It improves soil conditions and allows the roots of trees to go deep into the soil thereby decreasing soil compaction and soil bulk density. Additionally, planting trees that grow with dense foliage around quarries can aid in reducing the harm caused by dust from quarries to the environment.

ii) Collaborations between Agencies

Fostering collaboration between mining corporations and conservation establishments, groups or institutions can aid in enhancing effective mine reclamation, as they can offer the much-required expertise in coming up with best practices for managing water, plant, wildlife and soil. Maintaining a sincere working relationship with conservation groups and other relevant stakeholders can as well assist regulatory authorities when issuing licenses and reviewing permit requests.

iii) Backfilling

Reclamation of mines could involve restoration of overburden that was excavated or repositioned to get to the minerals. When dug areas are built up, re-landscaping or re-contouring can be incorporated along with drainage control measures. Re-contouring will be guided by the mine plan objective that is the envisioned end use for the land. Where natural processes are sought, re-contouring will typically attempt to return landforms to the mine site's approximate original contour, or to mimic natural contours. Where other human uses are planned for, the land can be leveled or shaped in a manner that improves access or aids in future infrastructure development.

Furthermore, this management can comprise techniques such as covering of dug areas using mine spoil or fly ash and controlling the direction of flow of surface water to ensure that it does not enter the mine structures. Doing so avoids the risk of rising water becoming contaminated by dissolved metals and other substances and potentially being discharged into rivers and streams.

2. **Government Intervention**

The government can step in and contribute to restoration of quarries through a number of ways. These include;

a) Carrying out regular environmental audits on all the quarries in the study area will ensure an orderly inspection of quarries' interaction with the environment, in order to assess the effectiveness of its conservation or anti- pollution programme. Government officials ought to visit the quarries from time to time to ascertain that any form of pollution is mitigated.

b) The relevant government offices that issue out permits for mining to be carried out should develop a policy, such as one that prohibits quarries from operating new sites within the locality before rehabilitating their previous sites. Moreover, mining companies should present a carefully detailed post mining restoration plan and guidelines which should be assessed before the commencement of the activity which include restoration of damaged roads in the locality as a result of heavy trucks ferrying materials.

c) Ensuring proper planning and execution of plans throughout the quarrying process to regulate the development of unplanned settlements once quarrying activities are completed, the County government should adopt the option of closing all the quarries. The closure plan should specify the land use that the shut quarries should be transformed to. The best strategy is for the land to be reverted to the government for some time to undertake reclamation and afterwards a change of land use can be undertaken.

d) The government through the Ministry of Environment should stipulate the required buffer zone that should be adhered to when setting up quarries near residential and commercial zones. This will ensure clear boundaries between residential and mining sites are allocated. The proposed buffer zone should also be surrounded with fast growing trees possessing dense foliage, which in the long run will mitigate air and noise pollution, as trees act as air purifiers and cushions against the spread of noise.

e) The government should conduct meaningful awareness programs through the concerned authorities to all the quarrying stakeholders more so the communities. From the study results, Most of the residents were unaware of the policies that guide quarrying activities. All

stakeholders working in the quarrying sector including Ministry of mining, county government, Ministry of Environment, corporates and communities should also strengthen synergies amongst themselves to ensure effective awareness creation on issues related to mining, environmental impact mitigation and enforcement of mining regulations.

3. **Creation of alternative sources of livelihood**

The residents of Zowerani should be encouraged to pursue alternative sources of livelihood to reduce over-dependence on quarrying activities as the only source of sustaining livelihood in the area. The monopoly of practicing quarrying in the area increases over-exploitation of the quarrying stones thereby leading to further destruction of the environment. The National Government in collaboration with the County Government should come up with alternative economic activities that the residents can engage in so as to control quarrying in Zowerani. For example, the area enjoys the advantage of being adjacent to the ocean, this means that with the provision of equipment like nets and fishing boats, more people could be encouraged to join fishing which is an equal income generator so as to reduce the over-dependence on quarrying as the a means for sustaining livelihoods in the area.

4. **Implementation of proper planning intervention measures**

The relevant authorities should put in place proper planning intervention measures to ensure that the quarrying activities do not extensively interfere with the other neighboring land uses. Proper zoning plans should be developed to segregate the different land uses to ensure that each and every land use exists independently in its own geographical space. For example, the zoning plans should clearly define the boundaries for the different land uses such that residential land use does not share the same space with mining land use such as quarrying. This will help control the health impacts of quarrying on the residents of the area.

6.4 AREAS OF FURTHER RESEARCH

1. Despite numerous policies, legal frameworks, mining by-laws and mining regulations having been formulated and enacted both at National and County government levels and having been in force for a longer period now, mining operations such as quarrying are still not being conducted in a manner that meet the set standards and are in contravention of the existing laws and policies. This has in turn led to continued massive environmental degradation and serious health impacts on the surrounding and neighboring communities respectively. Further research therefore needs

to be carried out to determine why haphazard quarrying continues to be the norm of the day despite all the legal instruments at disposal of relevant authorities to regulate it.

2. Novel environmental restoration procedure is a critical area in furthering research. This is because with the destruction of the local landscape and eco-environment, a series of environmental problems, including land degradation, dust pollution has been witnessed. Therefore, this method which takes full advantage of the local construction materials, including the rock debris, construction waste after quarrying has taken place, recommends, the design and of an artificial slope which eliminates the environmental problems induced by mining exploitation activities. This approach provides site conditions favorable for artificial re-vegetation or any form development that should occur in the future/proposes the best use of land after restoration.

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APPENDICES

University of Nairobi
Dept. of Urban and Regional Planning
Master of Arts in Urban and Regional Planning
Research Project, Zowerani sub-location, Tezo Ward, Kilifi North Sub-County

Questionnaire: Household/ Residents

I am a master's in planning student at the University of Nairobi. The aim of this questionnaire is to collect data for a Research Project. The information and data provided will be confidential and is intended for academic purposes only.

Name of the Interviewer ----------Date of interview ----------

Name of the Respondent----------

Section A: Background Information

1. gender: Male ( ) Female ( )
2. Age: 15-20years ( ) 21-30years ( ) 31-40 years ( ) 41-50years ( ) above 50yrs ( )
3. Level of education: Primary ( ) Secondary ( ) Post-secondary ( ) None ( )
4. Marital Status: single ( ) Married ( ) widowed ( ) Divorced ( )
5. For how long have you lived here: 1-5yrs ( ) 6-10yrs ( ) 11-15yrs ( ) 16-20yrs ( ) above 20( )
6. Distance from the quarry: 1 0 – 500m ( ) 2 501m – 1km ( ) 3 1km – 2km ( ) 4 3km> ( )
7. Did you find quarrying going on? 1 Yes 2 No
8. If 'No' when did quarrying start in this locality? ----------
9. What uses are abandoned quarries put to? 1 Derelict 2 rehabilitated
10. Are you aware of any policies or legal frameworks governing quarrying activities? 1Yes 2 No
11. If yes which ones? ----------

Section B: Implications of Quarrying Activities on Coastal Land Uses

a) Environment and land form

1. how would you describe the landscape in this area in the past few years

   Bare ( ) Vegetative ( ) Eroded ( ) pitfalls ( ) unchanged ( )

2. how do you describe the landscape now

   Bare ( ) Vegetative ( ) Eroded ( ) pitfalls ( ) unchanged ( )

3. please tick where appropriate based on the statements below

statement	Yes	No
Are you able to farm near the quarry sites		
Do the quarry pits get filled up with water during rainy seasons		
If yes does the water ever get drained		
Does run-off water from the quarries drain in the ocean		
Do you witness breeding of mosquitoes as a result of water in the pits		
Do you think immediate restoration measures are necessary		

b) Air Pollution

4. how do you agree on the following statements please tick where appropriate

   Key: Strongly Agree (**SA**) Agree (**A**) Disagree (**D**) Strongly Disagree (**SD**)

Statement	SA	A	D	SD
The main source of dust in this village is Quarrying activities				
Vehicles transporting quarry material also generate a				

lot of dust				
Concentration of the dust at the atmosphere is mostly during blasting				
A lot of dust emission is experienced during dry seasons				
Rainy season reduces the amount of dust generated from the quarry				
Dust from the quarries has been a source of different ailments in the village				
Dust affects crops by coating dust on the leaves				
Dust settle on the roofs of our houses				
Dust affect our vision during the day				

c) Noise Pollution & Vibrations

5. how do you agree on the following statements please tick where appropriate

Statement	Yes	No
The main sources of noise is from the haulage , blasting, excavation and machine cutting of the stones		

Has there been cracks developing on the buildings due to vibrations and noise from the quarries?		
If yes has any of the cracked buildings collapsed?		

SECTION C ENVIRONMENTAL COMPLICATIONS

a .Human Health

6. please respond to the following statements by ticking yes or No

statement	yes	No
Is dust and noise from the quarries a nuisance to you		
Has the dust affected your Health?		
Has the noise caused hearing problems?		
Do the pits left behind after quarrying pause danger to your homestead?		
Do the pits hold water during rainy season?		
Do the pits act as breeding sites for mosquitoes		

7. What dust and noise related diseases have suffered from? (you may tick more than one)

Disease	**Yes**
Pain in the chest	
Difficulty in breathing	
Sore throats	
Eye problems	

Ear problems	
Skin disease	
Heart problems	

What water-borne related diseases have suffered from? (You may tick more than one)

Disease	**yes**
malaria	
cholera	
typhoid	
elephantiasis	
bilharzias	

SECTION D: MITIGATION MEASURES

8. Show how you agree on the following statements please tick where appropriate

Key: Strongly Agree (SA) Agree (A) Disagree (D) Strongly Disagree (SD)

Statement	SA	A	D	SD
Dusty roads should be watered regularly				
Barriers and traps should be erected around the quarry sites				

Quarries very near to homesteads and institutions should not be licensed				
Alarms should be issued before blasting exercises				
Strict measures should be taken to rehabilitate post quarried land				
Violators of quarrying regulations should be violated				

Suggest other rehabilitation measures that you may be aware of----------

---

Thank You

University of Nairobi
Dept. of Urban and Regional Planning
Master of Arts in Urban and Regional Planning
Research Project, Zowerani sub-location, Tezo Ward, Kilifi North Sub-County

Questionnaire: Quarry Owners/Company

I am a master's in planning student at the University of Nairobi. The aim of this questionnaire is to collect data for a Research Project. The information and data provided will be confidential and is intended for academic purposes only.

Name of the Interviewer ----------Date of interview ----------

Name of the Respondent----------

Section A: Background Information

1. gender: Male ( ) Female ( )
2. Age: 15-20years ( ) 21-30years ( ) 31-40 years ( ) 41-50years ( ) above 50yrs ( )
3. Level of education: Primary ( ) Secondary ( ) Post-secondary ( ) None ( )

Section B: Information on the Quarrying activities

1. What is your position in the company? ----------
   ----
2. what kind of ownership for the quarry land
   Own ( ) Leased ( ) Government Land ( )
3. When was this quarry established? ----------
4. How did you identify the potentiality of this area for quarrying activities? ----------
   ----
5. What is the size of land where the quarrying is taking place? ----------
6. What was the land used for before the quarrying started? ----------
7. How many workers do you have? ----------
8. Do you have a medical cover for the workers? Yes ( ) No ( )
9. If Yes which One? ----------

10. What protective gear have you got for the workers in your quarry? ----------

---

---

11. What do you use for the blasting ----------

12. What are some of the challenges you experience in your quarry ----------

---

13. In your opinion ,What are some of the impacts of quarrying activities on the environment

---

14. What do you think are the effects of your quarry on the surrounding communities?

---

14. How do you control

(i) Dust----------

(ii) Noise----------

(iii) Land subsidence----------

(iv) Loss of vegetation cover----------

(v) Risks associated with the use of explosives in the quarrying----------

---

15. 15. Do you have any waste management programs in your quarry? Yes ( ) No ( )

16. If (yes) which one----------

17. If (No) how do you dispose -off your waste----------

18. Are you aware of any policies or legal frameworks governing quarrying activities?
Yes ( ) No ( )

19. If yes, which ones----------

20. Are there any rehabilitation plans put in place once the quarry productive life is over?
Yes ( ) No ( )

21. If yes, which are they?----------

Thank You

University of Nairobi
Dept. of Urban and Regional Planning
Master of Arts in Urban and Regional Planning
Research Project, Zowerani sub-location, Tezo Ward, Kilifi North Sub-County

Questionnaire: Quarry Workers

I am a master's in planning student at the University of Nairobi. The aim of this questionnaire is to collect data for a Research Project. The information and data provided will be confidential and is intended for academic purposes only.

Name of the Interviewer ----------Date of interview ----------

Name of the Respondent----------

Section A: Background Information

1. gender: Male ( ) Female ( )
2. Age: 15-20years ( ) 21-30years ( ) 31-40 years ( ) 41-50years ( ) above 50yrs ( )
3. Level of education: Primary ( ) Secondary ( ) Post-secondary ( ) None ( )
4. Marital Status: single ( ) Married ( ) widowed ( ) Divorced ( )

Section B: Health & Safety Issues

1. For how long have you been engaged in the quarrying activities

   Less than one year ( ) 1-5 years ( ) 6-10 years ( ) 11-15 years ( ) over 20 Years ( )
2. how best do you describe the work you do in this Quarry

   Blasting ( ) cutting stones ( ) loading Stones ( ) other: Specify ( )
3. On average how many hours do you work per day?

   Less than 8 hours ( ) 8-12 hours ( ) over 12 hours ( )
4. Do you have any protective gear that you use during your quarrying activity?

   Yes ( ) No ( )
5. If yes, which specific protective gear? ----------
6. How best can you describe the noise levels within the quarrying area?

   Deafening ( ) **tolerable** ( ) **not audible** ( )
7. what are the causes of the highest noise levels in the quarry site

   Vehicles ( ) **stone cutting machines** ( ) **detonators** ( )

8. Is there dust emission emanating from the quarrying activities?

   Yes ( ) No ( )

9. Have you ever had any of the following occupational illness/conditions?

(i)	nasal Discharge	yes ( ) No ( )
(ii)	chest pains	yes ( ) No ( )
(iii)	dry cough	yes ( ) No ( )
(iv)	productive cough	yes ( ) No ( )
(v)	difficulty in breathing	yes ( ) No ( )
(vi)	eye irritations	yes ( ) No ( )
(vii)	noise induced hearing impairment	yes ( ) No ( )
(viii)	skin irritation	yes ( ) No ( )
(ix)	back pains	yes ( ) No ( )
(x)	physical injury	yes ( ) No ( )

10. Where do you seek for medical treatment?

    Self-Medication ( ) local dispensary ( ) Local Hospital ( ) Local Herbalist ( )

11. Do you have a medical cover Yes ( ) No ( )

12. If yes Specify the Medical Cover----------

13. What are some of the challenges that you experience from then quarrying

    ---

    ---

14. What other benefits do you get from your employer apart from the salary?

Thank You

University of Nairobi
Dept. of Urban and Regional Planning
Master of Arts in Urban and Regional Planning
Research Project, Zowerani sub-location, Tezo Ward, Kilifi North Sub-County

Key Informant Interview Guide: County Geologist

I am a master's in planning student at the University of Nairobi. The aim of this questionnaire is to collect data for a Research Project. The information and data provided will be confidential and is intended for academic purposes only.

Name of the Interviewer ----------Date of interview ----------

Name of key informant ----------Designation ----------

1. For how long have you served in your current station? ----------
2. Apart from your Department, which other agencies are involved in regularization of quarry activities within the county? ----------
3. What are the main challenges faced in quarrying activities in this area? ----------
   ----
4. In your opinion what are the challenges faced in regulating this industry? ----------
   ----
5. In your opinion what appropriate measures should be put in place to address the above mentioned challenges? ----------
   ----
6. What policies are in place to enhance positive impacts of stone quarrying in the area? ----------
   ----
7. Are there policy challenges in regulating the stone quarrying in the county? ----------
   ----
8. What do you think should be done to ensure sustainable stone quarrying?----------
   ----
9. What is the future for quarrying activities in this area? ----------
   ----

Thank You

University of Nairobi
Dept. of Urban and Regional Planning
Master of Arts in Urban and Regional Planning
Research Project, Zowerani sub-location, Tezo Ward, Kilifi North Sub-County

Key Informant Interview Guide: County Physical Planning Officer

I am a master's in planning student at the University of Nairobi. The aim of this questionnaire is to collect data for a Research Project. The information and data provided will be confidential and is intended for academic purposes only.

Name of the Interviewer ----------Date of interview ----------

Name of key informant ----------Designation ----------

1. For how long have you served in your current station? ----------

2. Has the county prepared a county spatial plan? Yes ( ) No ( ) ----------

3. If Yes Which Year was it prepared? ----------

4. If yes how has quarrying as a land use being captured in the spatial plan----------
---
---

5. Is there a region which has been set aside with special regulations for stone mining within the spatial plan? .....

6. How many application of change of user to quarrying activities do you receive per month within Tezo ward----------

7. Does the above no. reflect the quarrying activities taking place within Tezo Ward area?

---

8. What do you think should be done to ensure sustainable stone quarrying ----------
---

9. What do you think the County government should do to improve stone quarrying? ----------
---

Thank You

University of Nairobi
Dept. of Urban and Regional Planning
Master of Arts in Urban and Regional Planning
Research Project, Zowerani sub-location, Tezo Ward, Kilifi North Sub-County

Key Informant Interview Guide: Environment officer

I am a master's in planning student at the University of Nairobi. The aim of this questionnaire is to collect data for a Research Project. The information and data provided will be confidential and is intended for academic purposes only.

Name of the Interviewer ----------Date of interview ----------

Name of key informant ----------Designation ----------

1. For how long have you served in your current station?----------

2. Do you provide any technical education to the stone miners? Yes [ ] No [ ]

3. What other support do you provide for stone quarrying in the area ----------
---

4. What are the causes of stone quarrying in the area? ----------
---

5. What project do youroll out to enhance impacts of stone quarrying as a measure to environmental sustainability?

.....

6. What challenges do you face in affecting impact of stone quarry initiatives?.....
.....

7. What policies are in place to enhance positive impacts of stone quarrying in the area?.....

8. What policy challenges exist towards stone quarry in the district?.....
.....

9. Do you think stone quarrying favor mining industry

.....

10. Do you think stone quarrying has an effect on surrounding environment? Yes [ ] No [ ] If yes how.....

11. What do youthink should be done to ensure sustainable stone quarrying

.....

12. What do youthink the government should do to improve stone quarrying?

.....

Thank You

University of Nairobi
Dept. of Urban and Regional Planning
Master of Arts in Urban and Regional Planning
Research Project, Zowerani sub-location, Tezo Ward, Kilifi North Sub-County

Key Informant Interview Guide: Health officer

I am a master's in planning student at the University of Nairobi. The aim of this questionnaire is to collect data for a Research Project. The information and data provided will be confidential and is intended for academic purposes only.

Name of the Interviewer ----------Date of interview ----------

Name of key informant ----------Designation ----------

Name of the Dispensary----------

1. For how long have you served in your current station? ----------

2. What is the monthly turn out of patients in this dispensary? ----------
3. Out of the total patients how many have respiratory related complications ----------

4. In your opinion do you think the above no is on the higher side compared to statistics in the other neighboring health/dispensaries? Yes ( ) No ( )

5. If yes to the above question do you attribute the increase of these cases to the quarrying activities which are carried out in this area? .....

6. What challenges do you face in dealing with these cases due to stone quarry activities?.....

7. Do you receive any casualties as a result to accidents in the quarrying sites? Yes ( ) No ( )

8. If yes how many?.....

9. What Measures would you propose to reduce patients with cases related to quarrying activities? .....

10. What do you think should be done to ensure sustainable stone quarrying .....

10. What do you think the County government should do to improve stone quarrying? .....

Thank You

University of Nairobi
Dept. of Urban and Regional Planning
Master of Arts in Urban and Regional Planning
Research Project, Zowerani sub-location, Tezo Ward, Kilifi North Sub-County

Key Informant Interview Guide: Revenue officer

I am a master's in planning student at the University of Nairobi. The aim of this questionnaire is to collect data for a Research Project. The information and data provided will be confidential and is intended for academic purposes only.

Name of the Interviewer ----------Date of interview ----------

Name of key informant ----------Designation ----------

1. For how long have you served in your current station?----------

2. What is the monthly revenue collection out of quarrying activities within this sub county?----------
---

3. Out of the total revenue collected what percentage goes back to help the community to improve the condition of this area ----------
---

4. Are there legislations within your department that is related to mining and quarrying within the county? Yes ( ) No ( )

5. If yes to the above question which one?
.....
.....

6. What percentage is the revenue from stone quarrying out of the total revenue collection in the county?
---

7. What challenges do you face in collecting revenue from stone quarry activities----------
---

8. What plans do you have within your department to improve revenue collection for stone quarrying within the county?
---

9. What do you think should be done to ensure sustainable stone quarrying ----------
---
---

10. What do you think the County government should do to improve stone quarrying? ----------
---

Thank You