SOCIAL AND ENVIRONMENTAL EFFECTS OF STONE QUARRYING IN TULUONGOI SUB LOCATION, TENGES DIVISION, BARINGO COUNTY

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A RESEARCH PROJECT REPORT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTERS OF ARTS IN ENVIRONMENTAL PLANNING AND MANAGEMENT IN THE UNIVERSITY OF NAIROBI

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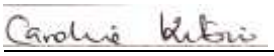
DECLARATION

This research project is my original work and has never been submitted or presented in part or-wholly for a degree in any University

Signature  Date 10th November 2020

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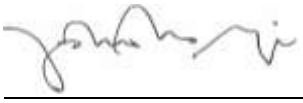
Signature  Date 10th November 2020

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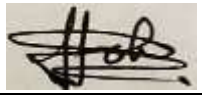
Signature  Date 11th November 2020.

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DEDICATION

I dedicate this research study to my parents and siblings. You have been a great motivation and a strong pillar.

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ABSTRACT

Stone quarrying has been recognized as a socioeconomic activity serving as a fundamental source of livelihood for some communities. Nonetheless, most operations are often accompanied by adverse effects on the same communities and the environment. Arguably, with the right planning and management, many of the negative effects of stone quarrying activities can be minimized. Thus, the study sought to establish the social and environmental effects of stone quarrying in Tuluongoi Sub location, Tenges Division, Baringo County. Specifically, it sought to examine the social effects of stone quarrying; to establish the effects of stone quarrying on the physical environment; to determine the level of awareness of environmental rules and regulations governing stone quarrying, an aspect that has been less explored and; to identify the measures put in place to mitigate the negative social and environmental effects of stone quarrying in the study area. The study applied qualitative and quantitative approaches with a sample size of 120 households, 97 quarry workers, and six key informants. The sampling methods used were census for the quarry workers, stratified sampling for households, and purposive sampling for the key informants. Data were collected using questionnaires, in-depth interviews, observation, and pictorials. Data was analysed through content analysis, descriptive and inferential analysis, while SPSS was used to generate tables, graphs, and frequencies. Cross tabulation for chi-square was used to test the hypotheses at a 0.05 rejection level for all inferences. Majority of the respondents considered stone quarrying a health hazard with majority of quarry workers self-medicating themselves. The majority of the respondents cited damage to the environment to be long-term and that it occurred daily. It was concluded that awareness of environmental rules and regulations on stone quarrying significantly influences environmental degradation. The study recommended NEMA's enforcement of compliance of environmental rules, regulations, policies, and principles governing stone quarrying and the need to develop a county quarrying and mining policy. The study recommends future research on the individual and institutional factors influencing the awareness of and compliance with the various environmental rules and regulations.

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ABBREVIATIONS & ACRONYMS

EIA	Environmental Impact Assessment
EMCA	Environmental Management and Coordination
GoK	Government of Kenya
ICN	India Committee in the Netherlands
ILO	International Labor Organization
KNBS	Kenya National Bureau of Statistics
NEMA	National Environment Management Authority
NEP	National Environment Policy
NERC	Natural Environment Research Council
SPSS	Statistical Package for Social Scientists
USGS	United States Geological Survey
UTCCP	University of Tennessee Center for Clean Products

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Stone quarrying is the extraction of stones from natural rock beds, primarily for the construction of roads and buildings (Punmia, Jain & Jain, 2013). It is carried out using different methods depending on the mineral composition, chemical, and physical constituents of rocks. Stone quarrying is done almost on the ground level, which is a contrast to a mine that is carried out deeply below the earth's surface (Punmia, Jain & Jain, 2013). Quarrying methods include quarrying with channeling, explosives, and equipment and tools (heating, excavation, and wedging) (Kumar 2014). Stone quarrying is commonly done through excavation.

Quarrying of stones has changed gradually from ancient times. For instance, in England during the 1600s, rock quarrying was limited to surface deposits and glacial erratic field boulders (Gage & Gage 2015). The commercial deep excavation method of quarrying being done today began in the early 1800. Gage and Gage (2015) indicate that rock quarrying in the 1600s was mainly used for specific purposes. According to Evans (2009), stone quarrying was a vital aspect of mining in medieval Europe, possibly more important than all the other mining sectors. According to the author, France was ranked the richest in stone quarrying, which was done through both underground and open quarries.

According to the Natural Environment Research Council, quarrying has played a significant role in boosting local economies for several years (NERC, 2017). The continued global population growth has propelled an increase in stone quarrying to fulfil the building and construction needs (Lad & Samant, 2014). As a result, several points of stone quarries have emerged. The Kentucky Geological Surveys (2012) state that the crushed stones at Western Kentucky, which is the largest stone quarry in the United States, generates annual sales of between $190 and $250 million. The report indicates that crushed stones contribute significantly to Kentucky's economy in many ways, including highway construction.

Despite the likely increase in quarrying of stones, the U.S and other multinational companies are slowly implementing sustainable resource management strategies to avert environmental problems associated with the quarrying activities (Kogel et al., 2006). Some of the principles adopted are to maximize the economic significance of a resource by extracting as many materials as possible from disturbed areas while minimizing potential environmental and

social impacts by protecting the growing communities from the negative effects emerging from poorly managed and poorly located operations.

In 2004, a referendum was held in Cyprus to either endorse the United Nations proposal themed Annan Plan to resolve the Cyprus reunification plan. Consequently, speculations on high demand for housing and accommodation in touristic Kyrenia region led to a higher number of applications for new construction the first year after referendum compared to the last 30 years (Hall, Smith & Marciszewska, 2006). The authors argue that current levels of construction are causing a massive strain on the environment. Notably, the stone quarries have been expanded, and the excavation process has compromised the water resources and adversely changed the topography (Hall, Smith & Marciszewska, 2006). The study blames the local municipalities and planning authorities for not restraining illegal, poor constructions and lack of adherence to environmental, planning, and building regulations.

According to a report conducted by the India Committee in the Netherlands in June 2010, children and adults living and working in quarrying and mining areas live in deplorable conditions (ICN, 2010). 86% of the women workers interviewed for the ICN report stated that they are from tribal communities and that they work at the quarries to earn an income to support their families given that most of their husbands are dead or bedridden because of silicosis due to the inhalation of dust that contains silica. The occupational disease, silicosis, is common in stone quarries and has caused several deaths (ICN, 2010). A biomedical research report supports the fact that quarry workers operating in stone cutting are at high risk of silica dust resulting in a deterioration of the pulmonary function (Kumar et al., 2014).

Similarly, in Italy, landslides of modest magnitudes have been reported inside the quarrying yards and external areas (Nando *et al*., 2011). The report demonstrated that landslides were associated with freeze, thaw, and heavy rains. The authors further explain that the landslides occurred in unfavorable geological situations where there are faults or the rock masses were broken. Burkina Faso hosts several unregulated quarries that draw so many people whose primary agenda is to make money (Hindman, 2009). A significant number of children, including child immigrants, have worked in stone quarrying activities on different capacities such as stone cutting. According to a report on human rights practices in 2009 within the western African countries, several children were trafficked to work in stone quarries, labour farms, and domestic work (GPO 2012). Similarly, in Tanzania, child labour is common in artisanal mines and stone quarrying points (Lupilya & Potter, 2016).

Twerefou et al. (2015) consider awareness of a community on the impacts of stone quarrying and policies and regulations governing the operations to be vital. However, the study done in Ghana illustrates that, while relevant environmental rules and regulations exist, quarry workers neglect them citing hindrance from the direct involvement of those in authorities with quarrying activities. Melodi (2017), based on a study in Ogun State Nigeria, recognizes the need for relevant government agencies to revise environmental management policies and principles governing quarrying to reduce the implications on humans and the environment reduced to significantly. On the other hand, Hamza and Kanyama (2016) admit the existence of mining and quarrying policies in Zanzibar but urges for recognition and incorporation of the needs of small scale stone quarry workers to ease the reduction of environmental problems from their activities.

Stone quarrying in Kenya is an activity that has been taking place for decades. The frequency of stone quarrying has significantly gone up recently due to the increasing population that prompted a high demand for housing, especially in the urban areas (Adimo, Njoroge & Waweru, 2018). Most of the quarrying activities in Kenya are unregulated, causing massive negative effects on the environment (Baker et al., 2015). The emergence of informal quarrying sites in Kenya and its neighboring countries is because of the ability to extract rocks with ease compared to high costs and technicality of manufacturing cement (Wells & Wall, 2001). The report by Wells and Wall shows that the high market demand for building stone in Kenya and Tanzania is the reason quarrying undertakings have been established in new areas, most of which are unregulated instead of strengthening activities in existing quarries.

Kenya has several stone quarrying sites. According to Mhlongo and Amponsah-Dacosta (2015), different quarrying sites manifest different levels of impacts on human development and the environment. Besides, stone quarrying has both positive and negative effects. Notably, stone quarrying has contributed to economic and societal development; conversely, it has exacerbated the damage to the environment and social well-being, such as human health, especially when quarries are abandoned. They leave huge gullies, ugly holes, and provide breeding places for diseasing causing organisms (Mhlongo & Amponsah-Dacosta, 2016).

Displacement, conflicts, entry of foreigners, discomfort, and change in societal norms are some of the social problems resulting from stone quarrying, as highlighted by Adimo, Njorogo, and Waweru (2018) in their post-quarry perceptions study in Kiambu. Similarly,

quarrying operations have caused several deaths. According to a 2016 article published in the Daily Nation on Thursday, February 25th, quarry workers in Meru had to choose to either die poor or risk dying by going ahead with stone quarrying (Kimanthi, 2016). According to the article, stone excavation in Meru is their main source of income; however, the stone breakers are at risk of losing their lives due to unfavorable working conditions such as lack of protective gear.

Just like in Zanzibar, according to Hamza and Kanyama (2016), Kenya has principles, laws, and policies governing quarrying operations such as the NEMA's 2011 land use Guidelines on Quarrying. The National Environment Policy 2013 acknowledges the vitality of environmental education, both formal and informal, to raise awareness and change the public's attitude and enhance a sense of responsibility on ecological matters. The policy also alludes that communicating environmental information to all persons is still a pressing problem (NEP, 2013). Stone quarrying sites in Tuluongoi Sub location are some of the many quarries in Kenya and have been actively operational for several years. According to the Baringo County Integrated Development Plan (2018-2022), Tuluongoi Location is one area that hosts several stone extraction sites in Baringo County (BCG, 2018).

1.2 Statement of the Problem

Worldwide, stone quarrying activities, whether small or large-scale, are considered to be inherently disruptive to the environment and societies and can have detrimental impacts for decades (Ming'ate & Mohamed, 2016). The detrimental impacts of stone quarrying are more amplified, especially where the operations are characterized by inappropriate and wasteful practices and inadequate rehabilitation measures (Sati, 2015). Nonetheless, small-scale stone quarrying activities, especially in rural areas, have been identified as a major source of livelihood despite the dangers they pose to the environment and other livelihood activities such as farming. These two facets of stone quarrying activities make it difficult for key players to answer the questions as to whether or not quarrying activities should be allowed to continue or not (Nartey, Nanor, Klake, 2012).

The availability of abundant building stones, idle land, and lack of regulations have prompted increased extraction of stones in Tuluongoi sub-location to serve the rising demand for constructions in most parts of Baringo County. Quarrying in Tuluongoi sub location takes place on hillsides and takes the form of small scale quarrying activities that are unstructured. According to Baringo County Integrated Development Plan 2018-2022, Tuluongoi location

where the study area is, hosts several stone extraction sites and is the primary source of building and construction stones in the county (BCG, 2018).

The stone quarries in Tuluongoi location have been found to create employment opportunities for area residents and are a fundamental livelihood source. Nevertheless, various environmental problems, as highlighted in the county's CIDP 2018-2022, such as abandoned holes, soil erosion, land degradation, and diverted natural river water flows, have been recognized as part of the development challenges facing the county. In April 2020, the collapse of quarry in Perkerra ward in Baringo County saw two quarry workers buried alive while others were left nursing serious injuries (Kangogo, 2020).

These cases notwithstanding, the social and environmental effects of stone quarrying in this area have not been explored despite the area being one of the main sources of building stones within and outside Baringo County. The nature of stone quarrying activities in the study area in terms of their intensity, organization, planning, control, the methods used, and the overall management of the operations have not been examined in the existing literature. The level of awareness of environment rules and regulations governing stone quarrying and which is likely to determine the impacts of these operations in the area, has not been studied as well in the available literature.

It has been argued that while quarrying can cause significant impact to the environment with the right planning and management, many of the negative effects can be minimized or controlled, and in many cases, there is great opportunity to protect and enhance the environment, such as with the translocation of existing habitats or the creation of new ones (Endalew, Tasew, & Tolahun, 2019; Darwish et al., 2011). Hence, to realize a balance, adequate actions, and measures to mitigate the impact of stone quarrying on the environment and surrounding communities is inevitable. This requires extensive research on the quarrying sites so that the degree of the impacts and the appropriate remedies that can be taken are identified. It is difficult to take sustainable mitigation measures without a detailed investigation of the impacts. Therefore, this study sought to establish the social and environmental effects of stone quarrying in Tuluongoi Sub location, Tenges Division, Baringo County. The study further sought to determine the level of awareness of environmental rules and regulations governing stone quarrying operations in the area and whether this could explain the nature of impacts witnessed.

1.3 Research Questions

The study attempted to answer the following questions for Tuluongoi Sub location: -

i. What are the social effects of stone quarrying in Tuluongoi Sub location?
ii. How has stone quarrying affected the physical environment in Tuluongoi Sub location?
iii. What is the level of awareness of environmental rules and regulations governing stone quarrying operations in Tuluongoi Sub location Tuluongoi Sub location?
iv. Which measures have been put in place to address the negative social and environmental effects of stone quarrying in Tuluongoi Sub location?

1.4 General Objective

To establish the social and environmental effects of stone quarrying in Tuluongoi Sub location, Tenges Division, Baringo County.

1.4.1 Specific Research Objectives

i. To examine the social effects of stone quarrying in the study area.
ii. To establish the effects of stone quarrying on the physical environment in study area.
iii. To determine the level of awareness of environmental rules and regulations governing stone quarrying in study area.
iv. To identify the measures put in place to mitigate the negative social and environmental effects of stone quarrying in the study area.

1.5 Research Hypotheses

i. H_o: There is no significant relationship between stone quarrying and the social wellbeing of residents in Tuluongoi Sub-location.

ii. H_o: Stone quarrying has no significant contribution to environmental degradation in Tuluongoi Sub-location.

iii. H_o: Awareness of environmental rules and regulations on stone quarrying has no significant influence on environmental degradation experienced in Tuluongoi Sub-location.

1.6 Justification and Significance of the Study

The Baringo County Integrated Development Plan 2018-2022 recognizes the great potential of stone quarrying in Tuluongoi location as the area hosting several stone extraction sites and

is the primary source of building and construction stones in the county. The Annual Development Plan for the county 2017-2018, however, cites environmental degradation as the biggest challenge facing the county and one which is increasingly threatening the wellbeing of the communities living in the county. Quarrying operations in the county, including the stone quarrying activities undertaken in Tuluongoi sub location have been linked to the environmental challenges facing the county and their adverse implications on the lives of communities in the area. These issues, some of which can be effectively mitigated with the application of available quarrying guidelines, rules, and regulations developed by the National Environmental Management Authority (NEMA) and the Ministry of Mining, continue to persist as nothing tangible is being done to address them.

The researcher's preliminary observations revealed that quarrying operations took place even less than 5 metres away from homes in the study area, and quarry workers did not adorn any protective gear contrary to the stipulated NEMA guidelines. Falling rocks, landslides, clearing of vegetation, and abandoned quarries were also the aftermath of stone quarrying in the area. It is unfortunate that falling stones previously killed workers. Change of river course and blockage was also an outcome observed. These observations raised concerns about the awareness of and compliance with environmental rules and regulations on stone quarrying among the residents and the effectiveness of mitigation measures.

It has been noted in previous studies that with the right planning and management, many of the negative effects associated with stone quarrying can be minimized or controlled. In many cases, there is a great opportunity to protect the environment and surrounding communities. This requires well informed and adequate actions and measures to mitigate the negative impacts of stone quarrying. Hence, in order to take sustainable mitigation measures, a detailed investigation of the impacts of stone quarrying operations is necessary. Despite the great potential for stone quarrying in Tuluongoi Sub location, this activity's social and environmental effects in the area had not been highlighted in past research. The link between the awareness of the available environmental rules and regulations on stone quarrying and the effects of this economic activity had also not been explored in past research. To fill these gaps, the researcher embarked on a study to establish the social and environmental effects of stone quarrying in Tuluongoi Sub location, Tenges Division, Baringo County.

Therefore, the findings of this research would be beneficial to NEMA, County Government or Baringo, Ministry of Mining, researchers, and the locals. The findings would be crucial in informing NEMA, the relevant Baringo County Government departments, department of

mining, and other relevant bodies on the need for instituting proper measures, policies, and regulations to govern the stone quarrying operations in the area and elsewhere. Given that no other research had been conducted in the study despite its significance to the construction sector in the county, the document would form a crucial reference point for researchers in carrying out studies as recommended.

1.7 Scope of the Study

Even though stone quarrying activities have effects that cut across several aspects, this confined itself to establishing the social and environmental effects of stone quarrying in Tuluongoi Sub location while determining whether there is a linkage between awareness of environmental principles, rules, and regulations governing stone quarrying and the harshness and severity of the implications. The study focused on two villages with three active quarries within Tuluongoi Sub location, Tenges Division, Baringo County. The specific villages were chosen because they hosted the three active quarrying sites, those quarrying operations have been going on for several years and many homes are located very close to the quarries. The study targeted quarry workers, household heads not involved in stone quarrying, NEMA officials, healthcare workers, and the Ministry of Mining officials posted to the county. The study was carried out between January and August 2020.

1.8 Limitations of the Study

A number of limitations were faced while conducting this study. Some of the quarry workers at first showed an unwillingness to share some crucial information required in this study for fear that the information collected could be used to their disadvantage, for instance, the closure of quarrying sites by relevant authorities. Others did not allow the researcher to take photos in the quarrying sites. As a result, the researcher had to spend more time assuring them that the study was being conducted solely for academic purposes. The information provided by the household heads and observations made by the researcher were crucial in providing detailed insights where the quarry workers withheld crucial information.

Given that some of the environmental effects of stone quarrying activities were more amplified and clearer during the dry season, the researcher couldn't capture these effects through observation. They instead relied on the accounts given by the respondents. Moreover, since the researcher had extensive experience with environmental issues, particularly within the county, their experience and knowledge might have been a temptation for them to have preconceived opinions about the issues under study, which had the potential to undermine the

objectivity of the study. To deal with this challenge, the researcher was cognizant of other scholars' findings and was also guided by the research supervisors' comments. The help of research assistants also ensured that the data collected was objective.

The researcher also faced financial and time constraints, even though the researcher had prior planning. These constraints were worsened by the global health crisis that is still ongoing, which slowed down the data collection process. Another limitation was difficulty accessing some homes because of the steep terrain. Hence, the researcher obtained data from the households that could be easily accessed. Furthermore, the quarry workers were all men hence making the study appear gender insensitive.

1.9 Definition of Terms

Abandoned quarries: depleted quarries that were left without any rehabilitation or fencing

Blasting: breaking of rocks for excavation using a machine or explosives

Environmental regulations: refers to the guidelines and rules stipulated by relevant bodies that quarries operations must abide by.

Household: a unit of an individual(s) residing in the same dwelling

Household head: any individual who has the power to make decisions on behalf of the household or is designated to make decisions

Livelihood: A source of securing for the basic necessity of life such as food, shelter, clothing, fodder. In this case, stone quarrying, livestock keeping, farming are sources of livelihood.

Noise pollution: emission of unwanted sound that may cause harm to human and animal health. In this case, noise from tracks, lorries, blasting, and cutting of stones.

Noise: an unwanted sound that may cause harm to human health

Quarry site: a place with several points of stone extractions

Quarry worker: a person involved in any of the activities taking place within the quarry sites

Quarry: to extract stones or rocks through cutting and blasting

Stone quarrying: the process of extraction of stones from the ground for building and construction purposes. Stone quarrying, in this case, concerns unregulated quarries.

Awareness: to know and understand such aspects as the environmental rules and regulations

Social: in this context refers to issues affecting humans and the community directly such as health, displacement, conflicts, awareness, education, child labour, water scarcity, noise and deaths

Social well-being is the ability of people to coexist and prosper socially and economically. In this research, social wellbeing is characterized by variables such as conflicts, tension, health conditions, displacement, migration, and involvement of children in quarrying operations.

Physical environment: The physical environment in this context referred to the observable features such as scars on the land, excavations, abandoned quarry pits, stone wastes, vegetation and trees, dust, changed water course and cracks.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of literature and studies done on stone quarrying. The sections covered include stone quarrying as a source of livelihood, social effects, environmental implications, environmental guidelines and regulations, awareness of rules, regulations, principles, and mitigation measures. The chapter also covers the theoretical framework, conceptual framework, and summary of gaps from literature studied.

2.2 Stone Quarrying

Stone quarrying is associated with both positive and negative effects on the social and environmental well-being (Endalew et al., 2019). According to Lameed and Ayodele (2010), stone quarrying is done for the economic good at the expense of the social and environmental aspects; if not addressed with cautions, the effects can be devastating to a community. Population growth and demand for increased housing and commercial infrastructure are considered primary reasons the stone quarrying industry continues to thrive (Adimo, Njoroge & Waweru, 2018). However, the reasons people engage in stone quarrying vary depending on the community's social and economic needs.

According to Bewiadzi, Awubomu, and Glover-Meni (2018), stone quarrying in Daglama, Ho municipality Ghana is a source of livelihood survival through direct and indirect employment opportunities to the residents. Similarly, according to a project analysis on the socioeconomic impacts of a quarrying project, employment is considered one of the visible benefits of a given community (Euromines, 2016). The document demonstrates that employment is generated at different stages of quarrying from exploration to rehabilitation phases. Most jobs are created externally through road pathway and road construction to and out of the quarry, the establishment of new business to serve the demands of the immigrants.

Harm occasioned by stone quarrying also depends on the needs of a community. Intensive quarrying operations result in a change of landform, biodiversity loss, reduced agricultural lands, habitat destruction, air pollution, and loss of aesthetic value (Endalew et al., 2019; Lameed & Ayodele, 2010; Hamza & Kanyama, 2016). Deaths, injuries, chest pains, and respiratory-related ailments are some of the health concerns associated with stone quarrying activities (Lad & Samant, 2014).

Despite the economic value they generate from stone quarrying, communities living close to the quarries suffer other social implications such as displacement, discomfort, fear, rising conflicts, and the influx of foreigners (Adimo, Njoroge & Waweru, 2018; Lad & Samant, 2014). Several unregulated quarries record increasing cases of child labour. A 2013 report carried out by ILO on child labour in mining and quarrying in Ghana revealed that 10,500 children took part in quarrying and mining activities in 2003 as reported by the Ghana Child Labour Survey (ILO, 2013).

2.3 Social Effects of Stone Quarrying

While stone quarrying is associated with positive effects, it poses negative implications on the social aspects of the people living within or close to the quarries. Adimo, Njoroge, and Waweru (2018), in their study, uncovered that social issues such as domestic violence, erosion of societal ethics, an influx of new people, displacement, and insecurity were occasioned by stone quarrying. The study also underscored that loss of cultural heritage grounds such as caves and shrines commonly used for traditional activities and rituals is lost due to quarrying. As observed from the study findings, domestic violence, insecurity, and the influx of foreigners topped the list (Adimo, Njoroge & Waweru, 2018).

Similarly, Lad and Samant (2014) note that regular conflicts arise between the communities living close to the quarries and the quarry owners. Mancini and Sala's (2018) findings indicate that disputes and social tensions occur due to the unequal distribution of resources from extractive activities. Conflicts between landowners or companies and illegal miners are common in politically motivated torture and killings among anti quarrying and mining activities (Mancini & Sala, 2018). Terminski (2012), in a working paper, acknowledges that about 60 percent of the world's minerals, including stones, are located among indigenous communities. In the event of trying to protect their territories and resources, conflicts between the community and the landowners arise.

Terminski's (2012) working paper on development-induced displacement and human security considers displacement from extractive activities, a social phenomenon similar to compulsive evacuation by an administrative body. The working paper maintains that continued excavations and expansion of mines and quarries directly impact the immediate community, causing conflict-induced displacements. Twerefou et al. (2015) affirm that displacements have more severe effects that trigger conflicts between the local communities, and the landowners confirm assertions by Terminski (2012). In most cases, planned compensations

for displacements are expected due to quarrying activities; however, this never happens in small-scale or unregulated quarries. Owena and Kemp (2014) associate physical displacement, relocation, and resettlement of affected communities to more social risks.

Social costs associated with stone quarrying are huge hence becoming an impediment to the lives of the local community close to the quarry sites. The communities around the quarry sites are forced to spend a lot of money to purchase portable drinking water and foot health-related bills (Melodi, 2017). The provision of alternative drinking water and compensation were considered vital interventions to lost social attributes. Lack of peace, comfort, and constant fear of falling stones are common because most quarries occur close to people's homes (Lad & Samant, 2014). Safety is never assured. In support of Lad and Samant's (2014) arguments, Saraya (2016) agrees that rock blasting causes ground vibration affecting the comfort and stability of homes of people living close to the quarrying sites. Cracks on the floors and walls of homes and other infrastructural facilities often occur. The researcher observed buildings close to the operations sites had cracks because of the heavy vibrations.

Stone quarrying, like any other activity, attracts everyone's attention irrespective of age and gender for as long as there are no restrictions. Forced child labour is a social problem eminent in most quarries, especially in developing countries. According to an analytical study by ILO (2013), young children in Ghana engaged in illegal quarrying activities with a significantly high number being children from local communities. The investigation relates to a comparative study by ILO in 2006 that uncovered that children in different parts of the world engaged in quarrying at different levels.

In Nepal, children tend to start working in quarries at around 10-12 years, where they combine schooling and working. In Madagascar, adolescent children tend to drop out of school as they engage in collecting stone blocks, sorting, and other related activities (ILO, 2006). In Guatemala, ILO says low-income families pitch camps in public shores where children as young as five years engage in breaking rocks and adults and children work for over hours a day. Mancini and Sala, (2018) findings demonstrate a significant concern on forced and compulsory labour, and child labour hence concurs with ILO's study.

Gender disparity and discrimination is a social issue manifested in the stone quarrying industry. According to Lahiri-Dutt (2007), women joined the informal mining and quarrying sector as an alternative source of livelihood to subsistence agriculture to improve their income levels; Lahiri-Dutt cites a 1999 ILO's report. Mostly, low prices of commodities,

reduced employment, drought on farming, and high inflation rates prompted many people, particularly women who depended on subsistence agriculture, to seek alternative sources of income to survive and better the quality of their lives (Priyadarshi & Lahiri-Dutt, 2014).

According to a study by Olugbenga, Olushola, and Ajibola (2015) in Ekiti State, Nigeria, on the role of women in quarry operations, while women worked fulltime in the quarries, they participated in secondary roles while the men are taking up the primary tasks like drilling and blasting. The study recommended addressing the evident gender inequalities in the sector through equipping women with technical skills. Similarly, a 2016 mining and minerals policy document by the mining ministry in Kenya agrees that the extractives sector escalates gender disparity. Women are increasingly taking part in the extractive sector; however, they are disadvantaged when it comes to decision-making, control over resources and limited practical knowledge (GoK, 2016).

The quarrying and mining industry is usually an area associated with considerable risks to occupational health and safety (Tribhuwan & Patil, 2009). The major occupational health and safety hazards as a result of stone quarrying include physical injuries, fatal accidents, and work-related respiratory illnesses such as tuberculosis and silicosis because of the inhalation of dust. Tuberculosis is transmittable; hence, it can easily be communicated among workers with a high emission of dust. Silicosis, on the other hand, is an occupational lung disease resulting from inhaling silica particles. While the length of time spent quarrying is associated with health problems, Mbandi (2017), using chi-square to test the hypothesis, concluded that there was no connection between wellbeing and the number of years spent excavating stones.

An environmental impact assessment study carried out on stone cutting industries and quarries in Jammain, Palestine, argues that dust is one of the most visible and irritating effects linked to quarrying (Saraya, 2016). The dust may be from a point source as a result of blasting, drilling, or crushing, from haul roads and excavation. The study found out that cough, hearing impairment, nasal inflammation, and dyspnea were the most prevalent diseases associated with quarrying in Jammain. Similarly, skin diseases, high blood pressure, and asthma score were associated with quarrying operations.

According to Saraya (2016), there are several accidents during quarrying operations; 13.9% of the respondents demonstrated the prevalence of fractures while 10.2% said the accidents resulted in permanent disabilities, with 3.7% of the respondents expressed fatality during the incidents. The researcher claimed that most of the incidents occur due to a lack of monitoring

and controlling measures. Wanjiku et al. (2014), in a study on occupational health of quarrying, found that the quarry workers and quarry owners perceived the quarrying activities as the source of poor health conditions.

Kumar et al. (2014), in their study on the deteriorating pulmonary function among quarry workers in India, concluded that exposure to dust containing silica poses adverse effects on the functioning of the pulmonary. The rate of deterioration depends on the concentration and duration of exposure. Silicosis can be seen only after a more extended period of exposure to silica dust (Kumar *et al*., 2014). A study conducted in Abeokuta, Nigeria, on the health implications of granite quarrying in the residents and quarry workers revealed that the residents suffered from health risks associated with breathing in dust from the air (Olusegun, Adeniyi & Adeola, 2009). Some of the respondents expressed shock resulting from noise caused by explosives and ground vibration to be a health risk. The detonation of explosives creates vibrations that trigger stress, loss of sleep, fatigue, and increased pulse rate.

In Minya, Egypt, almost eight thousand people work in deplorable stone quarries (ILO, 2014). The workers are subjected to high risk to occupational diseases and accidents because they have only essential resources but no social insurance. ILO asserts that close to 80% of quarries in Egypt are illegal, and just 10% of the workers in the quarrying industry have social insurance. The workers use poorly maintained machinery with no safety measures hence the frequent deaths and diseases like eye and lung disease (ILO, 2014). Consequently, the average life expectancy of individuals working in quarries and open mines has reduced to 45.

Eshiwani (2014) conducted a study in Embakasi, Nairobi, on the effects of stone quarrying on the environment, and one of the objectives assessed was about health implications. The study demonstrated that hearing problems, respiratory infections, chest pains, common cold, eye infection, and coughing were illnesses associated with quarrying activities. Respiratory infections and hearing problems topped the list in that order. The researcher argued that health issues resulted from a lack of protective gear while carrying out quarrying activities. Eshiwani found out that there was a significant relationship between quarrying operations and the health of the workers.

2.4 Environmental Implications of Stone Quarrying

Mahtab Stanton and Roma (2015), in their study about the environmental impacts of rock blasting close to the Bay of Fundy, Canada, confirm the presence of huge environmental repercussions generated from quarrying operations near the bay in addition to lowering the quality of life. Detonations close to the water generates compression waves that can adversely damage the bladder and eggs of fish. Similarly, the study indicates that noise affects water animals. Water pollution due to the explosive residue is also apparent at the Bay of Fundy. Besides, Sayara (2016) says quarrying operations interrupt natural water recharge leading to reduced quality and quantity of drinking water for wildlife and downstream users and those close to the stream.

Quarrying affects the air quality of a local area because of the dust emissions from quarrying operations and hauling, eventually implicating human health (Tribhuwan & Patil, 2009). On the contrary, Bewiadzi, Awubomu, and Glover-Meni (2018) established that air quality in the Daglama quarry site in Ghana was compromised because of the use of the flame burning method to soften the stone before using crude tools to break it. According to the study, the process involves the use of lorry tires to enhance the process, ultimately releasing carbon monoxide, which is harmful to human and animal health and the environment. The dust also has inauspicious effects on vegetation, agriculture, and animals. Lad and Samant (2014) associated dust emissions with reduced agricultural yields because of the deposition of dust on the crops.

Quarrying is an unsustainable operation as it involves the extraction of natural resources from the ground to meet human needs without replacing (Bowen & Pallister, 2006). Blasting of stones and rocks leaves scars and ugly holes on hillsides and the ground, respectively. The findings by Adimo, Njoroge, and Waweru (2018) support the fact that quarrying activities intensified scars on unrepaired land in quarried zones. A text by the International Conference on Land Degradation and Zdruli (2010) maintains that decades of unregulated quarries to support urban and industrial development have left multitudes of scars on the land depriving the environment of its aesthetic integrity as per Tsolaki-Fiaka et al. (2018).

Stone quarrying activities occupy large pieces of land where trees and vegetation are cleared. Lameed and Ayodele (2010) argue that biodiversity loss is a notable impact of quarrying activities. According to the authors, flora and fauna are destroyed or driven to extension due to continued quarrying and vegetation clearing. Lameed and Ayodele expound that quarrying

disrupts the natural food supply in the ecosystem forcing wildlife to migrate. Similarly, Adimo, Njoroge, and Waweru (2018) reveal that quarrying damages large forest areas, resulting in the loss of plants and wildlife residents to the quarried zone.

Bewiadzi, Awubomu, and Glover-Meni (2018) agree based on their study deforestation, habitat destruction, ecosystem damage, and wildlife extinctions are evident negative outcomes of stone quarrying. Oyinloye and Olofinyo (2017) in their study in Akure region, Nigeria, noted that quarrying activities negatively impacted vegetation. Fifty percent of the respondents said quarry operations damaged plants and led to reduced vegetation growth.

A document developed by the University of Tennessee Center for Clean Products acknowledges that stone in itself is a considerable waste concern in the stone quarrying industry (UTCCP, 2009). An earlier survey done in 2006 by the same center demonstrated that anywhere from 3 to 93 percent of the total stone quarried ends up as waste. Additionally, more wastes are generated from fractured rocks. The document asserts the detrimental environmental and safety effects of quarry wastes as they pose dangerous working environments if not well organized and leave a visually undesirable impact (UTCCP, 2009). According to Tsolaki-Fiaka et al. (2018), quarry wastes deposited within the operational area led to shrinkage and disappearance of vegetation, obstruction of surface water runoff during rainy seasons, and increased soil erosion.

According to Maina-Gichaba, Kipseba, and Masibo (2013), most landslides in Kenya are caused by water and human activities such as mining and quarrying, leading to socioeconomic and environmental injuries. In Italy, landslides in quarrying zones occurred almost always due to heavy rains, thaw, or freeze (Nando et al., 2011). Rop and Anyona (2016), in a study on landslide preparedness and mitigation in Kipkelion District, Kenya, showed that quarrying alongside clearing of vegetation and deforestation were the main causes of landslides in the area.

2.5 Environmental Guidelines and Regulations Related to Stone Quarrying in Kenya

2.5.1 NEMA’s 2011 Land Use Guidelines on Quarrying

NEMA's 2011 integrated national land-use guidelines stipulate that an environmental impact assessment should be done before quarrying begins. All operations should adhere to the noise and excessive vibrations regulations established in 2009. Safety distance should be observed in that quarrying operations without blasting need to be done 50m away from any house; 100m to any school, health facility, or shipping center and 40m away from any rail, river, or

road reserve while quarries with controlled blasting should operate according to advice from a technical officer.

Landowners are expected to come up with rehabilitation or after use plan and has to be approved by the district environment committee and that quarries need to be restored within twelve months of depletion of the quarry, which should be approved by the same committee or an appointed agent with the issuance of a clearance certificate confirming it. Similarly, the document outlines the occupational health and safety guidelines, which include the prohibition of loose hanging rocks near the quarry, erection of warning signs in the appropriate font, and language at the entry of every quarry or near high cliffs and that all roads from quarries be made safe and accessible. All persons working in quarries should be provided with protective gear, clean water, and sanitation and first aid kits with trained aiders. Further, quarry workers are required to be trained in health, safety, and environmental issues. A person in charge of safety should be on the quarry site and the establishment of safety, health, and environment committees.

It is also mandatory under the guidelines for quarry sites to be designated, mapped, and change-of-use permits confirmed before a new site is established. Also, the erection of adequate barriers to check on stones rolling downslope is required. It is also a requirement to enhance local quarry operators' capacity on disaster preparedness and response through training and provision of appropriate equipment (NEMA, 2011).

2.5.2 Wildlife Conservation and Management Act, 2013

Section 45 (1) of the act stipulated that no person would be allowed to carry out a mining or quarrying activity within a national park or reserve without consent from the Kenya Wildlife Service (KWS). The act also provides that approval and permission will be given once an environmental impact assessment has been conducted as per the EMCA Act 1999, that the area is not a habitat for wildlife; not a critical catchment area or source of spring and does not contain endangered species.

2.5.3 The Forest Conservation and Management Act, 2016

Under section 46 (1) of the forest conservation and management Act 2016, Kenya Forest Service shall consent for quarrying activities in a forest where the area has no endangered, rare or threatened species and that an environmental impact assessment or audit has been done. The act also provides that the area should not be an important catchment area and should not be of cultural significance or host sacred trees or groves. Section 46 (3) of the

same act prohibits the provision of a quarrying license if the applicant has not implemented safety measures protecting wildlife, livestock, or humans crisscrossing the forest from related injuries. Further, section 46 (4) mandates the licensee to the compulsory restoration of quarried areas in any forest upon completion of the activity should there be depletion of vegetation cover.

2.5.4 The Water Act, 2016

Section 143 (1a) of Water Act 2016 requires that no person shall without authority under the act willfully or neglectfully cause abstraction, obstruction, diversion, or interference of a watercourse or water source. Also, (1b) prohibits any individual that conveys, throws, permits, or causes to be thrown off any dirt, rubbish, trade waste, or any obstructive matter into or near a water resource in a way that is likely to give rise to contamination of the water resource. Section 143 (2) considers a person that contravenes the part mentioned above to have committed an offence. Section 144 (1) of the act requires that the offender remedies the contravention by cleaning up the pollution within a specified time.

2.5.5 Environmental Management and Co-Ordination (Waste Management) Regulations 2006

Part two of the regulation focuses on solid waste and prohibits any person from disposing of waste on any public street, highway, road, recreational area, or a place not designated. The regulation also mandates a person whose activities generate waste to segregate them and transfer the trash to a licensed transporter or disposed of in the right place.

2.5.6 The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009

The regulation considers vibrations levels exceeding 0.5 centimetres per second past any source property boundary or 30 metres from any moving source to be excessive. Thus, the regulation allows that works of mining or quarrying can be carried out in the area within the permissible noise and vibration levels and that the correct machinery is being used.

2.5.7 The Occupational Safety and Health Act No. 15 of 2007 (Revised 2010)

Section 101 (1) requires that every employer provide and maintain protective clothing and appliance for employees involved in injurious or offensive substances. The protective gear includes goggles, head coverings, footwear, and gloves. Section 99 (1) mandates that

employees be acquainted with an operation that may cause ill health or body injury such that new machinery cannot be introduced without training the operator.

2.6 Awareness of Environmental Rules and Regulations on Stone Quarrying

Quarrying activities are governed by principles, laws, and regulations that must be adhered to. The ability of communities within the vicinity of a quarry to comprehend the quarrying regulations ensures quarry owners operate within the mandated laws. Twerefou et al. (2015), in a working paper on the attitudes of local people to mining policies and interventions in Ghana, established that individuals working in illegal small scale extractives were aware of a few rules and regulations but had no idea of the details involved. The study's findings confirm a significant percentage of the respondents were aware that their actions should not pollute the environment and the need for environmental compliance; however, they could not account for compliance standards. The study explains that some respondents participated in training on how to manage chemicals while onsite. However, they cited training was out of context in relation to their work and expectations.

A study conducted in Ndarugu, Kiambu, Kenya, on the management status and perception of post quarried sites uncovered that landowners and quarry firms were responsible for rehabilitating depleted quarries (Adimo, Njoroge & Waweru, 2018). Despite that, the large part of the quarried land was not restored. The study cited a lack of efficient legal procedures and many landowners lacking the awareness of the need to rehabilitate quarried land. The study recommended the need for awareness creation and capacity building on quarry restoration. Whereas a well-informed landowner or quarry firm is essential, the level of awareness of environmental regulation among the local community is essential. In January 2020, the NEMA was forced to close down a quarry in Kilimambogo after public outcry of the dangers of the quarrying activities posed on their health and the environment (Ministry of Environment & Forestry, 2020). The quarry was closed down based on non-compliance with NEMA rules and regulations.

According to Lad and Samant’s (2014) study in Kolhapur District in India, despite the death incidences, injuries to children, and cattle as a result of abandoned quarries, no attempt was made to restore or reclaim such quarries in respect to the laid down rules and procedures. The study further explains that the interaction with the quarry workers and the locals established that none of them had any clue of the status of the quarries or the rules and regulations governing the quarrying operations. The research also argues that the authorities concerned

had no satisfactory information regarding the number of illegal quarries or the permissible quarrying standards. The study then concludes that the scanty nature of information is why the irreversible adverse effects on the environment. Similarly, Twerefou et al. (2015) indicate that the social and economic pressures affecting a community will influence their attitudes towards the extractive industry's policies and regulations.

Communicating the possible negative effects of a mine or a quarry on human health and the environment before the start of operations affects people's views towards policies and interventions (Twerefou et al., 2015). In support, a study conducted in Uwandani Pemba, Zanzibar, on the challenges of addressing environmental issues emanating from quarrying activities argues that environmental education is crucial (Hamza & Kanyama, 2016). The study found out that lack of an understanding of environmental implications of stone quarrying among the local community is one of the challenges affecting the ability to mitigate the effects. Further, key informants in this study cited the lack of support from the local community in addressing the environmental issues linked to poor understanding of the effects of quarrying activities on the environment.

2.7 Mitigation Measures to Social and Environmental Effects of Stone Quarrying

Establishing interventions to address social and environmental implications resulting from stone quarrying should be tailor-made to suit a specific area. The provision of environmental education is one of the basic mitigation measures that need to be considered (Hamza & Kanyama, 2016). While that is the case, the study by Hamza and Kanyama, (2016) in Pemba established that lack of an understanding of formal and environmental education was a massive challenge in tackling environmental problems related to stone quarrying. While the study recognizes the significance of knowledge on environmental conservation, it does not recommend addressing this challenge.

According to Lad and Samant (2014), stone quarrying activities tend to disturb aquifers resulting in reduced groundwater levels. Their study in Kolhapur District, India, elucidates that the respondents emotionally linked stone quarrying activities to water scarcity in the area. Averting the water table's depletion can be done through groundwater recharge via rainwater harvesting, recharge pits and ponds, and vertical and horizontal shafts (Misra, 2013). As a result, Melodi (2017) recommends providing alternative water if stone quarrying is a source of water source contamination or pollution. Misra (2013) suggests the supply of

safe drinking water and defluoridation to reduce human suffering from salinity and fluoride levels in groundwater caused by stone quarrying in some areas.

Rehabilitation of depleted quarries is considered an essential measure that promotes positive environmental and social wellbeing in a given community (Adimo, Njoroge, & Waweru, 2018). The study on post-quarrying perceptions in Kiambu, Kenya, demonstrates that the residents associated a rehabilitated quarry with reduced health hazards, enhanced safety, and biological restoration (Adimo, Njoroge, & Waweru, 2018). IUCN (2015) show that quarry rehabilitations involve limiting soil erosion and reducing water runoff by improving water harvesting and increasing rainwater infiltration.

Popović et al. (2015), on the other hand, recommends the use of landscape re-cultivation to restore quarries in urban areas. Popović et al. warn that restoring land to its original form or a similar state is technical and a long-term process. Koptseva and Egorov (2017), in their text, suggest the adoption of both the natural recovery of vegetation and artificial restoration of vegetation in depleted quarries. However, the authors acknowledge the setbacks of natural recovery that are difficult in harsh climatic conditions. Stone quarrying operations destroy the diverse plant species; achieving a long-term ecological restoration application of natural restoration is recommended (Zhang et al. (2018. Cohen-Fernandez and Naeth (2013) suggested planting woody plants when reclaiming abandoned quarries in forested areas.

A study was carried out on dismissed quarries in protected areas in Rome, Italy, to ascertain the reclamation approaches that demonstrate loss of geomorphological assets and loss of vegetation and forests (Di Filippo et al., 2001). The study argues that there was a severe alteration of the landscape due to the deep excavations. The authors proposed the renaturalization of flooded areas while dry-floors would be reafforestation to recreate areas for recreational activities and agricultural use. According to Bowen and Pallister (2006), the most environmentally viable measures for quarrying companies fill the holes with soil and stone. Reclamation of quarrying sites offers an opportunity for land use in different ways, including farming. Misra (2013) proposes, based on their study filling open quarries with soil and covering it with vegetation to reduce further soil erosion and weathering occurrences.

El-Fadel, Sadek, and Chahine (2001) investigated the management of quarries as waste disposal sites in Lebanon. The authors acknowledged the viability of utilizing an old quarry as a waste disposal point while recommending a monitoring plan to mitigate the potential impacts. In Lebanon, policymakers were forced to settle for old quarries as landfills to solve

unregulated quarrying operations and uncontrolled municipal solid wastes. Privett (2004) notes the utilization of dry quarries in the United Kingdom as landfills for constructions of houses, commercial, and recreational activities.

Proper implementation of policies and regulations governing stone quarrying operations is critical in mitigating negative effects on people's social aspects and the environment (Hamza & Kanyama, 2016). The authors recognize the existence of policies surrounding the utilization and protection of natural resources such as water, land, and air. Still, poor implementation is the reason for continued increased environmental and social challenges from stone quarrying in Pemba. A study carried out in the coastal part of Kenya on quarrying and mining activities established the need to empower the community on enforcing environmental compliance (Mwakumanya, 2014). The study argues that training and empowerment campaigns of the local communities living around mining and quarrying areas on environmental injustice redress and benefit-sharing should be a top priority.

The communities should be capable of enforcing health and safety standards and regulations and ensuring environmental compliance among quarry and mining practitioners (Mwakumanya, 2014). Recognition of small scale stone quarrying in legal and environmental regulations and the full involvement of all stakeholders in tackling environmental problems is essential (Hamza & Kanyama, 2016). Mwakumanya (2014) suggested the formation of social linkages about environmental governance as a community empowerment strategy to eliminate social and ecological injustices from extractive operations. Besides, the promotion of community-led alternative livelihood sources will reduce extractive operations.

Resettlement and compensation of communities affected by the extractive operations is a good practice to reduce harm on human wellbeing (Melodi, 2017; Mwakumanya, 2014). Recognition of community cultures, rights, and values with the help of inclusive mining and quarrying laws is fundamental (Mwakumanya, 2014).

2.8 Related Studies carried out in Kenya

Eshiwani (2014) assessed the effects of quarrying activities on the environment in Embakasi Nairobi. The residents expressed different views regarding the benefits generated from the quarries. 14.8 percent said the quarrying operations led to business opportunities, 6.3 percent said they benefited through employment, 7.0 percent said they could get construction materials while 71.8 percent said there is nothing beneficial from quarrying. Eshiwani also found out that most of the quarries had been abandoned and acted as dumping points. As a

result, the author recommended further research be done to establish the health implications of dumping wastes in abandoned quarries.

Mbandi (2017) did a study in Kitengela, Kajiado County to assess the environmental effects of quarrying and established that 90 percent of the respondents associated the air contamination on rock blasts and quarrying trucks especially during dry seasons. 70 percent of the respondents also expressed concerns in the change of geological scenery from being vegetative before quarrying to the current state which is bare and stony.

Waweru and Mukundi (2015) investigated the people's perceptions of quarrying and post-quarried land utilization along river Ndarugu, Kiambu. One of the findings was that quarrying improved household income on one hand. On the contrary, water pollution was perceived to negate the social and economic states of the residents. 31.6 percent of the quarried land was abandoned hence was of no economic benefit.

Ming'ate and Mohamed (2016) evaluated the impacts of stone quarrying on people's livelihoods and the environment in Mandera. Assessing the effects on the environment, land and vegetation degradation was a major problem with 63.4 percent of the respondents while water pollutions were one of the least problems at 5.6 percent. The researchers expressed concerns that while stone quarrying has financial and social benefits, it implicates the sustainability of the natural and human capital hence recommended using improved technologies and the restoration of quarries after use.

2.9 Theoretical Framework

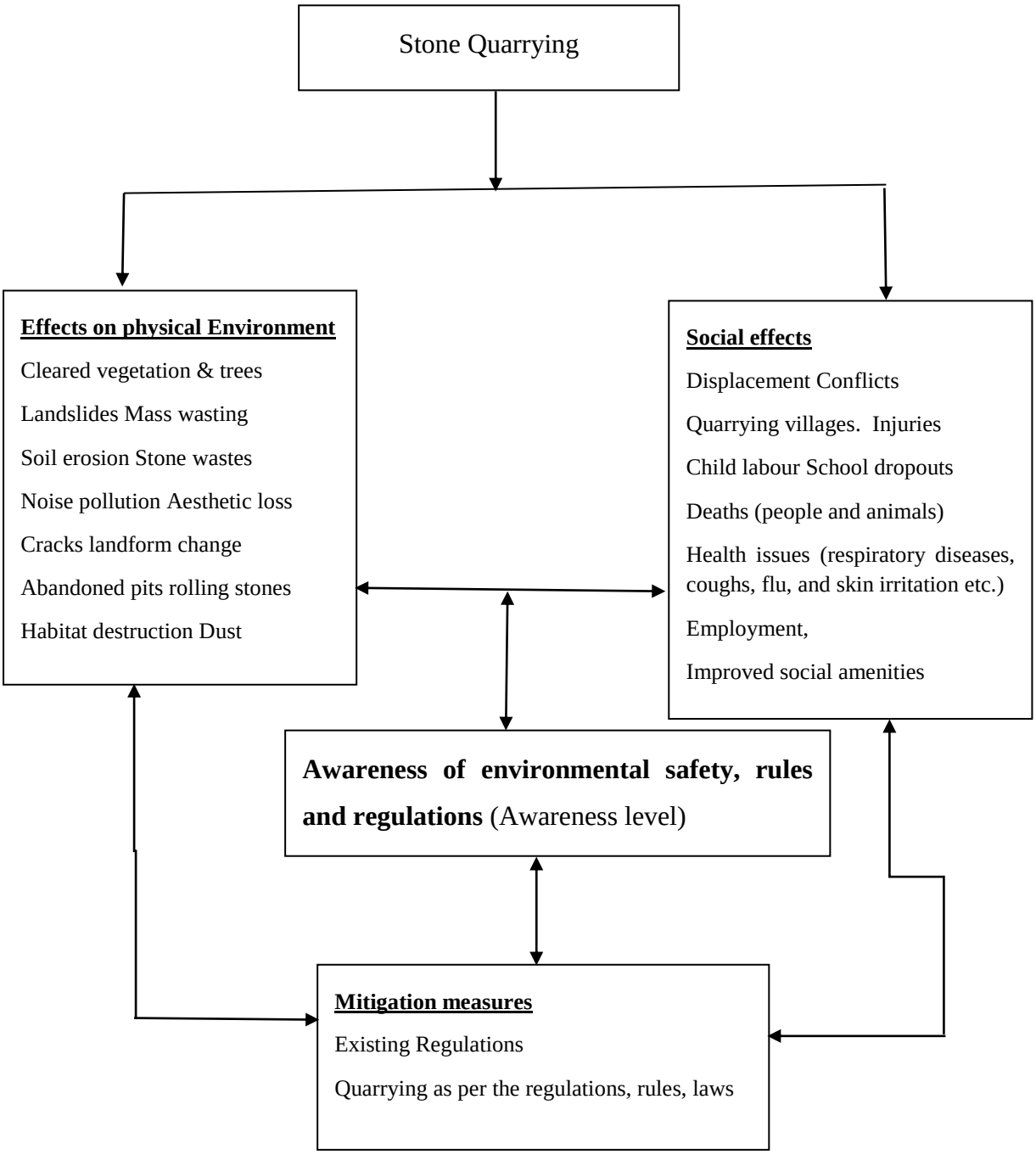
The neo-Malthusian theory developed from the Malthusian idea by the political economist Thomas Robert Malthus in 1798 and revised in 1803 forms a basis for this study. The Malthusian theory explains that the population grows exponentially while food supply increased arithmetically (Mayhew, 2014). Over the years, its proponents have updated the theory leading to the neo-Malthusian theory of population, which focuses more on population and environmental degradation. It gained prominence in the 1960s. According to Neo-Malthusian theory, population growth translates to overuse of scarce natural resources, resulting in adverse effects on the environment that ultimately impact human well-being. Neo-Malthusian theory predicted what is being experienced in the twenty-first century, climate change, famine, drought, desertification, and floods (Robertson, 2012). While the neo-Malthusian theory is considered a vital school of thought in explaining environmental sustainability, it is criticized for failing to recognize the shifting population growth rate

dynamics and technological advancement, which is being progressively adopted in the quarrying sector (Friedrichs, 2014). It is argued that neo-Malthusian analysis fails to recognize the role of technological and scientific innovations in influencing the market prices and demand for specific resources such as in the quarrying and mining industry driving their exploitation (White, Rudy & Gareau, 2017). Thus, in this case, population growth is considered less of a factor, which is contrary to neo-Malthusian theory.

Environmental neo-Malthusians such as Dr. Paul Ehrlich and Prof. Robert M. Hardaway argued that environmental impacts such as loss of biodiversity and land degradation destabilize nature's ability to regenerate (Friedrichs, 2014). Over time, the environmental impact increases while ecological resources decline. Consequently, humanity is forced to exploit more from the degraded environment causing more harm.

The theory forms a basis for this project because building stones are limited natural resources. Population growth, demand for improved roads and buildings have contributed to increased stone quarrying operations. The need to satisfy human wants and needs, including food supply that agricultural production cannot fulfil, also explain why people opt for stone quarrying as a source of income in Tuluongoi sub location.

2.10 Conceptual Framework



Source: Researcher (2019)

Figure 2.1: Conceptual Framework

Stone quarrying is an activity whose impact can be severe and irreversible depending on the nature of extraction, location, and community dynamics. While communities draw direct and indirect benefits from quarrying activities, the negative effects of social and environmental aspects can be distressing.

Figure 2.1 illustrates the researcher's conceptual framework showing stone quarrying as a central agent of change in human well-being and the environment. Quarrying activities trigger social change, such as creating employment, contributing to improved social amenities like schools, hospitals, water collection points, and roads. On the contrary, the communities encounter displacement due to encroachment, territorial conflicts, relocation due to disturbance, noise, and dust, child labour, increased school dropouts, the emergence of quarrying villages, injuries, deaths, increased allergies, and respiratory diseases.

Mass wasting, weakening of soil, landslides, loss of biodiversity, deforestation, soil erosion, noise and air pollution, massive stone wastes, vibration, cracks, abandoned pits, rolling stones, habitat destruction, and permanent scars on the land are some of the effects of quarrying on the environment. Awareness of environmental rules, laws, and regulations related to stone quarrying activities influenced the magnitude of impacts on the quarry workers and the community's environment and social attributes. The knowledgeable community can demand justice and compensation when quarrying operations are devastating, while the unaware population suffers in silence as the operations dehumanize their lives and surroundings. The ability to hold accountable the quarry/landowner for the destructive nature of their operations depends on the community's capability to decipher the regulation.

The nature of mitigation measures developed to avert the social and environmental damages from quarrying depends on the severity of damage, topography, soil type, methods of quarrying, and the location of the quarries.

2.11 Summary of Gaps from Literature Review

Most literature reviewed in this study focused on enforcement and implementation of environmental rules, regulations, and guidelines governing stone quarrying operation while locking out the aspect of awareness, a limitation this study sought to fill (Hamza & Kanyama, 2016: Mwakumanya, 2014).

Most empirical studies reviewed by Mbandi (2017), Ming' ate and Mohamed (2016), and Melodi (2017) evaluated the social and environmental effects of stone quarrying without considering the significance of awareness and comprehension of the relevant environmental rules and regulations that could influence the nature, intensity, and severity of impacts. This is a gap this study sought to fill by establishing whether there is a linkage between awareness of environmental rules, regulations, and principles on stone quarrying and the nature of impacts on social and environmental aspects of the community.

While Mbandi (2017) evaluates the effects of stone quarrying on the environment in Kitengela, the study only highlights the effects without considering the nature and severity of damage and the frequency of occurrence, aspects that this research attempted to address.

Just like this study, Mbandi (2017) used cross-tabulation for chi-square to test hypotheses, for instance, to establish whether mining and quarrying affected the landscape's appearance, but failed to establish the severity of the damage.

The review established that there was no existing document on the subject matter under investigation in Tuluongoi sub-location, a gap this study pursued to fill.

CHAPTER THREE: STUDY AREA AND METHODOLOGY

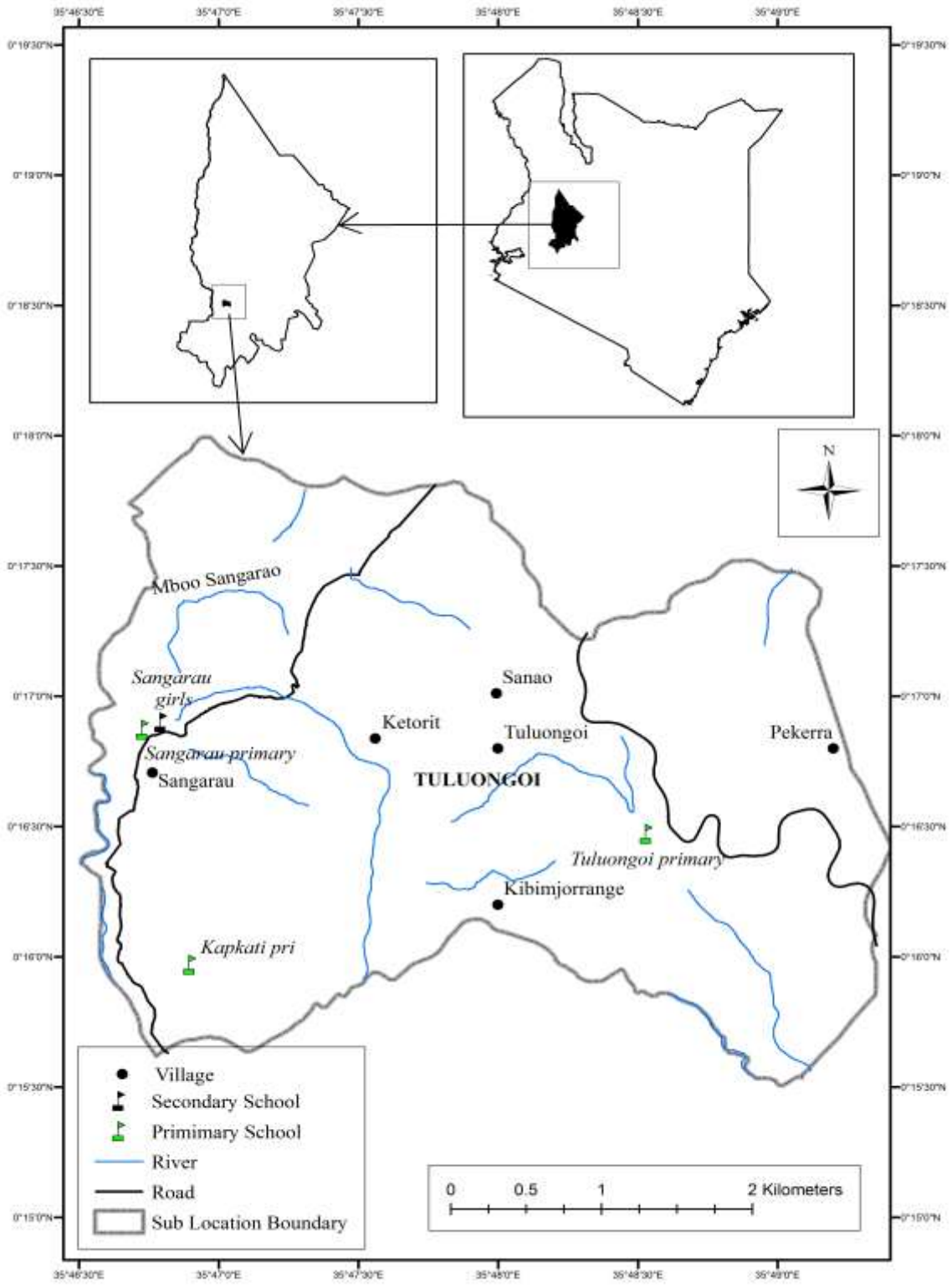
3.1 Introduction

This chapter contains information about Tuluongoi Sub Location which is the area of study. It also entails the methodology section that shows how data was collected, analyzed and presented based on the defined objectives. It is composed of research design, sample size and population, sampling plan, data collection tools and techniques, data analysis and presentation.

3.2 Study Area

3.2.1 Location of the Study Area

Baringo County is one of the forty-seven counties in Kenya located in the former Rift Valley Province with Kabarnet Town being the county headquarters. Baringo County occupies an area of 11,075 km² at an altitude of about 1067 meters above sea level and longitude 35° 30' East and 36° 30' West and latitude 0°10' South and 1° 40' North. Baringo County is divided into six administrative areas: Baringo South, Baringo Central, Baringo North, Tiaty, Eldama Ravine, and Mogotio. The area under study is Tuluongoi Sub Location which is found in Tenges Division, Baringo South Constituency. It is located along Eldama-Ravine-Kabarnet high way. Tuluongoi sub location is approximately 16.5 square kilometers KNBS (2010).



Source: Researcher (2019)

Figure 3.1: Map of the Study Area

3.2.2 Population of Tulungoi Sub Location

According to the 2009 census report, the population of Baringo County was 555, 561 people with an average of 50 people per square kilometer and the average age distribution being; 0-14 years (48.4 %), 15-64 years (48.2 %) and 65+ years (3.3 %). The population of Baringo County has grown exponentially. While population growth is recorded regularly, a larger population is also migrating to major towns in the country in search of a better life. Devolution triggered a higher number of people moving back to the county to take up the newly created positions. As the social, economic and political behaviours of the people changed, demands for resources also transformed. That led to a lot of pressure inserted on natural sources without placing proper regulations to tame environmental damages. The educational levels of the people vary depending on their ages; the younger generation has been exposed to knowledge and information while a significant percentage of the older generation is illiterate.

Quarrying is one of the activities that was initiated in Baringo County to cater to the needs of the people from within and outside the county. Main quarries are found in Tenges Division of Baringo South Sub-county where Tuluongoi Sub Location which is the chosen area of study is located. The stone quarrying in Tuluongoi is considered one of the areas with the critical quarrying sites in Baringo and has been in operation for several decades (BCG, 2018).

Table 3.1: Population of Baringo County from 1969 to 2018

Census Year	Male	Female	Total
1969	80,885	80,856	161,741
1979	101,606	102,186	203,792
1989	172,847	175,143	347,990
1999	199,290	203,851	403,141
2009	279,081	276,480	555,561
2018	378,772	375, 242	754,014

(Source: KNBS, 2015)

Based on the figures above, it is clear that the population of Baringo County has been increasing. The increase in population demands more resources including residential and commercial structures, and good roads hence an increase in demand for stones for construction.

Table 3.2: Population of Tuluongoi Sub-location

Gender	Population
Male	717
Female	784
Total	1,501

Source: (KNBS, 2010)

3.2.3 Relief and Drainage

Baringo County is located at an average altitude of about 1067 meters above the sea level. Tuluongoi Sub Location which is the study area is generally hilly and sloppy. Quarrying takes place on the sloppy and hilly areas.

3.2.4 Geology

Metamorphic, igneous, and sedimentary rocks are mainly utilized as building stones. The sedimentary rocks consist of detrital and chemical sedimentary rocks. Detrital sedimentary stones are naturally cemented particles from chemical and mechanical weathering of existing rocks (Marble Institute of America, 2016). Examples include sandstone, conglomerate, shale, and limestone. They are characterized by layered appearance resulting from grains of different size, colour, or composition that deposit at different times (Pidwirny, 2006). Chemical sedimentary stones, on the other hand, are precipitates of chemicals such as salts that dissolve during weathering of existing rocks. According to the Marble Institute of America (2016), most chemical precipitates are of no significant importance because of their solubility of softness.

Metamorphic rocks are formed from any preexisting rocks under varied conditions such as high temperatures and high pressures in the upper mantle or at the base of the crust. Metamorphic building rocks include slates and marble and are of economic importance (Schaffer, 2016). The author states that metamorphic rocks are either igneous or sedimentary rocks whose original form has been altered due to pressure or heat. Based on the description of rocks above, stones being quarried in Tuluongoi Sub Location are sedimentary and are characterized by greyish colour and deposition of rocks at different times.

3.2.5 Climate

A larger part of Baringo including Tuluongoi Sub Location falls under arid and semi-arid areas (ASALs). The area has two rainy seasons within a year where long rains are received from March to June and short rains in October-November. The northern parts of the county have temperatures ranging between 30^0 and 35^0 C while the southern part while the southern part temperatures has range from 25^0 to 30^0 C.

3.2.6 Economic Activities

The main economic activity practiced in the study area is stone quarrying, livestock keeping, and crop farming. Due to the climatic conditions, the residents of Tuluongoi and neighboring areas are limited in the kind of crops they grow. Drought resistant and fast maturing crops are mainly grown, such as cassava, sweet potatoes, and ground nuts.

Livestock keeping is a popular activity practiced in small to large scale. The animals reared include sheep, cattle, donkeys, beekeeping, and poultry. Most people prefer animal breeds that can withstand the harsh weather conditions, especially during dry seasons.

Stone quarrying is fast becoming a significant economic activity in Tuluongoi Sub Location by benefitting those residents involved. Jobs have been created, to both locals and foreigners. The feeder roads from the main highway to the quarrying sites had to be constructed. The residents benefited from the stones for construction of homes, schools, dispensaries, among others. The accessibility and availability of the resource have influenced the new trend of construction of permanent buildings.

3.2.7 Justification of Choice of Study Area

According to the Baringo county integrated Development Plan 2018-2022, Tuluongoi Sub location is one of the principal sources of building and construction stones in the county. Stone quarrying is intense and has been taking place in the study area for several years. Despite the associated risks, quarrying takes place up to less than 5 meters from people's homes, sloppy, and hillsides. Due to lack of regulations and quarrying being done in private lands, it was considered prudent to carry out the study there.

3.3 Methodology

3.3.1 Research Design

This study used both qualitative and quantitative methods in data collection and analyses.

3.3.2 Target Population

The target population for this study comprised of quarry workers from three active quarrying sites, the residents of Tuluongoi sub location whose coverage is estimated to be 16.5 square kilometers with a total population of 1,501 people, health workers at a local healthcare facility, quarry managers from the three quarrying sites as well as NEMA officials and Ministry of Mining officials posted in the county (KNBS, 2010). Tuluongoi Sub Location has an estimated 304 households; however, the study targeted households from only two villages hosting the quarrying sites with a total of 172 households, Ketorit with 77 and Sangarau with 95 households. Household heads not engaged in stone quarrying were considered in this case. The total number of regular workers at the 3 quarry sites was 97; Sangarau 55, Chemos 15 and Ketorit 27. Two officials each from NEMA officials and Ministry of Mining had been posted to the county.

Table 3.3: Target Population

Category	Target Population
Household heads	172
Quarry workers	97
Quarry managers	3
NEMA officials	2
Local healthcare providers	4
Officials from the Ministry of Mining	2

3.3.3 Sample Size and Sampling Procedures

Due to the small number of regular quarry workers in the three quarries, a census of all these quarry workers was taken. Hence, all the 97 were considered in this study. Purposive sampling was used to sample all the 3 quarry managers, one healthcare worker, one NEMA official and also one official from the Ministry of Mining. In determining the sample size for

the household heads, the study applied the Yamane (1967) formula basing it on 95% confidence level or at 0.05 rejection level, the sample size was determined as follows:

$$n = \frac{\mathrm{N}}{1 + \mathrm{N}(e^2)}$$

Where;

n=the sample size

N= the size of the population

e= Error margin or the precision level desired or the significance level which is 0.05 (95% confidence level)

Using the formula yields a sample size of

$$n = \frac{172}{1 + 172(0.05^2)} = 120$$

Therefore, the study obtained a sample size of 120 household heads while the samples from the two villages were proportionately determined as shown below;

Sampled household heads per village (n) = (number of household heads per village/total number of household heads) *120

Ketorit; n= (77/172) *120 =54

Sangarau; n= (95/172) *120 = 66

Therefore, stratified sampling method was used to ensure that household heads from the two villages were well represented in the study. Table 4.2 summarizes the sample size and sampling technique used for each category of study participants.

Table 3.4: Sample Size

Category	Target Population	Sample Size	Sampling Technique
Household heads	172	120	Stratified sampling
Quarry workers	97	97	Census
Quarry managers	3	3	Purposive sampling
NEMA officials	2	1	Purposive sampling
Local healthcare providers	4	1	Purposive sampling
Officials from the Ministry of Mining	2	1	Purposive sampling

3.3.4 Data Collection Methods

The sources of data for the study are primary and secondary data sources. Secondary data sources such as peer-reviewed articles, journals, theses and authoritative sites such as international and government agencies and academic books have been utilized in this study (Vartanian, 2011). Primary data collection procedures involved the use of interviews, questionnaires, photographs, and observations. Questionnaires were administered to the household respondents and selected quarry workers; the questions were both open-ended and closed-ended. The interviews were administered to the key informants.

Photographs were used to enhance the research. Observation method was used to gather information of activities taking place within the quarrying areas and the surrounding environment such as the wastes, abandoned quarries, and damage on vegetation, dust and general outlook of the quarrying sites to enable informed judgments when discussing the findings.

3.3.5 Validity and Reliability of the Research Tools

Valid data collection instruments eliminate errors. Thus, to ensure validity, the research tools was subjected to expert opinions. The supervisor reviewed the tool beforehand. A pilot study was conducted to test the tool before embarking on the actual data collection exercise. To establish the dependability of the research tools, a test and retest method was done on a few individuals, 9 quarry workers and 12 household heads in Ilyagat village in Tebei Sub location, that is, 10% of the actual sample for the two groups of participants. The feedback

collected was evaluated to ascertain whether the instrument captures the desired data consistently.

The overall reliability coefficients were 0.758 for the quarry workers' questionnaire and 0.731 for the household heads questionnaire. The questionnaires were thus considered for use in the main study in line with Best and Kahn (2006). Qualitative reliability was ensured through the documentation of all procedures. The researcher also went through the written responses from the interviews for obvious mistakes, made sure there was no drift in definitions of codes or applications of the items during the coding process and ensured that communication from meetings were documented. The findings were also compared with the findings of different studies which were independently derived.

3.3.6 Data Analysis and Presentation

The qualitative data obtained was analysed through content analysis and presented through narratives. The quantitative data on the other hand was processed and analyzed using statistical tests and presented in tables, charts and graphs. Descriptive statistics such as frequencies and percentages were used to describe the features of the data collected. The study used a nonparametric statistical test, specifically Chi-square, to validate the formulated hypotheses. Chi Square statistic is used for testing relationships between categorical variables. The chi-square test is used to determine whether there is a statistically significant difference between the expected frequencies and the observed frequencies in one or more categories. The hypothesis of the Chi-Square test is that a relationship exists on the categorical variables in the population. The significance of the chi square relationship was assessed using the probability values (p values where the critical p value in this study was 0.05). An associate p value less than 0.05 led to the rejection of the null hypothesis.

3.3.7 Ethical Considerations

Ethical considerations are a critical part of a study (Trochim, Donnelly & Arora, 2016). This study ensured that it conformed to the ethical guidelines to assure the confidentiality and anonymity of the respondents and upheld integrity throughout the research process. Voluntary and informed consent was sought from the respondents. Persons under the age of 18 and those considered vulnerable or of special needs did not participate in the study. The researcher sought letters of authorization to collect data in Tuluongoi Sub location from the University of Nairobi and National Commission for Science, Technology.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the study findings and their discussion based on the data that was analysed. The organization of the chapter is guided by the specific objectives of the study. For the qualitative data, content analysis was conducted while both descriptive analysis and inferential analysis were carried out in analyzing the quantitative data. The results are presented in frequency tables, charts, narratives and plates.

4.2 Response Rate

The study participants consisted of household heads, quarry workers, quarry managers, healthcare workers, NEMA officials and officials from the ministry of mining office in Baringo County. To this end, the researcher administered 120 questionnaires to the household heads and 97 questionnaires to the quarry workers. Out of the 120 questionnaires administered to the household heads, 103 questionnaires were properly filled and returned while 69 questionnaires were received from the quarry workers. This represented 85.8% and 71.1% successful response rates for the household heads and quarry workers respectively. Even though the researcher set to conduct six key informant interviews, only five were conducted due to the unavailability of one of the quarry managers representing a response rate of 83.3%. The response rates for these categories of study participants were considered adequate for analysis and reporting consistent with Kothari (2013) who argued that a response rate of 50.0% and above is considered adequate for a study.

4.3 Demographic and Socio-Economic Characteristics of Respondents

This section contains information relating to the demographic characteristics of the respondents such as their gender, age bracket, marital status as well as their highest level of education. The number of people residing in a given household, the place of origin of the quarry workers and their average monthly earnings are also highlighted in this section.

4.3.1 Gender of Respondents

The study found that all the quarry workers were male while the majority of the sampled household heads, 84 (81.6%), were female. The fact that all the quarry workers were men could be attributed to the perception that women had no strength to engage in the various stone quarry activities and the view that society could not allow the involvement of women in such activities which were considered a men's job. During the interview sessions, one of the

quarry managers pointed out that a majority of women participated in the marketing and selling of the quarried stones and were mostly not found at the quarry site. The manager also explained that some women employed men to quarry the stones on their behalf. Birabwa (2006) observed that due to their feminine nature, women found some stone quarrying activities such as digging and crushing very strenuous. Coupled with the responsibility of attending to domestic chores, women's attendance at quarries according to the author, was irregular. The findings also concurred with those of Olugbenga, Olushola, and Ajibola (2015) who noted that in quarry operations, women participated in secondary roles while the men took up the primary tasks like drilling and blasting.

4.3.2 Age of Respondents

The study sought to find out the age of the respondents. The findings as outlined in Table 4.1 reveal that generally, a large number of the quarry workers in the three quarries were youthful. This could be attributed to the nature of the stone quarry activities which required mostly energetic people. Ezichi (2018) argued that the use of simple tools to extract hard rock material made stone quarrying a strenuous activity. This therefore, limited it to the youth and the able bodied. The findings also show that overall, most of the households in the study area were headed by relatively youthful persons.

Table 4.1: Age of Respondents

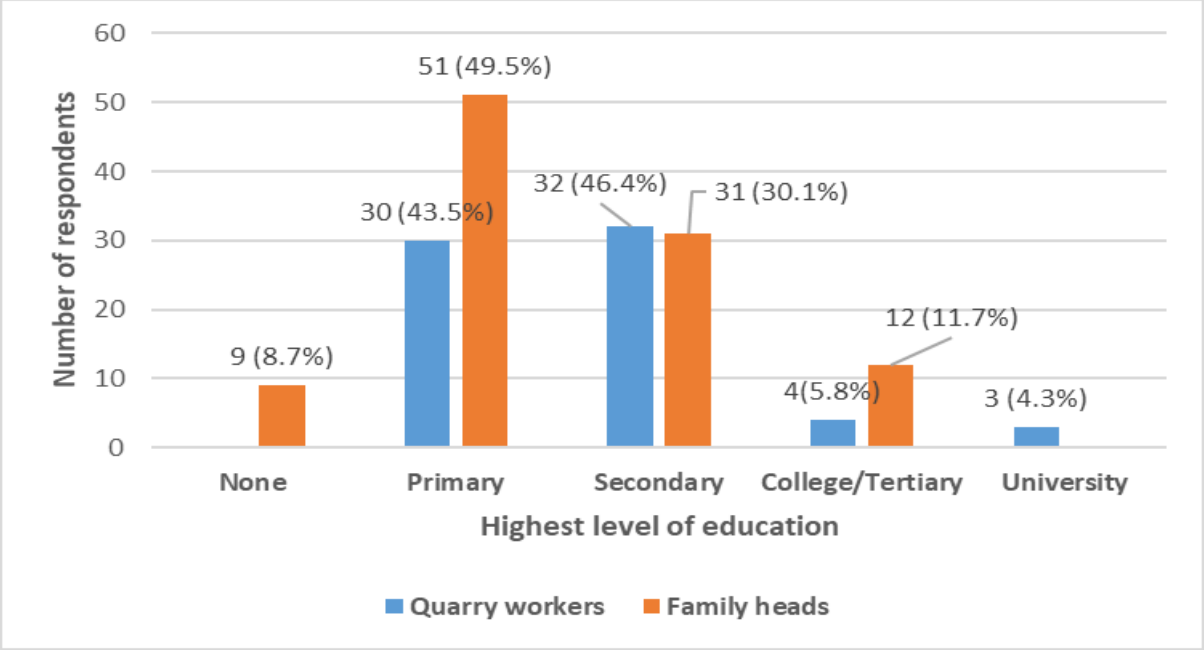
	Quarry workers			Household heads	
Age bracket	**Frequency**	**Percent**	**Age bracket**	**Frequency**	**Percent**
20 and below	7	10.1	25 and below	18	17.5
21-30	22	31.9	26-35	35	34.0
31-40	18	26.1	36-45	9	8.7
41-50	11	15.9	46-55	5	4.9
51-60	7	10.1	56-65	31	30.1
Above 60	4	5.8	Above 65	5	4.9
Total	**69**	**100.0**	**Total**	**103**	**100.0**

Source: Field Data (2020)

4.3.3 Highest Level of Education of the Respondents

The highest level of education attained by the quarry workers and household heads is shown in Figure 4.1. The study findings reveal that 30 (43.5%) of the quarry workers had primary level education, 32 (46.4%) had secondary education while 4 (5.8%) and 3 (4.3%) of the quarry workers had attained college/tertiary education and university education respectively. As for the household heads, 9 (8.7%) had no education, 51 (49.5%) had attained primary

education, 31 (30.1%) had obtained secondary education while the rest, 12 (11.7%) had college/tertiary education. The findings show that most of the respondents had some basic education which could enable them comprehend and respond to the questions presented to them. Furthermore, the finding that a large proportion of the quarry workers had obtained primary and secondary school education could be explained by the observation that stone quarrying did not require advanced abilities and that most of the work they engaged in was informal. The finding could also be attributed to the lack of funds which could help them further their education. Consequently, many chose to work in the quarries. According to Osiruemu (2007), formal education is an important tool for human capacity development. Accordingly, people with low or no education tend to engage in informal economic activities such as stone quarrying.



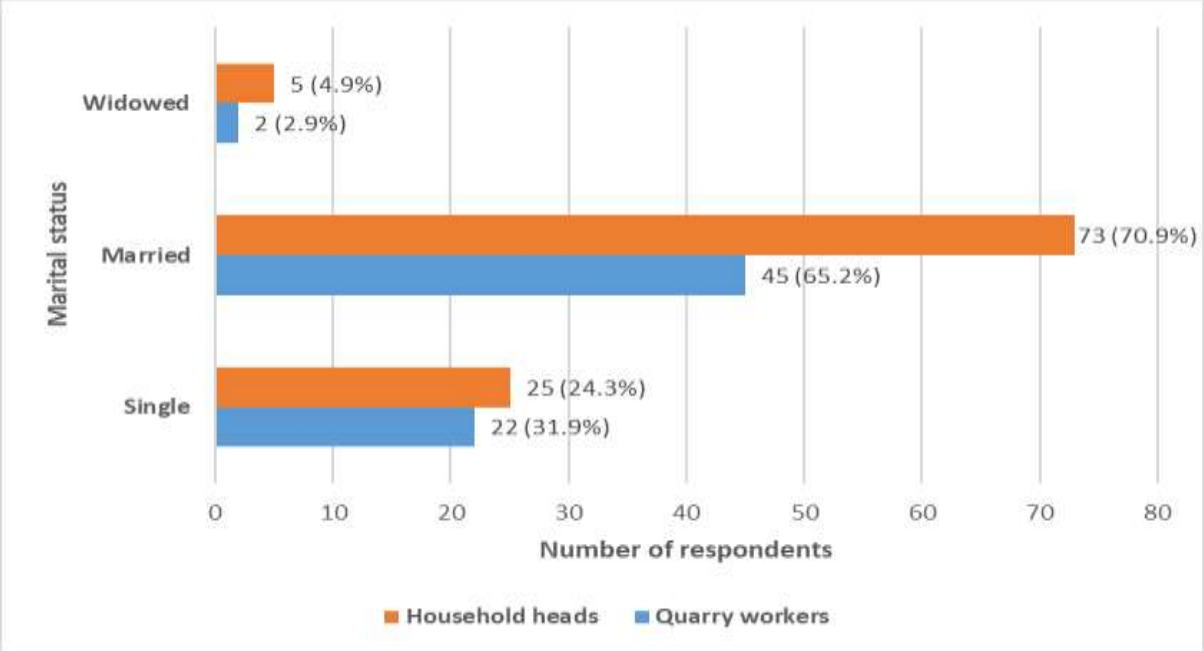
Source: Field Data (2020)

Figure 4.1: Highest Level of Education of the Respondents

4.3.4 Marital Status of the Respondents

The marital status of the respondents was also determined. The findings are presented in Figure 4.2. It was found that 22 (31.9%) of the quarry workers were single, 45 (65.2%) were married while 2 (2.9%) of the quarry workers were widowed. Pertaining to the household heads, 25 (24.3%) were single, 73 (70.9%) were married while 5 (4.9%) of the household heads were widowed. These findings imply that most of the respondents were family people

and for the quarry workers, the added responsibilities of supporting their dependents especially if they were the sole bread winners, was a reason for their engagement in stone quarrying activities.



Source: Field Data (2020)

Figure 4.2: Marital Status of the Respondents

4.3.5 Average Monthly Earnings from Stone Quarrying Activities

The quarry workers were asked to indicate their average monthly earnings from stone quarrying activities. The study noted that 21 (30.4%) of the quarry workers earned less than KSHs. 10,000, 36 (52.2%) earned between KSHs. 10,000 to 20,000, 6 (8.7%) of the quarry workers earned KSHs. 21,000 to 30,000 while 4 (5.8%) and 2 (2.9%) of the quarry workers earned KSHs. 31,000 to 40,000 and over KSHs. 50,000 respectively. These findings demonstrated that the monthly earnings of most of the quarry workers in the quarries considered in this study ranged from KSHs. 10,000 to 50,000. This implied that stone quarrying was an economic activity which generated some considerable amount of income for most of the quarry workers. According to Ming'ate and Mohamed (2016), stone quarrying significantly contributed to the incomes of the quarry workers, quarry owners and the community in general.

4.3.6 Place of Origin of Quarry Workers

The results obtained revealed that majority of the quarry workers, 54 (78.3%) were area residents of the two villages while the rest, 15 (21.7%), had migrated into the villages. These findings implied that stone quarrying activities in the study area attracted a number of people from the periphery who sought to make a living from engaging in these activities. This finding is in line with those of Bewiadzi, Awubomu, and Glover (2018) who found that stone quarrying was a catalyst of migration where several people, confronted by worsening economic and political situations among other problems, exploited opportunities found within other regions or areas.

4.3.7 Number of People Residing in a given Household

The number of people belonging to a given household was further investigated. The findings revealed that 26 (25.2%) of household heads indicated that their households had 1 to 3 members, 42 (40.8%) stated that their households were composed of 4 to 6 members while the rest, 35 (34.0%) noted that their households had 7 to 9 members. These findings implied that the size of households in the study area were relatively large. The 2019 Kenya Population and Housing Census revealed that the average household size in Baringo County was 5 members per household.

4.4 Stone Quarrying

The study explored the stone quarrying operations in the two villages in Tuluongoi Sub-location from the perspective of the different categories of respondents.

4.4.1 Involvement of Household Members in Stone Quarrying

The household heads were asked to indicate whether any member of their household worked in the quarries within the selected villages. From the responses given, 60 (58.3%) of the household heads stated that there were member(s) of their households working in the quarries. These findings implied that stone quarrying was an economic activity exploited by several households as a source of livelihood in the study area. These findings were consistent with those of a study by Melodi and Ogunyemi (2019) on stone quarrying engagement in Nigeria.

4.4.2 Major Reasons for Engagement in Stone Quarrying Activities

The major factors that drove the quarry workers to take part in stone quarrying activities were determined. The findings are as summarized in Table 4.2. It was found that a majority of the quarry workers, 56 (81.2%), were driven to stone quarrying by the need to secure a source of income or livelihood due to unemployment. This was to enable them meet the day to day needs of their families. Poverty and lack of alternative source of income was highlighted as a major factor by 43 (62.3%) of the quarry workers with many of them stating that farming was no longer sustainable while 7 (10.1%) noted that the search for additional income was a major factor that drove them to stone quarrying. The other major factors were lack of education to guarantee other better jobs and the view that stone quarrying was an easy job requiring little skills as indicated by 5 (7.2%) and 9 (13.0%) of the quarry workers respectively.

Table 4.2: Quarry Workers' Main Reasons for Uptake of Stone Quarrying Activities

Quarry workers response on the main reasons for uptake of stone quarrying activities	Frequency	Percent
Search for a source of income/livelihood-lacking employment	56	81.2
Poverty and lack of alternative source of income/livelihood-only available job-Farming not sustainable	43	62.3
Easy job requiring little skills	9	13.0
Source of additional income	7	10.1
Limited of education to guarantee other better jobs	5	7.2

Source: Field Data (2020)

These findings presented in Table 4.2 meant that even though there were several factors that drove people to stone quarrying in the study area, unemployment or search for a source of income/livelihood, poverty and lack of alternative sources of income/livelihood were the major drivers. Adimo, Njoroge and Waweru (2018) argued that the reasons people engaged in stone quarrying varied depending on the community's social and economic needs. The findings also were in agreement with those of Bewiadzi, Awubomu, and Glover (2018) who found that economic hardship and unemployment were leading contributors to people's engagement in stone quarrying activities as they sought to sustain their livelihood in terms of employment and family income.

4.4.3 Factors that led to Establishment of Stone Quarries in the Community

On their part, the household heads were asked to state the various factors that had influenced the establishment of stone quarries in their community. Their responses are outlined in Table 4.3. The findings showed 80 (77.7%) of the household heads stated that the presence of the required building rocks was a factor, 45 (43.7%) stated that stone quarrying was considered as the only alternative source of livelihood, 42 (40.8%) noted that stone quarrying was established due to the fact that the land in this community was unproductive for agriculture while 31 (30.1%) and 8 (7.8%) of the households noted that increased demand for building blocks and advice from geologists were factors that led to the establishment of the quarries in this community. These findings meant that the endowment of the study area with building rocks coupled with the need for a source of livelihood were the leading factors that led to establishment of quarries in the region under study. According to Lanjuow and Abusaleh (2004), exploitation of natural resources is vital to rural livelihood improvement and hence, stone quarrying, aside from the employment and income that it generates, the industry is a major source of raw materials for building and other constructional works.

Table 4.3: Factors that led to establishment of stone quarries in the community

Factor	Frequency	Percent
Presence of the required building rocks	80	77.7
The only alternative source of livelihood	45	43.7
The land is unproductive for agriculture	42	40.8
Increased demand for building blocks	31	30.1
Advice from geologists	8	7.8

Source: Field Data (2020)

4.4.4 Other Income Generating Activities undertaken by Quarry Workers

The study further sought to establish the other income diversifying activities that the quarry workers were involved in apart from stone quarrying. The findings are presented in Table 4.4. The study found that 32 (46.4%) of the quarry workers were involved in small scale farming, 7 (10.1%) were livestock keepers while an equal number of quarry workers, 2 (2.9%) each, were engaged in carpentry, driving, masonry and poultry keeping. The rest of the quarry workers 22 (31.9%) were not involved in another income generating activity. These findings meant that quite a large number of the quarry workers in the study area were engaged in other economic activities to earn a living which also meant that it was possible for people to engage in stone quarrying activities on a part-time basis.

Table 4.4: Income Diversification Activities Undertaken by Quarry Workers

Activity	Frequency	Percent
Carpentry	2	2.9
Driver	2	2.9
Small scale farming	32	46.4
Livestock keeping	7	10.1
Masonry	2	2.9
Poultry keeping	2	2.9
None	22	31.9
Total	69	100.0

Source: Field Data (2020)

These findings were in agreement with those of Asante, Abass, and Afriyie (2014) who observed that nearly over 65 percent of quarry workers in most settings combined quarrying with other livelihood portfolios such as farming, petty trading, masonry, with few others seeking livelihood in the service sector for instance, as teachers. Ellis (1999) also observed that quarrying was a difficult operation and besides, at times, returns from it were slow and inadequate. These, coupled with the limited formal sector employment and the need to ensure a sustained positive livelihood outcome underlined the multiple income portfolio strategy.

4.4.5 Period of Engagement in Stone Quarrying Activities

The period for which the quarry workers had been engaged in the stone quarrying activities in the study area was assessed. The findings are given in Figure 4.3. It was established that 9 (13.0%) of the quarry workers had engaged in these activities for less than a year, 26 (37.7%) had been engaged for 1 to 5 years, 20 (29.0%) noted that they had taken part in these

activities for between 6 to 10 years while 3 (4.3%) and 11 (15.9%) of the quarry workers had been involved in stone quarrying activities for 11 to 15 years and over 20 years respectively.

Source: Field Data (2020)

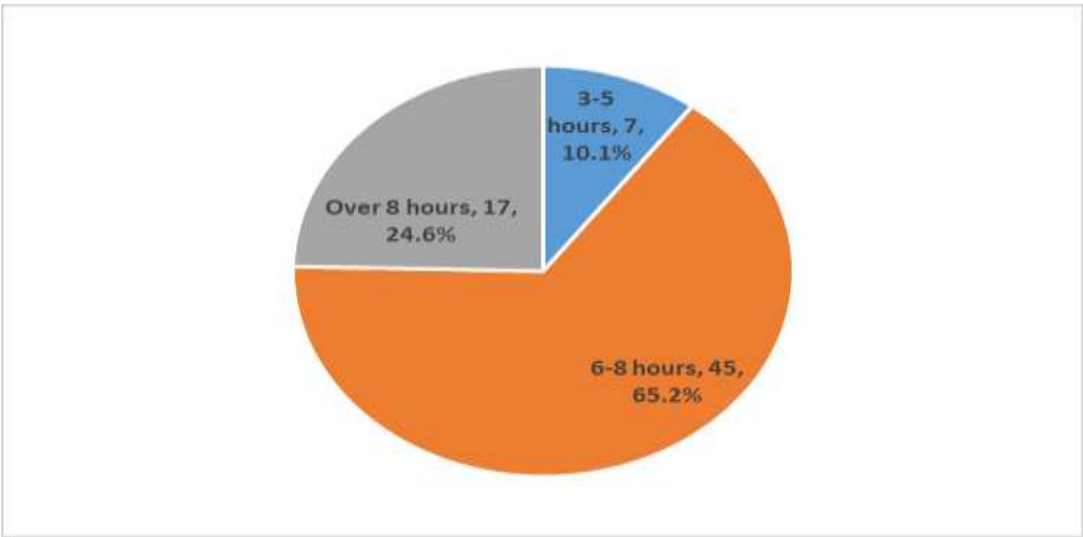
Figure 4.3: Period of Engagement in Stone Quarrying Activities

These findings demonstrated that most of the sampled quarry workers had engaged in stone quarrying for a considerable period of time and for that reason, they had adequate experience in relation to the effects of stone quarrying in the study area which would enable them to give articulate and well informed responses to the questions presented to them. The observation that a larger proportion of the quarry workers had engaged in stone quarrying for 1 to 10 years could be explained by the fact that quarry work was largely manual and only those at the prime phase of life could cope with the rigors involved. The harsh environment also acted as a push away from the quarries.

4.4.6 Hours Spent on Stone Quarrying Activities on a Daily Basis

The quarry workers were also asked to indicate the number of hours a day that they engaged in stone quarrying activities. The findings provided in Figure 4.4 reveal that 7 (10.1%) of the quarry workers engaged in stone quarry activities for between 3 to 5 hours a day, 45 (65.2%) spent 6 to 8 hours in these activities a day while the rest, 17 (24.6%), engaged in stone quarrying activities for over 8 hours a day. One of the quarry managers interviewed also

asserted that most of the quarry workers started their quarrying activities from 9.00 am to 5.00pm.



Source: Field Data (2020)

Figure 4.4: Hours Spent on Stone Quarrying Activities on a Daily Basis

It can therefore, be deduced that quarry workers spent many hours in stone quarrying activities on a daily basis, an indication that stone quarrying in the study area was intensive. Based on these findings, it can also be argued that a relatively large number of quarry workers in the study area were engaged in stone quarrying operations on a full time basis. These findings were consistent with that of Wanjiku (2015) who established that over 75 percent of quarry workers carried out the activities on a full day time schedule. The large number of work-hours might also be related to the fact that much of the work was carried out manually and so much time and energy might be required to achieve the same results as would be obtainable in cases where there was some form of modernization or mechanization as argued by Mu'awiyyah and Ogunleye (2012).

4.4.7 Methods/Tools used in Quarrying Stones

The method(s) used by the quarry workers in quarrying stones in the area were examined. It was found that a majority of the quarry workers, 63 (91.3%), were using hand tools while the rest, 6 (8.7%) were using blasting in quarrying stones in the area. The responses by the quarry workers were also supported by the quarry managers who pointed out that most of the quarry workers used crude tools and preferred not to use machines in breaking and shaping the stones since they feared that they could lose their jobs. The findings implied most of the stone quarrying operations carried out by the quarry workers in the study area were mainly manual

and could only be undertaken on a small scale basis since the tools used limited the level of productivity. Uglow (1999) argued that the simplest strategy for improving productivity, health and safety in the Kenyan small scale stone quarry sector was the improvement of the quality of tools even though this might result to some job losses.

Tools used by the quarry workers

Plate 1: Tools used by the quarry workers

4.4.8 Activities undertaken by Quarry Workers within the Quarry

The stone quarrying activities that the quarry workers engaged in within the quarries were also explored. The study results displayed in Table 4.5 show that 62 (89.9%) of the quarry workers were involved in digging or excavating, 26 (37.7%) were involved in wedging, 12 (17.4%) others were engaged in crushing or breaking of the stones, an equal number, 6 (8.7%) of the quarry workers each were involved in blasting, disposal of waste rocks and loading of stones to vehicles while 5 (7.2%) and 4 (5.8%) were involved in grinding and heating the stones respectively. The study further noted that 2 (2.9%) were also engaged in other activities specifically arranging the stones, exploration, removing dust from stones as well as transporting the stones. These findings implied that quarry workers in the study area engaged in multiple stone quarrying activities. The findings were in tandem with the assertions by Eshiwani (2014) that there were several activities that went on within the quarry and as a result the workers were engaged in the different activities.

Table 4.5: Activity or Activities Undertaken by Quarry Workers within the Quarry

Activity	Frequency	Percent
Digging or excavating	62	89.9
Wedging	26	37.7
Crushing/breaking stones	12	17.4
Blasting	6	8.7
Disposal of waste rocks	6	8.7
Loading stones to vehicles	6	8.7
Grinding	5	7.2
Heating	4	5.8
Other	2	2.9

Source: Field Data (2020)

Researcher interacting with a quarry worker

Quarry workers arranging quarried stones

Quarring in progress

Plate 2: Quarry workers carrying out their activities in the quarrying sites

4.4.9 Planning/Organization of Stone Quarrying Activities

The study sought to establish the nature of stone quarrying activities in the study area, that is, whether they were planned or organized. The findings revealed that 45 (65.2%) of the quarry workers believed that these activities were unplanned or unorganized while the rest, 24 (34.8%) were of the view that the activities were planned or organized. From the household heads' perspective, 46 (44.7%) perceived the activities as planned or organized while the rest, 57 (55.3%) asserted that these activities were unplanned or unorganized. On the basis of these findings, it can be argued that the stone quarrying activities in the study area were largely unplanned or unorganized. Endalew, Tasew, and Tolahun (2019) asserted that the planning of quarrying operations was necessary because with careful planning it was possible to minimize or control the adverse effects of stone quarrying in many cases

Those who believed that the stone quarrying activities in the quarries were planned or organized argued that there were committees in place that set guiding rules to coordinate activities within the quarries. Others noted that there was some form of management starting from the land owners to the workers on site. Those of a contrary view noted that there were no regulations in place and hence, anyone could undertake their activities anyhow, anywhere and anytime. The household heads emphasized that the members of the committees in place did not adequately follow up on issues raised but were more interested in the opportunities that could be exploited in the area. Hence, their presence in the community was not felt.

4.4.10 Training of Quarry Workers on Stone Quarrying and the Tools Used

The study investigated whether the quarry worker had received any training on stone quarrying and the tools used. It was established that 55 (79.7%) of the quarry workers had received some form of training while 14 (20.3%) had not received any training which meant that they taught themselves how to carry out the activities. All the quarry workers who indicated that they had received some form of training noted that training was informal in nature. These findings agree with those of Wanjiku (2015) who found that in most cases, quarry workers had no formal training in quarrying activities and mainly relied on observational or on job training.

Some of the skills acquired during the training as specified by the quarry workers pertained to the handling of various stone quarrying activities such as digging, excavating, wedging, extraction, heating and stone cutting, the tracing of sites where stones could be quarried as well as carrying out stone measures. They also observed how to handle the various tools

used, safety related issues along with how to maintain a clean environment. Nevertheless, a majority of the household heads, 76 (73.8%), were of the view that the people engaged in quarrying activities in the study area were not well trained and skilled to undertake proper and sustainable stone quarrying activities. According to Uglow (1999), quarry workers and owners needed proper training to increase their ability to take up new techniques and employ improved technologies that improved efficiency and also ensured environmental integrity.

4.4.11 Use of Protective Gear by Quarry Workers

The study sought to determine whether the quarry workers had any protective gear that they used during their daily quarrying activities. The findings revealed that a majority of the quarry workers, 58 (84.1%), noted that they did not use protective gears when carrying out these activities. Most of those who indicated that they did not use protective gear argued that the area was very hot and due to the nature of work they engaged in, they would sweat a lot and as a result, they did not use helmets and boots. Some indicated that when it was too dusty during the dry season or when blasting, they converted their clothes in to nose or mouth mask. Their main argument was that they were risking working in the quarries to fend for their families.

The responses given by the quarry workers resonated well with the comments of the household heads who asserted that in deed, they had not seen the quarry workers adorning any protective gear hence risking their lives. The responses given by the quarry workers were also supported by those of the quarry managers interviewed who pointed out that quarry workers in the area had no protective gears. The findings of this study support that of Ezisi, Eze, Okoye, and Arinze (2017) who observed that even though many stone quarry workers were aware that they needed to wear protective gears when carrying out the operations, most of them did not utilize them. The findings were also in agreement with those of Wanjiku (2015) which revealed that close to three quarters of stone quarry workers did not use protective clothing while at work and those who used them, only had gloves, overall and gumboots.

Quarry worker going about his daily activities without protective gear

Plate 3: Quarry worker going about their daily activities without protective gear

4.4.12 Efficiency of Protective Gear used by Quarry Workers

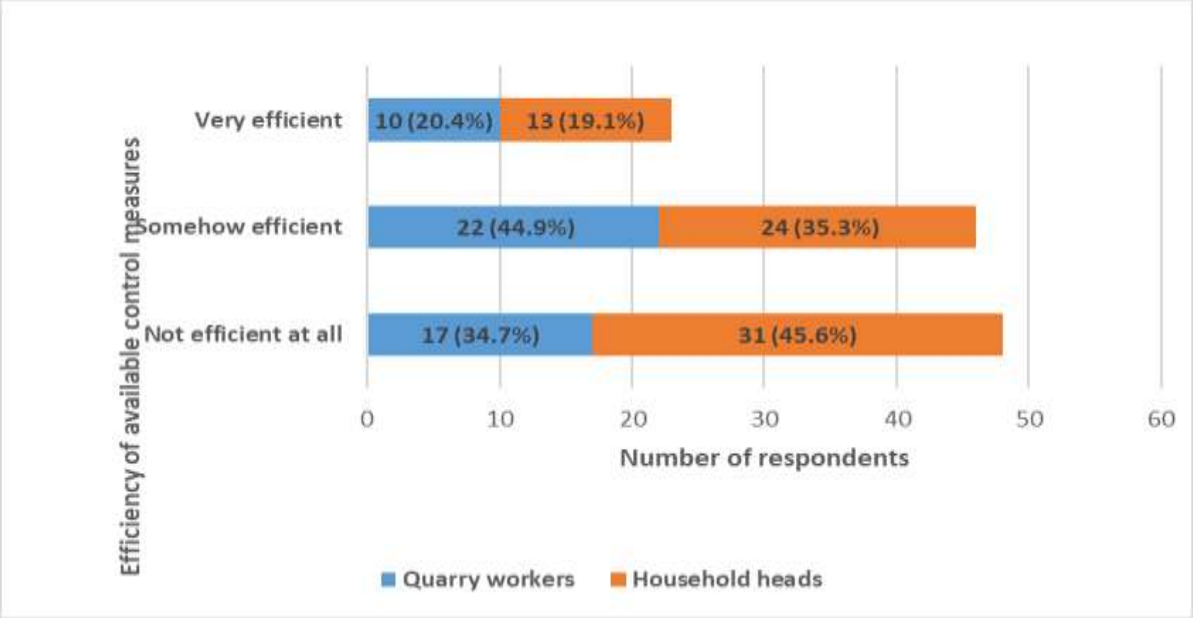
The few quarry workers, 11 (15.9%), who indicated that they were using protective gear pointed out that they were using gas masks, gloves and gumboots. Nonetheless, the majority of these, 9 (81.8%) argued that the protective gear they used were not efficient in protecting them when carrying out the quarrying activities. It can be deduced from these findings that the protective gear used by quarry workers in the study area were not efficient in protecting them quarrying their daily operations.

4.4.13 Availability of Measures to Control Stone Quarrying Activities in the Area

The study assessed whether there were any measures in place to control the stone quarrying activities undertaken in the study area. The findings showed that a majority of the quarry workers, 49 (71.0%), stated that there were control measures in place. The findings also show that 68 (66.0%) of the household heads asserted that such control measures were in place. Nyakeniga (2009) emphasizes the need for both the government and the community where stone quarrying is done, to come up with decisions and even resources to control stone quarrying activities so that these operations do not pose a danger to the surrounding communities, the lives of quarry workers and even the related negative impacts to the environment.

4.4.14 Efficiency of Available Measures to Control Stone Quarrying Activities

The respondents who noted that there were measures in place to control stone quarrying activities in the study area were asked to gauge their level of efficiency. The findings presented in Figure 4.5 show that 17 (34.7%) of the quarry workers noted that the control measures were not efficient at all, 22 (44.9%) stated that the measures were somehow efficient while the rest of the quarry workers, 10 (20.4%), indicated that the measures were very efficient. With respect to the household heads, 31 (45.6%) asserted that the control measures were not efficient at all, 24 (35.3%) underscored that the measures were somehow efficient while the rest, 13 (19.1%), stated that the control measures were very efficient. These findings implied that there was need for improvement of the measures available to control stone quarrying activities in the area.



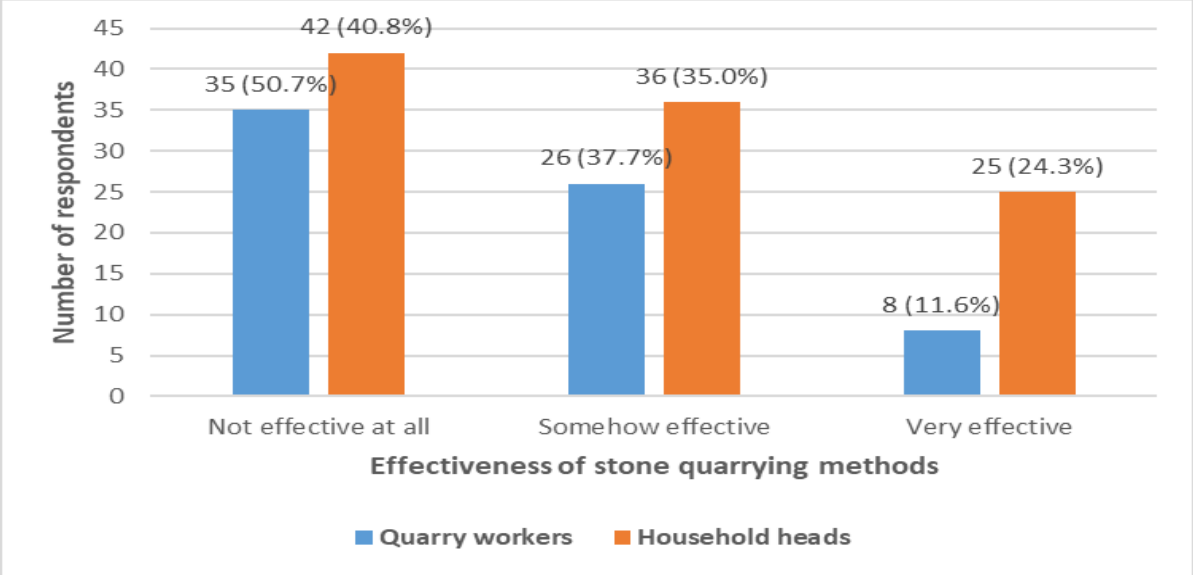
Source: Field Data (2020)

Figure 4.5: Efficiency of Available Measures to Control Stone Quarrying Activities

Those who found the measures somehow or very efficient cited that the committees formed to control the quarry operations imposed fines for those breaking set rules and held meetings especially when disputes erupted among parties. Such control measures had been applied efficiently when securing tools and the quarried stones/blocks and also handling money issues. Nonetheless, those who found the measure inefficient argued that measures targeting the protection of the environment and roads were not given much attention and in most times, the management of the quarries (committee members) did not themselves follow the set rules or enforce them among the quarry workers.

4.4.15 Effectiveness of Stone Quarrying Methods in Promoting Proper Quarry Management for Environmental and Social Sustainability

The effectiveness of the stone quarrying methods used by quarry workers in promoting proper management of the quarries for environmental and social sustainability in the study area was also examined. The findings outlined in Figure 4.6 reveal that 35 (50.7%) of the quarry workers noted that the methods were not effective at all, 26 (37.7%) found them somehow effective while the rest, 8 (11.6%), stated that the methods were very effective. On the other hand, 42 (40.8%) of the household heads pointed out that the methods were not effective at all, 36 (35.0%) found that the methods were somehow effective while the rest, 25 (24.3%), underscored that the methods were very effective. These findings also implied that actions to improve the effectiveness of the quarrying methods used by quarry workers in promoting proper quarry management for environmental and social sustainability. According to Darwish et al. (2011), quarrying in most nations is not well managed for environmental sustainability arguing that the methods used are very poor and there is no order in resource exploitation. Yet, with the proper management, many of the negative effects can be minimized or controlled.



Source: Field Data (2020)

Figure 4.6: Effectiveness of Stone Quarrying Methods in Promoting Proper Quarry Management for Environmental and Social Sustainability

The respondents who found the methods ineffective noted that most the quarry owners and workers were more interested in the money earned at the expense of the environment and left

the waste unattended to. It was also argued that the trees were cleared in the process of quarrying and there was no proper guidance regarding how to protect the environment and communities. As a result, when these communities did not show any concern or were not strict in protecting the area, the quarry workers encroached in prohibited areas. They further noted that quarry workers who were temporarily employed did not care about the impacts of their activities on the community or the environment. Those who found the methods somehow or very effective noted that most quarry workers used hand tools that were less destructive and some rules, for instance, not quarrying in the forest were followed to some extent.

4.4.16 Nature of the Impact of Stone Quarrying Methods used

Both the quarry workers and household heads were asked to describe the impact of the methods used in stone quarrying activities in the study area. The findings provided in Table 4.6 showed that 5 (7.2%) of the respondents stated that the methods did not have any impact, 22 (31.9%) indicated that the methods had little impact while 29 (42.0%) and 13 (18.8%) of the quarry workers found the methods to be destructive and very destructive respectively. With regard to the household heads, 7 (6.8%) were of the view that the methods had no impact, 25 (24.5%) saw the methods as having little impact, 39 (37.9%) of the household heads considered the methods destructive while rest, 32 (31.1%) found the methods to be very destructive. The findings imply that the impacts of the stone quarrying methods used in the daily operations in the quarrying sites considered in this study were varied. The findings are in agreement with those of Baah-Ennumh, Yeboah, and Akularemi (2019) who argued that depending on the method used in stone quarrying, there would be little or a high potential negative effect on the environment as well as the lives of those living around the quarry sites and that most countries were embracing rules to restrain the adverse impact of quarrying activities.

Table 4.6: Impact of the Methods used in Stone Quarrying Activities

	Quarry workers		Household heads	
Impact	**Frequency**	**Percent**	**Frequency**	**Percent**
Do not have any impact	5	7.2	7	6.8
Little impact	22	31.9	25	24.3
Destructive	29	42.0	39	37.9
Very destructive	13	18.8	32	31.1
Total	**69**	**100**	**103**	**100**

Source: Field Data (2020)

4.4.17 Acquisition of Modern Stone Quarrying Techniques and Technologies

The quarry workers' commitment to acquiring the modern and suitable techniques and technologies that promoted efficient stone quarrying in the study area was further assessed. The results obtained showed that a majority of the quarry workers, 57 (82.6%), underscored that the commitment to acquisition of these techniques and technologies was to a small extent. The findings are supported by the response of one of the quarry manager who pointed out that most of the quarry workers preferred not to use machines in breaking and shaping the stones, for instance, since they feared that they could lose their jobs.

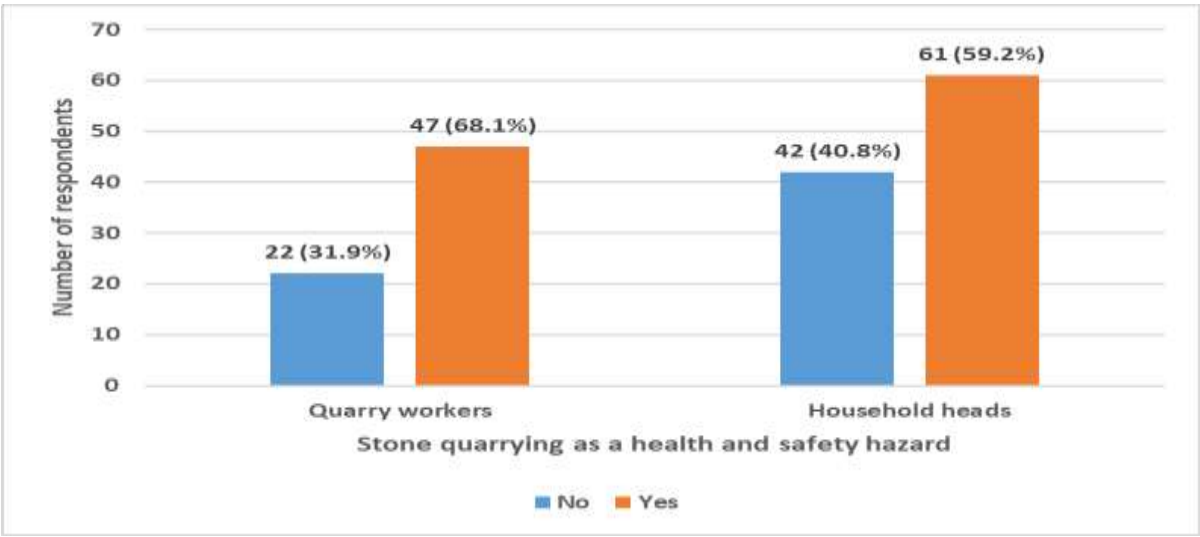
The responses given by the quarry workers pertaining to commitment to adoption of modern and suitable techniques and technologies that promote efficient stone quarrying resonated with the views of the majority of the household heads, 86 (83.5%), who indicated that in deed, there was no such commitment. Jalil, Jadoon, and Zaman (2014) argue that introducing appropriate technologies would improve efficiency and mitigate the health and environmental impact of small-scale quarrying. Olusegun, Adeniyi, and Adeola (2009) also argue that quarrying companies and their workers should be mandated to adopt modern technology, for instance, dust strapping such that a negligible quantity of dust escapes from the various operations at quarry site.

4.5 Social Effects of Stone Quarrying

The study examined the social effects of stone quarrying in Tuluongoi Sub-location from the perspective of both the quarry workers and household heads.

4.5.1 Stone Quarrying as a Health and Safety Hazard

The respondents were asked to indicate whether they considered stone quarrying operations in the area as a health and safety hazard to the quarry workers and the surrounding communities. The findings in Figure 4.7 show that 47 (68.1%) of the quarry workers, the majority, noted that the activities were a health and safety hazard. The study also found that 61 (59.2%) of the household heads in deed considered the operations as a health and safety hazard for the quarry workers and the surrounding communities. All the five key informants interviewed in this study also considered these operations as a threat to the health and safety of residents in the study area. It can therefore be inferred from these findings that, stone quarrying operations in the study area were considered a health and safety hazard to quarry workers and the surrounding communities by a large proportion of the residents. These findings supported the argument by Okafor (2016) that like many other man-made activities, quarrying activities caused significant impact on health. The findings also agreed with the views of Tribhuwan and Patil (2009) that the quarrying industry was usually associated with considerable risks to occupational health and safety of people.



Source: Field Data (2020)

Figure 4.7: Stone Quarrying as a Health and Safety Hazard

From the interviews conducted, the healthcare worker underscored that these operations had greatly threatened human lives citing dust that affected the lungs resulting to chest problems and also injuries caused by falling rocks, the tools used and when quarry workers collapsed during the activities. This argument by the healthcare worker was supported by the NEMA official who not only considered the stone quarrying operations a threat to humans but also animals. In explaining, the official noted that the quarrying sites in the study area were not fenced, that quarry workers in these sites did not have protective gears which exposed them to respiratory diseases among other illnesses, and that these quarry workers left behind unfilled holes where water which could lead to drowning of animals and children collected.

The two quarry managers interviewed also supported the views by the health worker and the NEMA official. One of the manager explained that several people had suffered injuries and others died due to collapsed quarrying sites. Others according to the manager, had suffered skin irritation due to mosquito bites during morning hours and in the evenings. The quarry manager argued that the health of the quarry workers was threatened by the failure to use protective gears such as helmets, boots, gloves and gas masks among others. The other quarry manager from Sangarau quarry noted that quarrying activities in the area had led to the killing of quarry workers due to falling stones and that there had been reported cases of children drowning in the abandoned holes where water had collected.

The findings supported that of Nartey, Nanor, and Klake (2012) that quarrying activities impacted the life of the communities living around the quarry zones and those working in the quarry where accidents and health hazards occurred due to existence of abandoned quarry pits. The findings further supported those of Hilson (2012) which showed that the increase in the number of abandoned quarries provided an area for water accumulation, that is, a breeding site for mosquitoes and freshwater snails that further spread diseases to the surrounding population if the water was not treated.

Depleted uncovered quarry by the foot path, endangering people and livestock

Uncovered pit by the road side endangering the lives of residents and livestock

Dangerous quarrying area

Plate 4: Quarrying areas posing a threat to the health and safety of quarry workers and residents

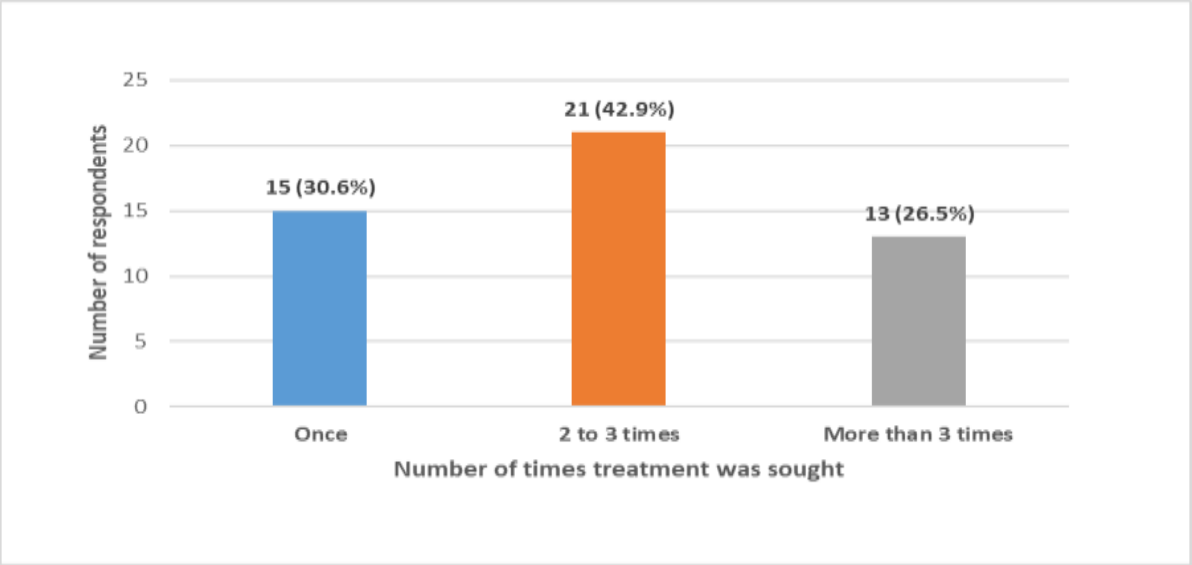
4.5.2 Household Members Suffering from Illnesses Associated with Stone Quarrying

The study probed whether any member(s) of the sampled households had suffered illnesses associated with quarrying operations in the study area. Quite a number of household members, 49 (47.6%), noted in deed, a member or members of their households suffered from ailments linked to the quarrying operations in the area while the rest, 54 (52.4%) stated that none of their household members had suffered from such diseases. These findings meant that there was a large proportion of households in the study area whose members had contracted ailments linked to stone quarrying activities in the area. These findings were consistent with those of Olusegun, Adeniyi and Adeola (2009) who found that residents who lived near quarrying sites suffered both psychological and health problems such as shock, nasal infection and asthma and due to their general low socio-economic status, they were incapable of taking any decisive measure towards relocating elsewhere.

From the responses given by the health worker, it was evident that they had received patients with illness associated with quarrying operations. According to the healthcare worker, on average, they normally received 5 patients with physical injuries and 10 patients with chest related problems on a monthly basis. The most affected people where the middle aged persons in the age bracket of 20 to 50 years. Pertaining to the severity of the illnesses, the healthcare worker noted that most patients had suffered dislocations, fractures and broken bones, others had contacted severe pneumonia due to dust affecting their lungs while others lost their lives where an average of 5 deaths per year were being reported.

4.5.3 Number of Times Household Member(s) Sought for Treatment for Stone Quarrying Related Ailments for the Past One Year

The household heads who had indicated that their household member (s) had suffered from ailments linked to stone quarrying operations in the area were further required to state the number of times on average, the affected household member(s) had sought for treatment for ailment related to stone quarrying activities in the area for the past one year. It was established that 15 (30.6%) of the household heads stated that the affected members had sought treatment once, 21 (42.9%) noted that treatment had been sought for 2 to 3 times while the rest, 13 (26.5%) indicated that the affected household members had sought for treatment for more than 3 times.



Source: Field Data (2020)

Figure 4.8: Number of Times Affected Household Member(s) sought for Treatment

These findings meant that most of the residents who were at risk of contracting diseases linked to the activities in the quarries considered in this study were at risk of ailing from these illnesses more than one time. This could be attributed to the frequency of occurrence of the health hazards and how regularly the residents were exposed to these health risks. According to Olusegun, Adeniyi, and Adeola (2009), the regularity of individual's interaction with such cells (zones) of varying hazards determined their possibility of contacting diseases related to quarrying operations.

4.5.4 Stone Quarrying Related Ailments for which Household Members Sought Treatment for

The ailments for which the household members sought treatment for as indicated by the household heads are as shown in Table 4.7. According to the study findings, 8 (16.3%) of the household heads stated that their household member(s) had been treated for fatal accidents, 13 (26.5%) noted that treatment had been sought for chest problems, an equal number of household heads, 4 (8.2%) highlighted hearing problems and malaria as ailments treated among their household member(s) while 5 (10.2%) and 9 (18.4%) of the household heads asserted that their household member(s) had sought treatment for respiratory infections and physical injuries requiring medical treatment respectively. The results further revealed that the household member(s) had been treated for other related diseases as noted by 13 (26.5%) of the household heads.

The findings agree with those of Eshiwani (2014) who found that malaria, respiratory infections, eye infections in children, common cold, allergy and chest problems were some of the most prevalent health problem contracted by residents who lived nearby stone quarrying sites. The findings also support that of Nartey, Nanor, and Klake (2012) who noted that acute respiratory tract infection, ear and eye infections, cough and pneumonia were other common health cases recorded by residents living nearby quarries.

Table 4.7: Stone Quarrying Related Ailments for which Household Members Sought Treatment for

Ailment	Frequency	Percent
Fatal accidents	8	16.3
Chest problems	13	26.5
Hearing problems	4	8.2
Malaria	4	8.2
Respiratory infections (e.g. coughs, pneumonia)	5	10.2
Physical injuries requiring medical treatment	9	18.4
Others	13	26.5

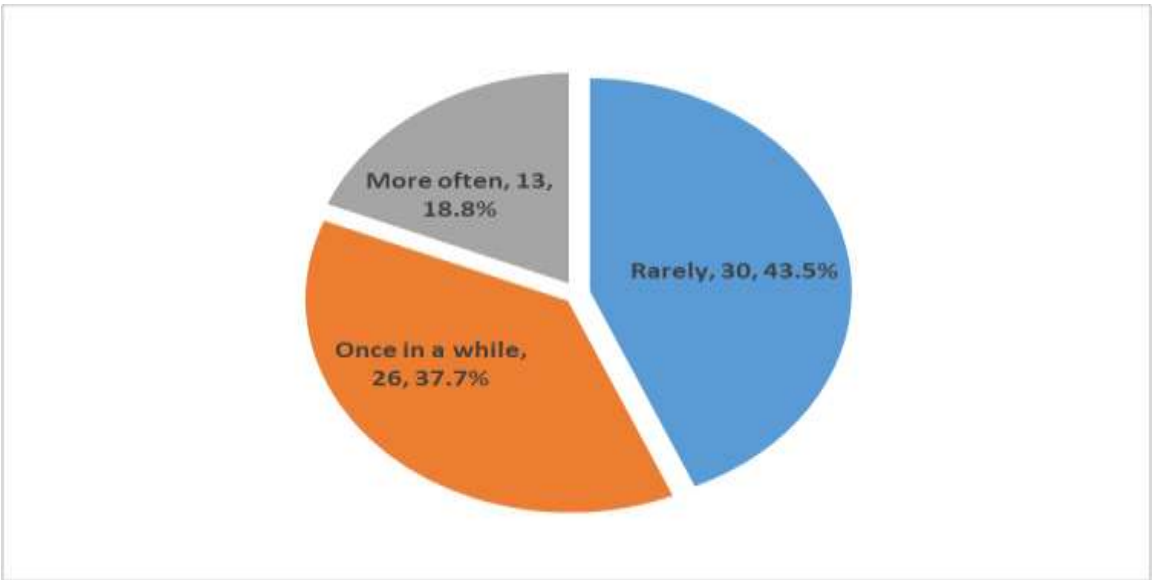
Source: Field Data (2020)

4.5.5 Suffering from Health and Safety Conditions Related to Stone quarrying and How Often Treatment was sought

The quarry workers were asked to indicate whether they had suffered any health and safety conditions resulting from stone quarrying. The study established that 55 (79.7%) of the quarry workers indicated that they had suffered from such conditions while the rest, 14 (20.3%) noted that they did not suffer any health and safety condition as result of these activities. The study also sought to find out how often quarry workers visited hospitals for treatment of ailments caught while working in the quarries within the study area. The findings displayed in Figure 4.9 reveal that 30 (43.5%) of the quarry workers indicated that they rarely visited the hospitals, 26 (37.7%) stated that they sought treatment once in a while and the rest, 13 (18.8%) visited hospitals for treatment of such ailments more often.

The quarry manager from Ketorit also observed that the quarry workers only visited health facilities when they experienced serious illnesses or injuries and preferred self-medication for minor illnesses or injuries. It can be inferred from these findings that the health seeking behaviour of quarry workers in the study was low since, even though a large proportion of these quarry workers indicated that they had suffered from an ailment related to stone

quarrying activities as illustrated in the following sub sections, they did not seek any kind of treatment or did not receive regular medical examination while working at the quarry.



Source: Field Data (2020)

Figure 4.9: Quarry Workers Seeking Treatment for Stone Quarrying Related Ailment

4.5.6 Self-Medication for Stone Quarrying Related Ailments among Quarry Workers

The quarry workers were also asked whether there were times when they had undertaken self-medication in relation to ailments caught while working in the quarries under study. The findings indicated that 50 (72.5%) of the quarry workers had in deed undertaken self-medication to treat ailments caught while quarrying stones while the rest, 19 (27.5%) had not engaged in self-medication. These findings agreed with the conclusion by Wanjiku (2015) that a high proportion of quarry workers sought to taking care of themselves (self-remedy) in case of health problems or emergencies compared to accessing treatment in local health facilities. The findings also concurred with the views by Ahmed et al. (2010) that most injured workers in mines and quarries attempted self-care before they accessed the local medical services.

4.5.7 Quarry Workers Seeking for Treatment for Stone Quarrying Related Ailments in the Past 6 Months

The study investigated whether the quarry workers had for the past 6 months sought any form of treatment for health problems associated with quarrying activities. From the findings obtained, 34 (49.3%) of the quarry workers indicated that they had sought such treatment while the rest, 35 (50.7%) did not seek any such treatment for the past 6 months.

4.5.8 Number of Times Quarry Workers Sought Treatment in the Past 6 Months

The quarry workers who had stated that they had sought treatment in the past 6 months were further asked to specify the number of times they had sought for treatment. The findings show that 13 (55.9%) of the quarry workers had sought for treatment once, 11 (32.4%) had been treated for 2 to 3 times while 4 (11.7%) had sought treatment for more than 3 times.

4.5.9 Stone Quarrying Related Ailments that Quarry Workers Suffered from

The quarry workers were requested to state the various illnesses associated with stone quarrying activities for which they had sought treatment for or engaged in self-medication. Their responses are summarized in Table 4.8. It was noted that 7 (10.1%) of the quarry workers had been involved in fatal accidents, 41 (59.4%) had experienced headaches/fevers, 9 (13.0%) had gotten eye problems while 5 (7.2%) and 29 (42.0%) of the quarry workers had suffered from skin irritation and chest problems respectively. It was also found that 31 (44.9%) of the quarry workers had suffered from Malaria, 35 (50.7%) had experience muscle pains while 28 (40.6%) and 17 (24.6%) had suffered from respiratory infections such as coughs and pneumonia and physical injuries requiring medical treatment respectively.

These findings agree with the observation by Olusegun, Adeniyi, and Adeola (2009) that there were similarities in the health problems suffered by the residents living near quarry sites and quarry workers. The findings also supported that of Bewiadzi, Awubomu, and Glover (2018) that cases of cough and blood spitting, chest pains, bodily pains, waist pains, and pneumonia health challenges confronting quarry workers. In addition, headache, major and minor injuries in the form of bodily cut, common cold, dislocation, sleepless nights and eye infections had also been identified.

Table 4.8: Stone Quarrying Related Ailments Treated or Self-Medication Taken

Ailment	Frequency	Percent
Fatal accidents	7	10.1
Headache/fever	41	59.4
Eye problems	9	13.0
Skin irritation	5	7.2
Chest problems	29	42.0
Malaria	31	44.9
Muscle pains	35	50.7
Respiratory infection (e.g. coughs, pneumonia)	28	40.6
Physical injuries requiring medical treatment	17	24.6

Source: Field Data (2020)

4.5.10 Reported Cases of Death within Quarries

The study also investigated whether there had been any reported cases of deaths that had occurred within the quarries in the study area. The results showed that 23 (33.3%) of the quarry workers and 36 (35.0%) of the household heads asserted that such cases had been reported. These findings were consistent with that of Abate (2016) that stone quarrying activities created steep rock cliffs and deep gaping pits on the surface making quarry workers prone to accidents and fatalities. According to the study, accidents were caused by collapse of walls on the stone workers and that there were death of children and youth reported while swimming in the collected water. The findings also supported that of Lad and Samant (2014) who noted that since most quarries were located in close proximity to houses and dwellings, the locals were more prone to the accidents caused by lack of protection of retaining walls or fences around the border of the steep sloped quarries which had been abandoned.

4.5.11 Involvement of Children in Stone Quarrying Activities

The involvement of children in stone quarrying activities in the study area was examined. The findings revealed that 39 (56.5%) of the quarry workers and 49 (47.6%) of the household heads noted that in deed, some children were involved in these activities. The study results compare with that of another comparative study by ILO in 2006 that uncovered that children in different parts of the world engaged in quarrying at different levels. The findings also support the views of Ata-Era (2016) that child labour was mostly profound in quarrying centres and that it was quite common to find children of school going age heavily engaged in stone quarrying in order to earn money for their families. At an early age, according to this author, children learn how to crush the stones into little blocks or assist with loading the

trucks with the stones. The findings of this study further support the viewpoint of Nyakeniga (2009) who found that at times, children voluntarily engaged in stone quarrying activities.

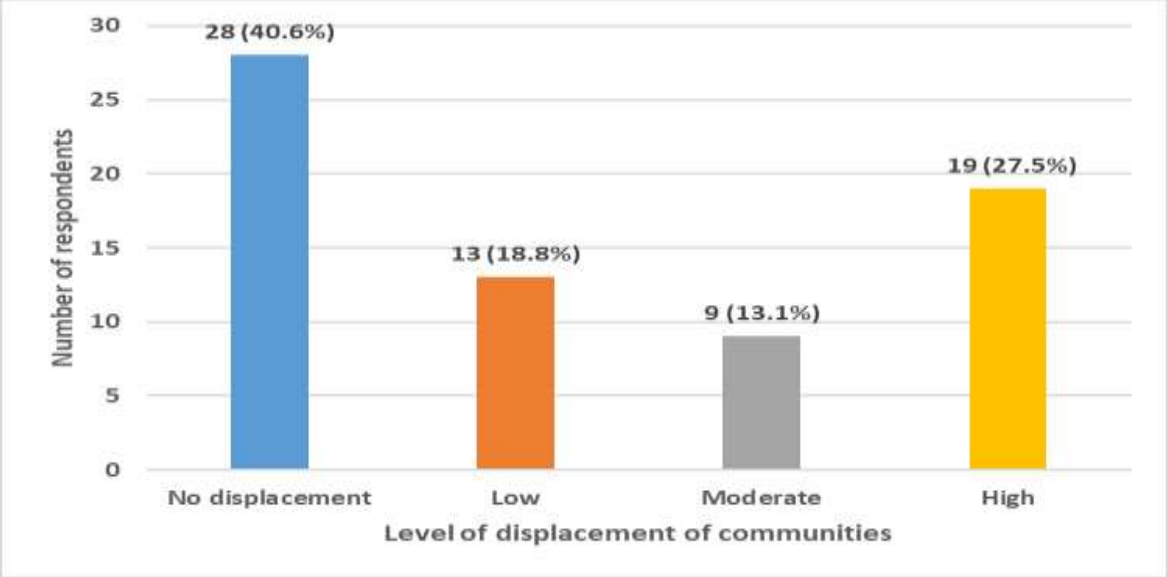
4.5.12 Impact of Children's Involvement in Stone Quarrying on School Enrolment

Those reported that children were involved in stone quarrying activities in the area were also asked to indicate if such involvement had impact on school enrolment. The results revealed that 20 (51.3%) of the quarry workers and 31 (63.3%) of the household heads noted that children involvement in these activities had impacted school enrolment. Those who noted that school enrolment had not been affected by children involvement in stone quarrying activities argued that children only worked in these quarries during weekends and holidays. The children engaged majorly in loading the stones on lorries to keep them busy and get some money for upkeep and to support the parents in paying for school fees. Conversely, those who posited that school enrolment was impacted cited that some students had quit or dropped out of school completely while others were discouraged to attend school due to continued poor performance which resulted to absenteeism. These findings were in accordance with that of an analytical study by ILO (2013) which showed that the education of children engaged in mining or quarrying activities was more often than not jeopardized because they had to balance their time between school and work. As such, education of these children was jeopardized because most of them might not have a complete and meaningful education and might eventually dropout of school and remain permanently on the mine/quarry sites.

4.5.13 Displacement of Communities due to the Stone Quarrying

The study examined whether there had been any displacement of communities due to the stone quarrying in the study area. The findings showed that 45 (43.7%) of the household heads indicated that displacement had actually occurred while the rest, 58 (56.3%) noted that no displacement had occurred as result of stone quarrying. The quarry workers were also asked to rate the level of displacement of communities due to the stone quarrying in the study area. The findings are presented in Figure 4.10. It can be seen that 28 (40.6%) of the quarry workers believed there was no displacement, 13 (18.8%) stated that the displacement was low, 9 (13.1%) found the displacement of communities to be moderate while the rest, 19 (27.5%) argued that the displacement was high. These findings are in tune with those of Adimo, Njoroge, and Waweru (2018) which revealed that displacement of communities was among the social issues occasioned by stone quarrying. The findings also compared with that

of Manzoor and Khan (2020) who found that due to increased stone crushing and quarrying activities, various social challenges and conflicts were also reported in many parts of the world and these included among others the displacement of communities.



Source: Field Data (2020)

Figure 4.10: Household Heads' Responses on the Level of Displacement of Communities

Those who cited displacement of communities noted that some households felt that their children were insecure due to falling stones especially those living at the base of the quarries. Hence, they had no option but relocate to other places. Others had moved to other places due to the agreement between the owners of the land and those who had acquired the quarries. Others relocated due to associated discomfort such as noise and dust, cracks that weakened their structures, loss of aesthetic value of the area as well as the loss of grazing land for their livestock.

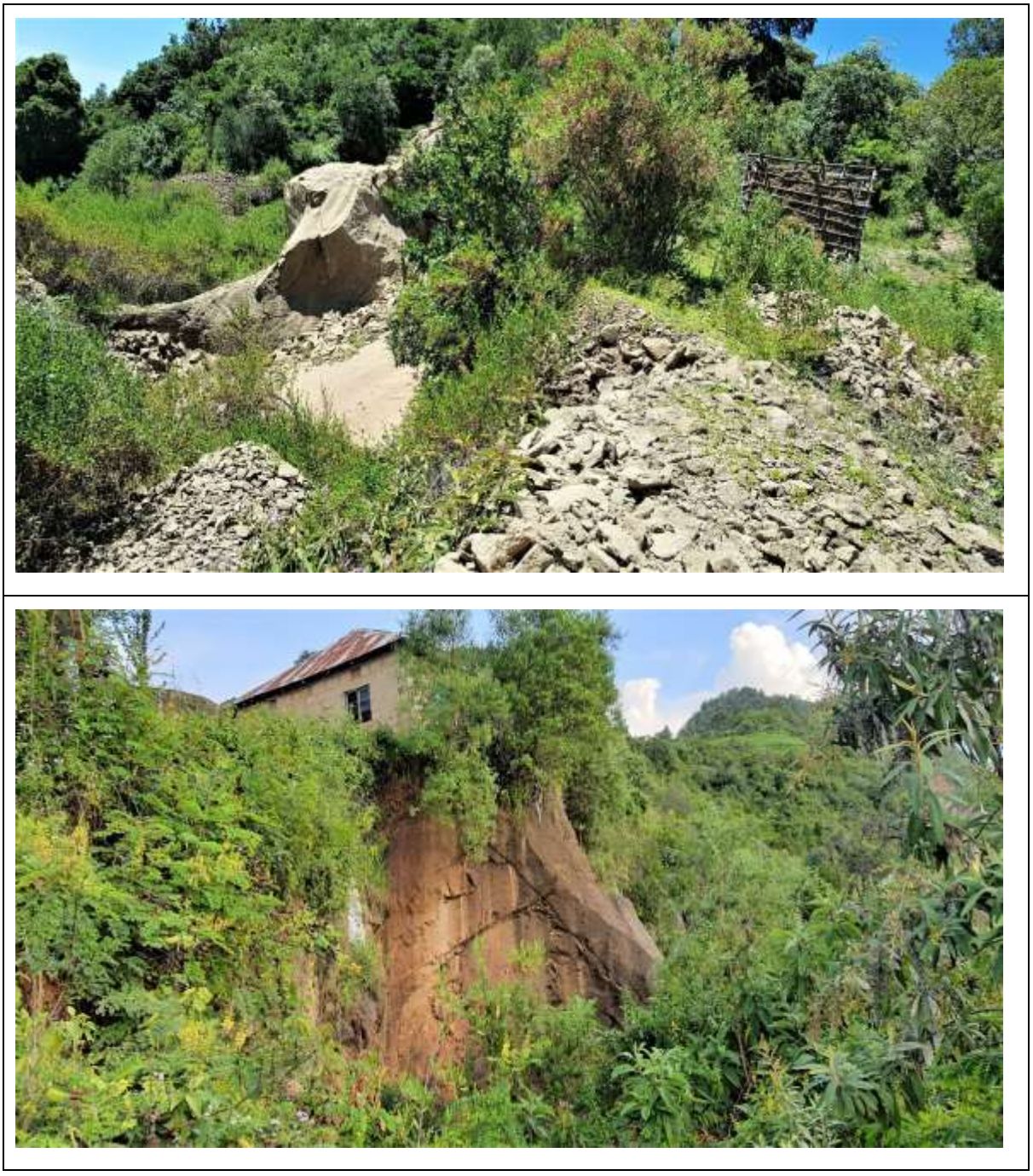
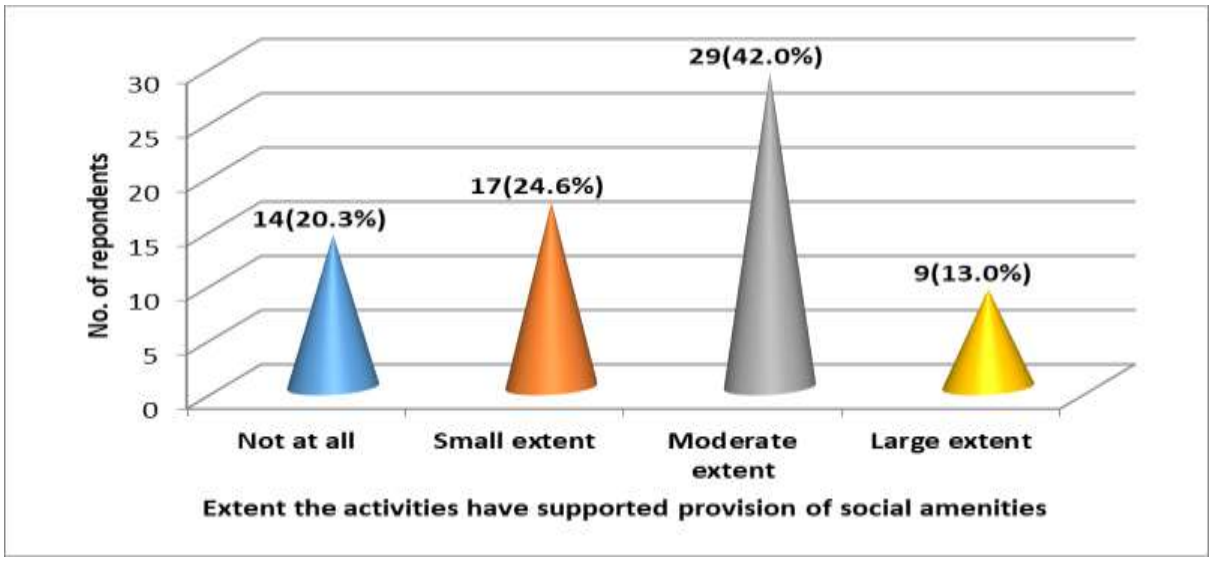


Plate 5: Households forced to relocate to other areas

4.5.14 Stone Quarrying Activities Supporting Provision of Social Amenities

The study investigated whether stone quarrying activities had supported the provision of social amenities such as clinics, schools as well as boreholes for the betterment of the wellbeing of the society in the study area. The findings showed that 69 (67.0%) of the household heads agreed that such activities had supported the provision of social amenities. The quarry workers also provided their views on the extent to which stone quarrying activities had supported the provision of social amenities for betterment of the wellbeing of

the society in the study area. The study findings as given in Figure 4.11 show that 14 (20.3%) of the quarry workers argued that the activities had not supported the provision of social amenities at all, 17 (24.6%) believed they had supported to a small extent while 29 (42.0%) and 9 (13.0%) of the quarry workers indicated that stone quarrying activities had supported the provision of social amenities in the study area to a moderate and large extent respectively. These findings were in agreement of that by Ata-Era (2016) who found that one significant social benefit resulting from quarry operations was support in the efficient construction and delivery of important social amenities and infrastructure such as schools, clinics, boreholes and market stalls.



Source: Field Data (2020)

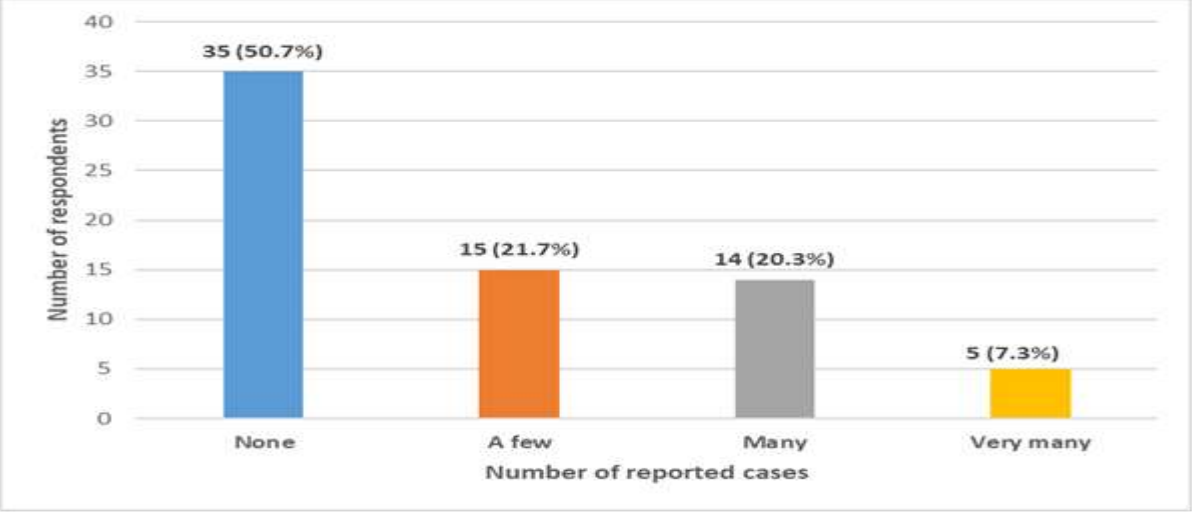
Figure 4.11: Extent Stone Quarrying Activities Supported Provision of Social Amenities

The respondents who noted that stone quarrying activities had supported the provision of social amenities stated that the activities had led to expansion of roads to increase accessibility to the areas and that building blocks had been availed for construction of schools such as Sangarau primary and secondary schools, Mwanga primary school, Tenges primary school and Tuluongoi secondary schools as well as the expansion of hospitals and dispensaries. A water project nearing completion and an irrigation scheme founded by quarry workers' association were also some of the amenities supported by the quarrying activities in the area. Better housing was also linked to these activities. Nevertheless, others decried that no social amenities in the area that could be liked wholly to the quarrying activities since much benefits went to none residents who developed their places.

The quarry manager from Ketorit noted that the activities had helped residents especially those engaged in agriculture and businesses to diversify their incomes. The activities had created a market for the farm produce of area residents. According to the manager from Sangarau quarry, the economic wellbeing of the area residents was highly dependent on these activities. They noted that incomes from these activities were used to pay school fees and meet other household needs. Roads had also been constructed due to stone selling. Other amenities including the building of schools and hospitals such as Sangarau Primary and Secondary Schools, Sangarau Dispensary, had been facilitated by these activities.

4.5.15 Development of Cracks in the Buildings of Surrounding Communities

The study sought to establish whether there had been any reported cases relating to the development of cracks in the buildings of surrounding communities in the study area. The study established that 30 (29.1%) of the household heads stated that buildings in the area had developed such cracks. The quarry workers were also asked to state on average, the number of cases that had been reported in relation to development of cracks in the buildings of surrounding communities in the area. The findings in Figure 4.12 reveal that 35 (50.7%) of the quarry workers indicated that there were no reported cases, 15 (21.7%) noted that the cases were a few, 14 (20.3%) argued that the cases were many while 5 (7.3%) stated that the cases were very many.



Source: Field Data (2020)

Figure 4.12: Development of Cracks in the Buildings of Surrounding Communities

Some household heads reported that some houses and toilets especially those close to the quarries, had sunk during the season of heavy rains while in others where small cracks had been observed, with time these cracks progressively became huge hence endangering the lives and properties of residents. These cases were more severe in places where blasting or intensive quarrying had taken place and majorly affected the unfinished houses that were built using cement blocks. Those who cited the nonexistence of cracks on buildings asserted the quarrying activities were carried out in places far from homes and that the quarrying was not deep.

These findings are consistent with that of Nwachukwu, Ojeaga, and Chinelo (2018) who found that quarry noise and vibration especially during rock blasting can lead to formation of micro cracks that could turn to mega cracks with time, causing the collapse or falling of nearby structures. The findings also agreed with the observations by Saraya (2016) that rock blasting caused ground vibration affecting the comfort and stability of homes of people living close to the quarrying sites where cracks on the floors and walls of homes and other infrastructural facilities often occurred to different degrees.

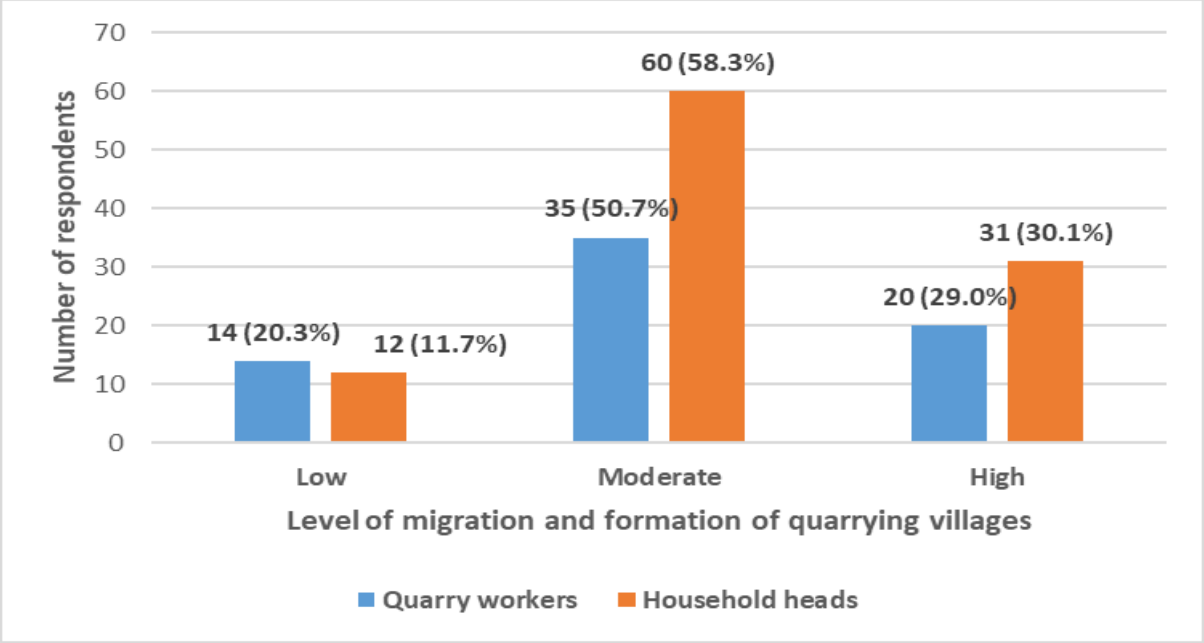
Cracks in the houses of residents

Cracked tank due to blasting and quarrying activties near it

Plate 6: Development of Cracks in the Buildings and Structures of Surrounding Communities

4.5.16 Level of Migration and Formation of Quarrying Villages around the Community

The findings presented in Figure 4.13 show the respondents' assessment of the level of migration of people to the study area and formation of quarrying villages around the community. The findings show that 14 (20.3%) of the quarry workers noted that the migration and formation of the quarrying villages was low, 35 (50.7%) noted it was moderate while 20 (29.0%) believed that the migration and formation of the villages was high. Pertaining to the household heads' response, 12 (11.7%) stated that the migration and formation of the quarrying villages was low, 60 (58.3%) found the level to be moderate while 31 (30.1%) indicated that the migration and formation of the villages was high. This finding is in line with those of Bewiadzi, Awubomu, and Glover (2018) who found that stone quarrying was a catalyst of migration where several people, confronted by worsening economic and political situations among other problems, exploited opportunities found within other regions or areas.



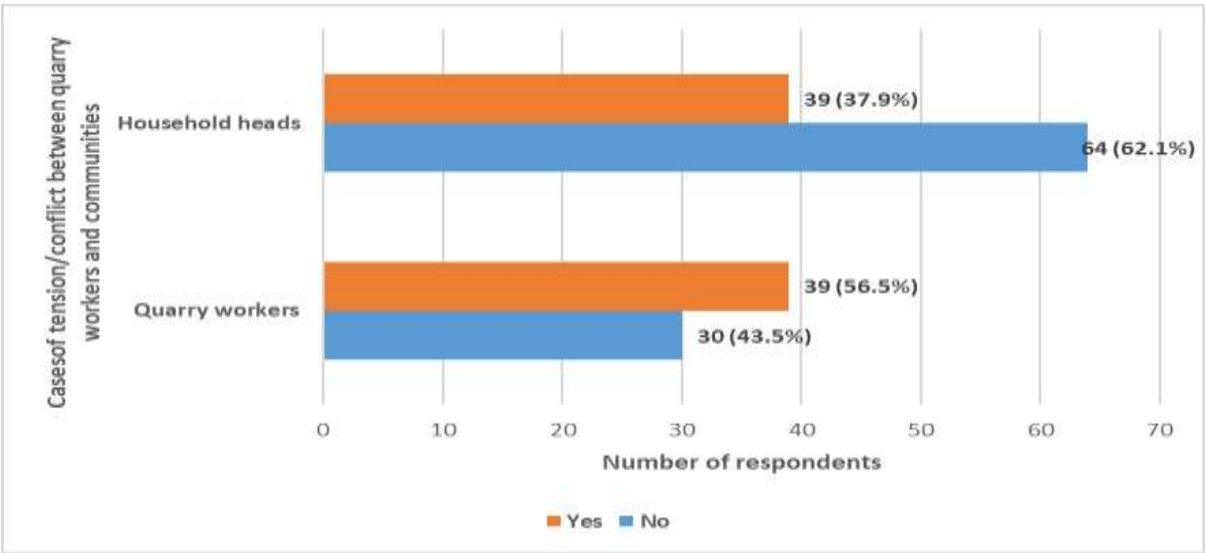
Source: Field Data (2020)

Figure 4.13: Level of Migration/Formation of Quarrying Villages around the Community

4.5.17 Cases of Conflict between Quarry Workers and the Surrounding Communities

The study further probed whether there had been any cases of tension or conflict between the quarry workers and the surrounding communities in the study area. The findings are given in Figure 4.14. According to the responses, 39 (56.5%) of the quarry workers and 39 (37.9%) of

the household heads stated that cases of tension/conflict between these parties had been witnessed in the study area.



Source: Field Data (2020)

Figure 4.14: Tension/Conflict between Quarry Workers and Surrounding Communities

The conflicts witnessed as highlighted by the respondents were attributed to issues of boundaries, that is, where the quarrying should be confined to, the loss of quarrying tools, destruction of farms, noise and development of cracks in the surrounding buildings, quarrying close to homes leading to mass wastage and landslides, falling of rocks, destruction of fences by falling stones as well as the blockage of animal path ways. Others were linked to debts, scramble for quarrying areas, intrusion of family relationships and general misunderstandings.

These findings support the sentiments by Lad and Samant (2014) that regular conflicts arise between the communities living close to the quarries and the quarry owners. The results also compare with those of Nwachukwu et al. (2017) who noted that while quarrying companies and government benefitted from quarrying activities, host communities suffered from the negative impacts which had led to persistent conflicts between the quarry operators and the host communities and that the common conflicts revolved around self-determination and resource control, land use compensation, infrastructural development, pollution and land degradation and reclamation.

Quarrying encroaching a road intersection

Destroyed barbed wire, stone waste deposited on neighbours land causing conflict

Quarrying activities blocking animal pathways

Plate 7: Quarrying activities brewing conflict between quarry workers and surrounding communities

4.6 Environmental Effects of Stone Quarrying

The study sought to establish the effects of stone quarrying on the physical environment in Tuluongoi Sub location, Tenges Division, Baringo County. The views of both the quarry workers and household heads were sought and are as discussed in the following sub sections.

4.6.1 Positive Impact of Stone Quarrying Activities on the Physical Environment

The respondents were asked whether stone quarrying activities had in any way positively impacted the physical environment in the area. The findings showed that 58 (84.1%) of the quarry workers indicated that no positive impact to the physical environment was noted while 11 (15.9%) stated that some positive impacts were notable. A majority of the household heads, 95 (92.2%), also stated that the stone quarrying activities had not in any way positively impacted the physical environment while 8 (7.8%) observed some positive impacts.

Those who noted that it had a positive impact argued that the activities had made some previously hilly areas flat, others noted that there were certain species of trees that had started growing within the quarries, it had reduced the habitation of harmful snakes which scared and injured people and their cattle, others noted that they could use the land for some other uses while others believed that the quarrying activities had led to the planting of trees in previously neglected areas. These findings contradict the assertions of Chatterjee (2010) who noted that the impact on the social economy can either be positive or negative, however, the environment is generally negatively impacted through loss of biodiversity, dust pollution, water pollution, lowering the water table, insightful scars. Eshiwani (2014) also argued that quarrying activities affect both the physical and the biological environment and that the effect to the environment in most cases is usually negative that is, the activities cause harm to the environment.

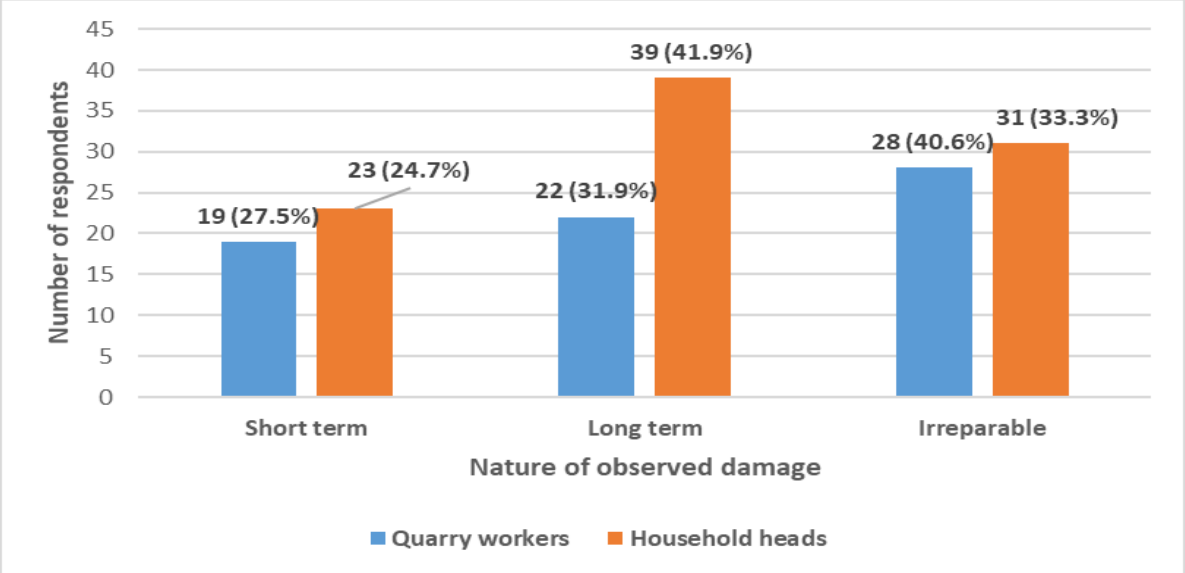
4.6.2 Observed Damage to the Physical Environment due to Stone Quarrying

The respondents were asked whether they had observed any damage to the physical environment being caused by the stone quarrying activities in the area. All the quarry workers stated that they had observed damage to the physical environment due to their activities. The findings also show that a majority of the household heads, 93 (90.3%), had also noted such damages. Responses given during the interview sessions reveal that all the key informants stated that they had observed such damage. These findings imply that stone quarrying activities had damaged the physical environment in the study area to a large extent and that this damage had been felt by a majority of the area residents. The findings concur with that of

Mahtab, Stanton and Roma (2015) who found that quarrying operations had notable negative ramifications for the environment. The findings are also consistent with that of Ezichi (2018) who found that different types of environmental damage and hazards inevitably accompany the different stages of stone quarrying.

4.6.3 Nature of Damage to the Physical Environment Observed

Those who had observed damage to the physical environment were also asked to describe the nature of the damages. The findings are presented in Figure 4.15. The study established that 19 (27.5%) of the quarry workers believed that the damage was short term, 22 (31.9%) noted that the damage was long term while 28 (40.6%) indicated that the damage was irreparable. With respect to the household heads, 23 (24.7%) had observed that the damage was short term, 39 (41.9%) considered the damage to be long term while 31 (33.3%) found the damage irreparable. The findings imply that the effect of stone quarrying activities to the physical environment in the study area ranged from short term damage to irreparable damage. The findings agree with that of Endalew, Tasew, and Tolahun (2019) who found that stone quarrying activities often have long-term environmental impacts. The findings also concurred with that of Mkpuma, Okeke, and Abraham (2015) who found that the environmental problems related to quarrying activities can either be permanent/temporary, beneficial/harmful, repairable/irreparable, but irreversible.

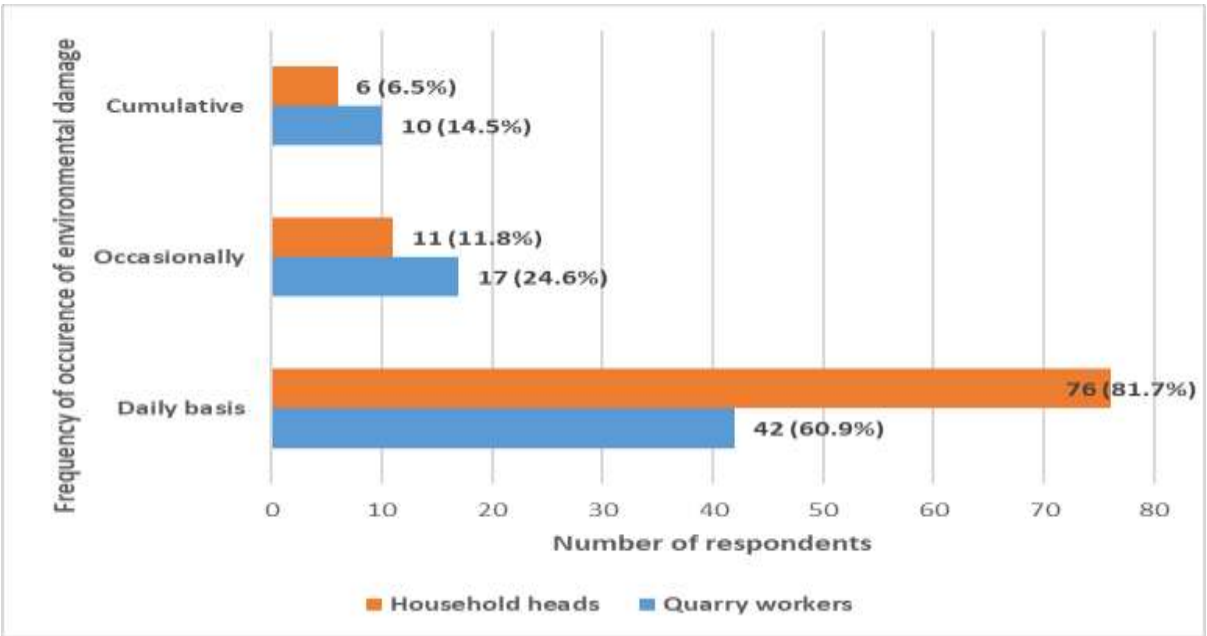


Source: Field Data (2020)

Figure 4.15: Nature of Damage to the Physical Environment Observed

4.6.4 Frequency of Occurrence of Damage to the Physical Environment

The respondents who had observed damage to the physical environment were asked to indicate how frequently the environmental damage occurred. The results presented in Figure 4.16 reveals that 42 (60.9%) of the quarry workers stated that the damage occurred on a daily basis, 17 (24.6%) noted that the damage was occasional while 10 (14.5%) believed that the damage was cumulative. On the other hand, 76 (81.7%) of the household heads observed that the damage occurred on a daily basis, 11 (11.8%) stated that the damage occurred occasionally while 6 (6.5%) found the damage to be cumulative. These findings implied that environmental damage to the physical environment in the study area occurred on a daily basis.



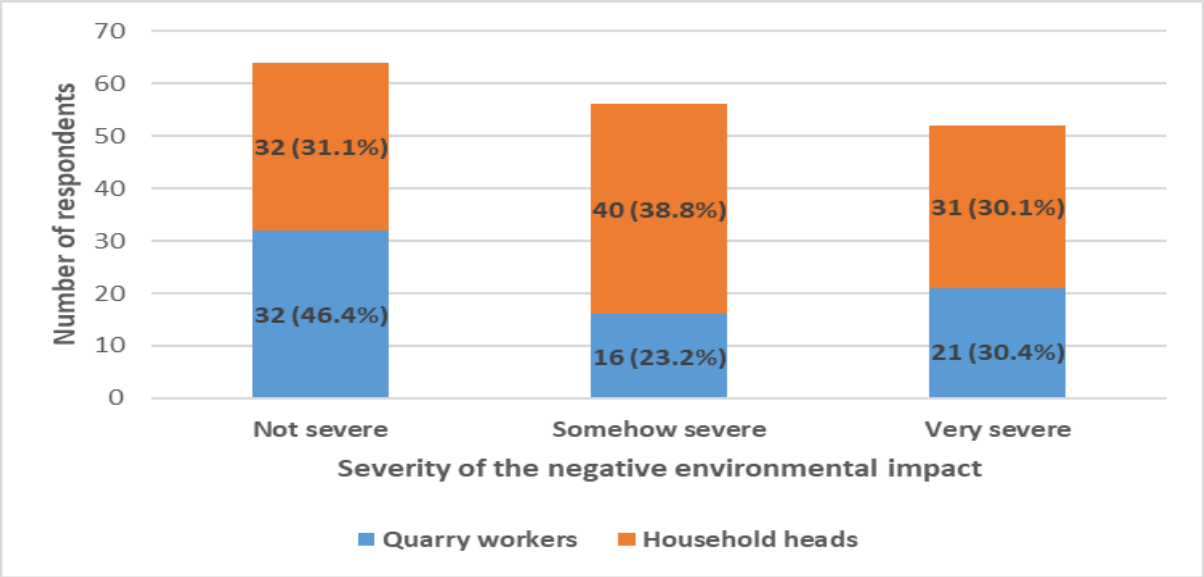
Source: Field Data (2020)

Figure 4.16: Frequency of Occurrence of Damage to the Physical Environment

4.6.5 Severity of Suffering from the Negative Environmental Impacts of Stone Quarrying

The study further probed the severity or harshness of the suffering from the negative environmental impacts of stone quarrying activities in the study area. The findings of the study are given in Figure 4.17. It was found that 32 (46.4%) of the quarry workers believe that the impacts were not severe, 16 (23.2%) found the impacts to be somehow severe while the rest of the quarry workers, 21 (30.4%) considered the impacts to be very severe. Based on

the household heads' responses, 32 (31.1%) of them viewed the impacts as not severe, 40 (38.8%) were of the view that the impacts were somehow severe while the rest, 31 (30.1%) found the impacts to be very severe. These findings meant that the severity of the suffering from the negative environmental impacts of stone quarrying was varied which could be determined by the level of proximity to the quarrying site. The findings agree with that of Uglow (1999) who found that the effects of stone quarrying can be severe if the screening of current operations and the restoration of quarried areas is not undertaken. Ezichi (2018) also pointed out that the distance from the source of quarrying activities determined the magnitude of environmental degradation experienced by residents.



Source: Field Data (2020)

Figure 4.17: Severity of Suffering from the Negative Environmental Impacts of Stone Quarrying

4.6.6 Damages on the Physical Environment Witnessed due to Stone Quarrying Operations

Table 4.9 summarizes some of the damages on the environment witnessed by the quarry workers as result of quarrying operations. The findings show that 63 (91.3%) of the quarry workers had witnessed the destruction of original vegetation cover and crops, 44 (63.8%) had noted the disruption of animal habitats, a similar number 38 (55.1%) had each witnessed soil erosion and river siltation and noise pollution and vibration while 41 (59.4%) and 51 (3.9%) of the quarry workers had witnessed dust pollution and loss of aesthetic value respectively.

The results also reveal that 46 (66.7%) of the quarry workers had witnessed the degradation of land and loss of top soil due to stone quarrying activities, 29 (42.0%) had noted the accumulation of water in abandoned pits which bred waterborne diseases in rainy seasons, 15 (21.7%) reported the contamination of water sources, 26 (37.7%) witnessed the alteration of water courses while 51 (73.9%) of the quarry workers had observed the permanent alteration of original land form. The study further observed that 31 (44.9%) of the respondents had witnessed landslides and mass wasting while 35 (50.7%) had noted abandoned hole and waste stone fills. Other damage witnessed by the quarry workers was the depletion of rocks.

These findings supported that of Melodi (2017) which revealed that quarry activities had various effects on the natural environment which included degradation of land and vegetation, noise pollution, air pollution and water pollution. The results were also consistent with the observation by Ru and Dejene (2016) that quarrying negatively affected the environment in a variety of ways during exploration and blasting, transportation and disposal of waste rocks and that the major environmental effects were destruction of vegetation, disruption of animal habitats, diversion and blockage of natural drainage systems, soil erosion and river siltation, noise and vibration; and dust pollution

Table 4.9: Damages on the Environment Witnessed due to Stone Quarrying Operations

Damage	Frequency	Percentage
Destruction of original vegetation cover and crops	63	91.3
Disruption of animal habitats	44	63.8
Soil erosion and river siltation	38	55.1
Noise pollution and vibration	38	55.1
Dust pollution	41	59.4
Loss of aesthetic value (i.e. loss of visual scenic value)	51	73.9
Land degradation and loss of top soil	46	66.7
Accumulation of water in abandoned pits	29	42.0
Contaminated water resources.	15	21.7
Alteration of water courses	26	37.7
Permanent alteration of original land form	51	73.9
Landslides and mass wasting	31	44.9
Abandoned holes and waste stone fills	35	50.7

Source: Field Data (2020)

During the key informant interviews, the quarry manager from Sangarau asserted that the vegetation in the area had been cleared to pave way for stone quarrying activities. They also noted that some trees near the rivers had been cut and that waste products from the quarry had been pushed in to the river. The quarry manager also noted that the stones had been

removed and unfilled holes left behind after the activities. Furthermore, hills in the areas had been levelled and roads constructed where it was initially impossible to. This was also reiterated by the quarry manager from Ketorit quarry who stated that the area used to be hilly but was becoming flat as stone quarrying activities intensified. The NEMA official on their part also noted that that most quarry workers and owners did not undertake decommissioning processes and activities such as levelling and reforestation once they completed their operations.

4.6.7 Effect of Stone Quarrying Activities on the Original Vegetation Cover and Trees

The views of household heads on how stone quarrying activities had affected the original vegetation cover and trees in the study area were sought. The findings revealed that 82 (79.6%) of the household heads stated that the original vegetation cover and trees in the area had been destroyed or cleared due to these activities while 21 (20.4%) noted no change or destruction. Those who noted destruction pointed out that indigenous trees and other plants had been cut, animal fodder was no longer available and crops originally planted in some areas could no longer thrive in the area. This was due to intensified quarrying activities and hence, the vegetation had to be cleared to pave way for such activities. These findings are consistent with the arguments of Lameed and Ayodele (2010) that biodiversity loss was a notable impact of quarrying activities because the activities occupied large pieces of land where trees and vegetation were cleared, hence, the flora and fauna were destroyed or driven to extension due to continued quarrying and vegetation clearing.

4.6.8 Effect of Stone Quarrying Activities on the Atmosphere

The impact of stone quarrying activities on the atmosphere in the study area was also investigated. The responses given by the household heads are summarized in Table 4.10. Based on the responses given, 26 (19.4%) of the household heads indicated that there was no dust or noise pollution in the area, 13 (12.6%) observed minimal noise pollution, 7 (6.8%) noted that the dust pollution in the area was minimal while 42 (40.8%) and 55 (53.4%) of the household heads decried that there was intense noise and dust pollution in the area respectively. According to Tribhuwan and Patil (2009), quarrying affected the air quality of a local area because of the dust emissions from quarrying operations and hauling, eventually implicating human health. Omasanya and Ajibande (2011) also note that blasting as a common technique used in loosening stone for quarrying involved the use of heavy

explosives and had drastic impacts on the immediate environment since the noise and vibration was annoying to human residents, domestic animals and wildlife.

Table 4.10: Effect of stone quarrying activities on the atmosphere

Impact on the atmosphere	Frequency	Percent
No dust or noise pollution	26	19.4
Minimal noise pollution	13	12.6
Minimal dust pollution	7	6.8
Intense noise pollution	42	40.8
Intense dust pollution	55	53.4

Source: Field Data (2020)

The household heads who indicated that there was no dust or noise pollution in the area noted that dust did not reach their residences and that there were no blasting activities nearby. Those who found the noise and dust pollution to be minimal noted that noise from blasting activities were heard from a far and that dust was experienced when it was extremely dry. Where noise pollution was intense, the household heads noted that blasting activities led to noise and vibrations that scared small children and cattle. The vibrations also led to development of cracks in their buildings. Intense dust pollution was notable during windy and dry seasons resulting to poor visibility and air quality.

4.6.9 Effect of Stone Quarrying Activities on the Aesthetic Value (Visual Scenic Value)

The household heads were also asked to describe the impact of stone quarrying activities on the aesthetic value (visual scenic value) of the study area. The findings showed that 85 (82.5%) of the household heads indicated that the visual scenic value had been destroyed or affected while the rest, 18 (17.5%) noted that the aesthetic value of the area had not been destroyed. Those who argued that the aesthetic value of the area had been destroyed decried that the area was no longer attractive with some terming it as ‘ugly’ more so due to the piles of waste rocks left in the area, abandoned holes, clearing of vegetation, flattening of hilly places as well as massive soil erosion.

The findings of this study compared to that of Tsolaki-Fiaka et al. (2018) who observed that decades of unregulated quarries to support development had left multitudes of scars and ugly holes on hillsides and the ground depriving the environment of its aesthetic integrity. The findings also supported that of Adimo, Njoroge, and Waweru (2018) who noted that quarrying activities intensified scars on unrepaired land in quarried zones.

4.6.10 Effect of Stone Quarrying on Landscape, Land Stability and Top Soil

Table 4.11 provides a summary of the household heads views pertaining to the impact of stone quarrying on landscape, land stability and top soil. The findings revealed that 14 (13.6%) of the household heads had noted that the landscape, land stability and top soil in the study area had not been destroyed, 89 (86.4%), a majority, had noted massive soil erosion, 17 (16.5%) decried of regular landslides while 33 (32.0%) observed that the landscape in the area had changed. Soil erosion was attributed to loose soil since there were no stones and trees to hold it and hence, when it rained, the soil was carried away especially along river banks. The landslides were linked to weak land while the change in landscape was attributed to the flattening of hilly places.

The study results are in accordance with the observations by Devi and Rongmei (2015) that stone quarrying activities had detrimental effects on landscapes since they usually left behind ugly scars which could transform useful land in to a waste land due to the ugly heap pits. Wangela (2019) also observed that stone quarrying caused serious disturbance to soil, severe soil erosion and loss of topsoil as well as removal of top cover. It is also argued by Nando et al. (2011) that landslides in quarrying zones occurred almost always due to heavy rains.

Table 4.11: Effect of Stone Quarrying on Landscape, Land Stability and Top Soil

Impact on aesthetic value	Frequency	Percent
No destruction	14	13.6
Massive soil erosion	89	86.4
Regular landslides	17	16.5
Changed landscape	33	32.0

Source: Field Data (2020)

4.6.11 Effect of Stone Quarrying on Water Resources

The impact of stone quarrying activities on water resources (water quality and water courses) was also explored. The findings reveal that 23 (22.3%) of the household heads stated that the water resources had not been destroyed, 76 (73.8%) complained of water contamination, 17 (16.5%) argued that the activities had changed water courses while 34 (33.0%) linked the activities to the drying up of rivers in the area. Those who cited water contamination noted that the water quality had been affected by silt resulting from soil erosion and this impacted the water uses. The drying of some rivers such as Cheparkechai River meant that there was no more water for use by residents. The households who believed that the water resources had not been destroyed indicated that there were no quarrying activities along or near the

river. According to Ezichi (2018), quarrying substantially modified the routing of recharge and water quality degraded and hence, measures must be taken to control runoff, sedimentation and deterioration of ground water. The findings also support the views by Sayara (2016) that quarrying operations interrupted natural water recharge leading to reduced quality and quantity of drinking water for wildlife and downstream users and those close to the stream.

Changed water course

Water flowing down to the river but is covered by waste rocks

Plate 8: Impact of Stone Quarrying on Water Resources

4.6.12 Effect of Stone Quarrying on Original Land Form and Use

The study sought to find out if there was alteration of the original land form and use in the study area due to stone quarrying activities. The findings showed that 94 (91.3%) of the household heads indicated that in deed the original land form and use had been altered while 9 (8.7%) noted that no alteration had taken place. Those who asserted that the original land form and use had been altered observed that grazing lands had become rocky leading to injuries to their cattle, others noted that agriculture was no longer viable in the area, others observed that hills in the area had been flattened while others pointed out that the land was full of humps of waste from quarrying activities. It was also argued by some of these household heads that some unfilled areas acted as water points during rainy seasons while others stated that some idle land was now being put to use. These findings are consistent with that of Endalew, Tasew, and Tolahun (2019) who reported that stone quarrying changed the land use system including previously cultivated land.

4.6.13 Presence of Abandoned Holes and Waste Stone Fills

With regards to abandoned holes and stone waste in the study area, a majority of the household heads, 99 (96.1%), stated that in deed such holes and stone waste fills were in the area. Most of the household heads noted that open abandoned holes were all over the area and due to accumulation of water in these holes, they became breeding sites for mosquitos even during dry seasons. Others observed that only those who wanted to reuse the areas made effort to refill them given that some quarry workers would do quarrying in the same holes after some time. According to Mwangi (2014), after the exploitation is complete, most quarries were abandoned and left open because filling them up was more expensive than the actual exploitation as lots of metric tons of soil and gravel were needed.

Plate 9: Water accumulation in abandoned holes

The other aspects of the physical environment affected by the stone quarrying activities pertained to reduced land size for use by residents especially where waste stones were dumped in other people's land.

4.7 Awareness of Environmental Rules and Regulations on Stone Quarrying

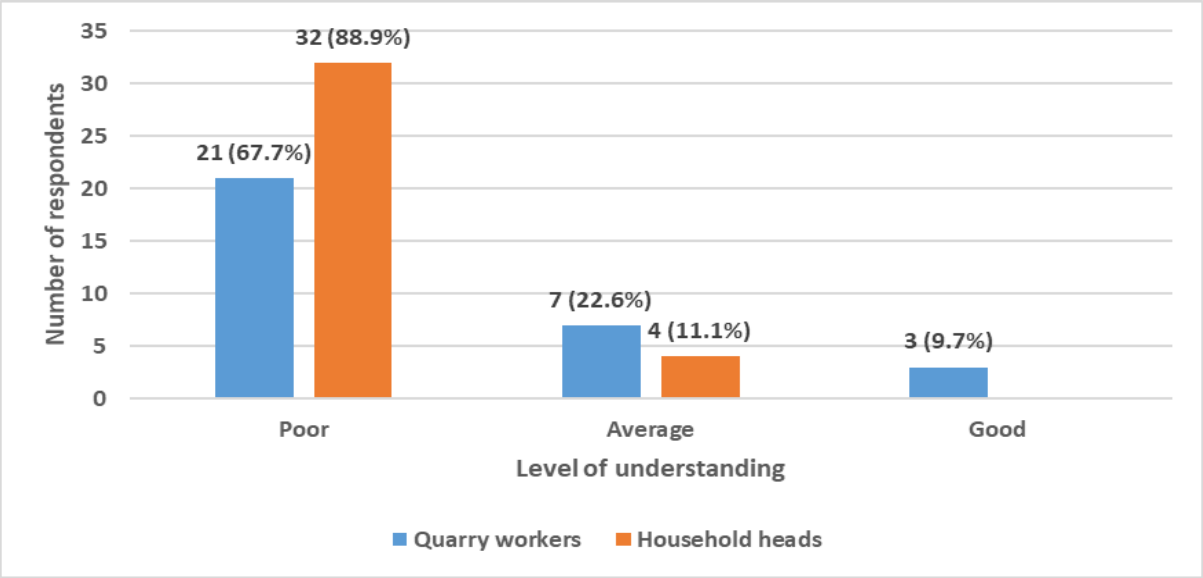
The study sought to determine the level of awareness of environmental rules and regulations governing stone quarrying among residents and quarry workers in Tuluongoi Sub location, Tenges Division, Baringo County. A series of questions were presented to the respondents.

4.7.1 Aware of any Environmental Rules and Regulations on Stone Quarrying

The study assessed whether the quarry workers and household heads were aware of any environmental rules and regulations regarding stone quarrying. The study noted that only 31(44.9%) of the quarry workers and 36 (35.0%) of the household heads indicated that they were aware of these rules and regulation. These findings imply that a large proportion of the respondents were not aware of environmental rules and regulations guiding stone quarrying. These findings were consistent with the observations by Lad and Samant (2014) that interactions with quarry workers and locals in most quarrying sites revealed that most of them had no clue of the status of the quarries, the permissible quarrying standards as well as the rules and regulations governing the quarrying operations.

4.7.2 Understanding of Environmental Rules and Regulations on Stone Quarrying

Those who noted that they were aware of at least one environmental rule and regulation regarding stone quarrying were also asked to rate their level of understanding or comprehension of such rules. As shown in Figure 4.18, 21 (67.7%) of the quarry workers noted that they had poor understanding of the rules and regulations, 7 (22.6%) said they had average understanding, 3 (9.7%) noted that they had good understanding while none had excellent understanding of these rules and regulations. With regards to household heads, 32 (88.9%) stated that their understanding of the current environmental rules and regulations was poor while the rest, 4 (11.1%), asserted that their understanding was average. The study findings imply that the comprehension of the requirements of the current environmental rules and regulation governing stone quarrying was not adequate for most of the quarry workers and also the household heads. The findings supported that of Twerefou et al. (2015) who established that individuals working in the extractive industry particularly on a small scale or even illegally, were aware of a few rules and regulations but had no idea of their details.



Source: Field Data (2020)

Figure 4.18: Understanding of Environmental Rules/Regulations on Stone Quarrying

During interactions with between the researcher and the quarry workers, one of them argued that they quarried stone to less than 10 metres from homes because they had no idea of the specific distance between the quarry zone and the first house. Where there were no complains raised, they assumed that their activities were done according to the laws since no one had incriminated the quarry owners or workers.

4.7.3 Environmental Rules/Regulations on Stone Quarrying the Respondents were Aware of

The results presented in Table 4.12 summarizes some of the environmental rules and regulations regarding stone quarrying that the quarry workers said they were aware of. The findings show that 7 (22.6%) of the quarry workers noted that they were aware that they should not destroy vegetation or cut tree while quarrying, 3 (9.7%) were aware that after quarrying, the land needed to be reclaimed, 2 (6.3%) were aware that they should not dig more than 8 feet under while 28 (90.3%) and 11 (35.5%) of the quarry workers indicated that they were aware that they should not quarry near water catchment areas so as to avoid siltation. The findings further showed that 6 (19.4%) of the quarry workers were aware that they needed to use environmentally friendly tools, 15 (48.4%) were aware that planting trees after quarrying activities was necessary, 2 (6.5%) were aware that they ought to limit noise and vibration when quarrying while 8 (25.8%) of the quarry workers noted that they were aware that they should not quarry in the forest and hilly areas.

Table 4.12: Environmental Rules and Regulations on Stone Quarrying that Quarry Workers were Aware of

Environmental rules and regulations	Frequency	Percent
Do not destroy vegetation, trees when quarrying	7	22.6
After quarrying, the land should be reclaimed	3	9.7
Do not dig more than 8 feet deep	2	6.5
Do not quarry near water sources, avoid siltation	28	90.3
Rehabilitation of quarries, fill up the holes	11	35.5
Use of environmentally friendly tools	6	19.4
Planting trees after quarrying	15	48.4
Limited noise and vibration	2	6.5
Do not quarry in the forest and hills	8	25.8

Source: Field Data (2020)

The household heads who noted that they were aware of at least one environmental rule and regulation pertaining to stone quarrying activities highlighted some of the rules and regulations that they were aware of. The responses given are provided in Table 4.13. The findings reveal that 29 (80.6%) of the household heads asserted that they were aware that when carrying out stone quarrying activities, destruction of vegetation or cutting down of trees is not permissible, 17 (47.2%) were aware there should be no stone quarrying activities near water catchment areas while 4 (11.1%) were aware that depleted holes should be filled after quarrying activities are completed.

Table 4.13: Environmental Rules and Regulations on Stone Quarrying that Household Heads were Aware of

Environmental rules and regulations	Frequency	Percent
Do not destroy vegetation or cut trees when quarrying	29	80.6
Do not quarry near water catchment areas	17	47.2
Depleted holes should be filled after quarrying activities	4	11.1

Source: Field Data (2020)

4.7.4 Reponses to Statements Relating to Environmental Rules/Regulations on Stone Quarrying

Both the quarry workers and household heads were presented with various statements relating to environmental rules and regulations on stone quarrying. They were required to indicate

whether they were aware or unaware of them. The responses by the quarry workers are given in Table 4.14. The study found that 9 (13.0%) of the quarry workers were aware that an environmental impact assessment should be performed prior to quarrying begins in a given place while the rest, 60 (87.0%) were unaware of this requirement. The findings also reveal that 21 (30.4%) of the quarry workers were aware that all quarry sites must be fenced, the rest, 48 (69.6%), were not aware of this regulation.

Pertaining to rehabilitation of depleted quarries by the land owners, 13 (18.8%) of the quarry workers stated that they were aware of the rule/regulation while the rest, 56 (81.2%), were unaware of this requirement. The study results revealed 16 (23.2%) of the quarry workers were aware that all persons working at the quarry sites should be provided with protective gear and first aid kits. The rest, 53 (76.8%) were unaware of the requirement. The findings further revealed that 25 (36.2%) of the quarry workers were aware that quarrying operation should be done 50m away from homes while the rest, 44 (63.8%) were aware of this rule/regulation. Last but not least, the study noted that 22 (31.9%) of the quarry workers were aware that warning signs should be erected at the entry point of each quarry site, the rest, 47 (68.1%), were unaware of this requirement.

Table 4.14: Quarry Workers' Reponses on Statements Relating to Environmental Rules/Regulations on Stone Quarrying

Statement	Aware		Unaware		Total	
	Count	%	Count	%	Count	%
An environmental impact assessment should be performed prior to quarrying begins in a given place.	9	13.0	60	87.0	69	100.0
All quarry sites must be fenced.	21	30.4	48	69.6	69	100.0
Depleted quarries should be rehabilitated by the land owners.	13	18.8	56	81.2	69	100.0
All persons working at the quarry sites should be provided with protective gear and first aid kits.	16	23.2	53	76.8	69	100.0
Quarrying operation should be done 50m away from homes.	25	36.2	44	63.8	69	100.0
Warning signs should be erected at the entry point of each quarry site.	22	31.9	47	68.1	69	100.0

Source: Field Data (2020)

The responses given by the household heads with regards to a number of statements relating to environmental rules and regulations are provided in Table 4.15. The findings show that 6 (5.8%) of the household heads were aware that environmental impact assessment should be performed before quarrying begins in a given place, 97 (94.2%) were unaware of this requirement. With regards to the fencing of quarry sites, 20 (19.4%) of the household heads were aware that all quarry sites must be fenced while the rest, 83 (80.6%) were unaware of this regulation. The study also established that while 33 (32.0%) of the household heads were aware that depleted quarries should be rehabilitated by the land owners, 70 (68.0%) of them were not aware of this requirement.

The study findings further revealed that 7 (6.8%) of the household heads were aware that all persons working at the quarry sites should be provided with protective gear and first aid kits while the rest, 96 (93.2%) were not aware of this rule. The household heads aware that quarrying operations should be done 50m away from homes were 29 (28.2%) while the rest, 74 (71.8%), were unaware of this requirement. The findings also show that 18 (17.5%) of the household heads were aware that warning signs should be erected at the entry point of each quarry site while 85 (82.5%) noted that they were unaware of the requirement.

Table 4.15: Household heads' Reponses on Statements Relating to Environmental Rules/Regulations on Stone Quarrying

Statement	Aware		Unaware		Total	
	Count	%	Count	%	Count	%
An environmental impact assessment should be performed prior to quarrying begins in a given place.	6	5.8	97	94.2	103	100.0
All quarry sites must be fenced.	20	19.4	83	80.6	103	100.0
Depleted quarries should be rehabilitated by the land owners.	33	32.0	70	68.0	103	100.0
All persons working at the quarry sites should be provided with protective gear and first aid kits.	7	6.8	96	93.2	103	100.0
Quarrying operation should be done 50m away from homes.	29	28.2	74	71.8	103	100.0
Warning signs should be erected at the entry point of each quarry site.	18	17.5	85	82.5	103	100.0

Source: Field Data (2020)

The NEMA official was asked whether there were any regulations governing the establishment of stone quarries and their rehabilitation. The official noted that such regulations were in place citing the EMCA 2015 Cap 27 provision for mining. The official also asserted that the authority ensured that environmental impact assessments are conducted before quarrying activities begin to determine the associated problems and mitigation measures. The official also noted that they had to ensure that recommendations of the environmental impact assessments are fully implemented since this would help reduce the negative impacts of these operations on the environment and people.

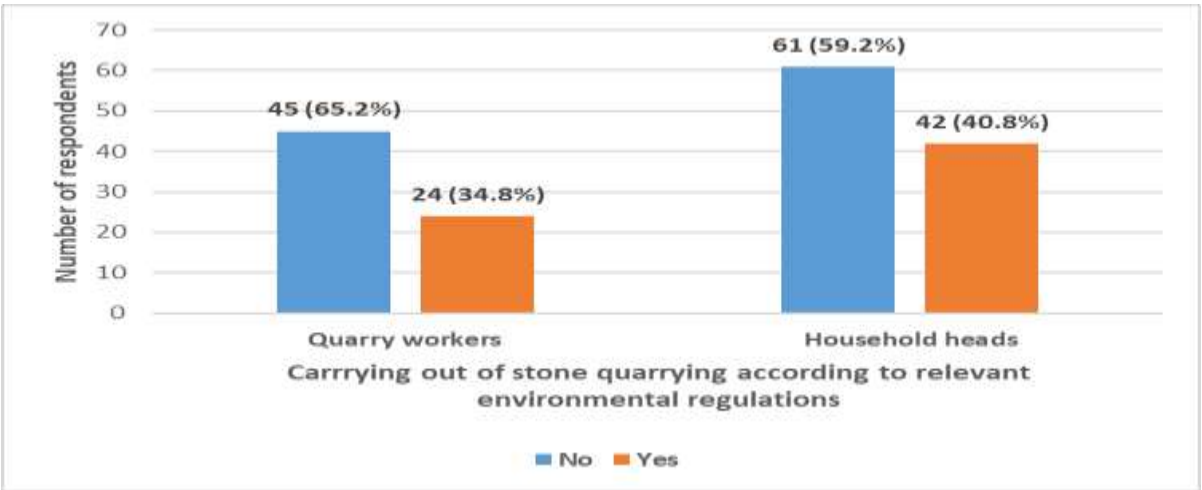
The official from the Ministry of Mining on their part noted that often, they were unaware of quarrying activities taking place in communities because individuals quarried on their own land either by themselves or by renting out. According to them, it was the responsibility of the quarry owner or land owner to approach the mining department seeking for authorization so that they can be given a letter of authorization to approach NEMA for EIA. Thus, NEMA relied on recommendations from the Ministry of Mining to demand for an EIA to be done. However, the official asserted that the mining department at Baringo County did not have its own mining policy. They concluded that the community and quarry owners in the area were not empowered on what procedures to follow to get the required permits and assessments. Hence, they lacked knowledge on the institutional frameworks, rules and regulations governing stone quarrying.

4.7.5 Stone Quarrying as per Relevant Environmental Rules and Regulations

The study also examined whether stone quarrying in the study area was done according to the relevant environmental rules and regulations. The findings are provided in Figure 4.19. The results show that 45 (65.2%) of the quarry workers believed that the activities were not undertaken according to these rules and regulations while the rest, 24 (34.8%) noted that in deed, the activities were conducted in line with the rules/regulations. With respect to the household heads, 61 (59.2%) of them asserted that the stone quarrying activities in the area were not carried out as per the relevant environmental rules and regulations while the rest, 42 (40.8%) believed that the activities were undertaken as per these rules and regulations.

It can be deduced from these findings that stone quarrying operations in the study area were carried out without adhering or complying with the stipulated environmental rules and regulations on stone quarrying. According to Kindiga (2017), quarrying activities are governed by principles, laws, and regulations that must be adhered to and that the ability of

communities within the vicinity of a quarry to comprehend the quarrying regulations ensures that quarry owners operate within the mandated laws. The findings are in agreement with that of Twerefou et al. (2015) who noted that though a significant percentage of quarry workers were always aware that their actions should not harm the environment, they did not comply with the set standards.



Source: Field Data (2020)

Figure 4.19: Stone Quarrying as per Relevant Environmental Rules and Regulations

The household heads who believed that stone quarrying activities in the area were done as per the relevant environmental rules and regulations noted that in some cases, some rules such as quarrying 50 metres away from homes were strictly observed. However, those of a contrary view decried that most of the rules were not observed and that quarry workers carried out their activities anyhow. Others argued that quarry workers only observed some rules such as refilling the already quarried areas that had been left to a small extent and when forced to do so. Many household heads decried that most quarry workers were more interested in the gains from the quarrying activities and were not interested much in protecting the environment. This was exacerbated by the unavailability of NEMA officials to enforce these rules.

The sentiments of the household heads were also backed by the responses from the quarry workers. Those who agreed that stone quarrying activities in the study area were carried out according to the laid down environmental rules and regulations stated that some rules such as land reclamation once the activities were completed in a given area and not quarrying near water sources and forests were being followed. They noted that terracing was done to a small extent. Nonetheless, most of the quarry workers argued that even where quarry workers were aware of the relevant rules and regulations, they did not adhere to them. They attributed this

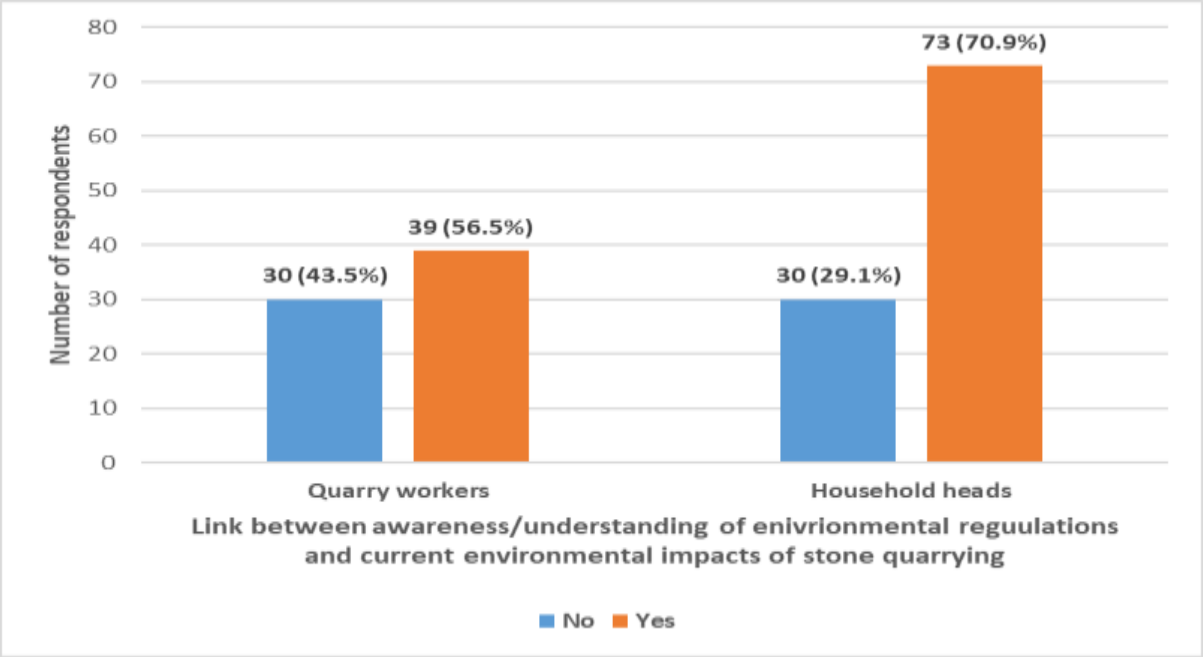
majorly to the fact that the quarry workers were more interested in the income from these activities and did not care about the environment. Furthermore, with little enforcement of these rules and regulation, the quarrying activities were carried out anyhow.

Plate 10: Quarrying very close to households risking lives of homes at the base of the quarries

4.7.6 Linkage between Awareness/Understanding of Environmental Rules and Regulations and Current Environmental Impacts of Stone Quarrying

The respondents were further asked to indicate whether the level of awareness of environmental rules and regulations could be linked to the current environmental impacts of stone quarrying activities witnessed in the study area. The findings are given in Figure 4.20. The study found that 39 (56.5%) of the quarry workers noted that there was a link between the two while the rest, 30 (43.5%) stated that the two were not linked. As for the household heads, 79 (70.9%) observed that there was a linkage between the awareness and understanding of the rules and regulations and the current impacts of the stone quarrying activities on the environment. The rest, 30 (29.1%), noted that there was no connection between the two aspects. These findings imply that most of the respondents in this study believed that there was a connection between the level of awareness or understanding of environmental rules and regulations and the current environmental impacts of stone quarrying in the study area.

The findings support the assertions by Hamza and Kanyama (2016) that the lack of understanding of environmental implications of stone quarrying and the relevant rules to protect the environment among the local community was one of the challenges affecting the ability to mitigate the effects. Adimo, Njoroge and Waweru (2018) observed that in many quarrying areas, large proportions of quarried lands were not restored due to many landowners lacking the awareness of the need to rehabilitate and restore quarried land thus calling for awareness creation and capacity building on quarry restoration procedures.



Source: Field Data (2020)

Figure 4.20: Linkage between Awareness/Understanding of Environmental Rules and Regulations and Current Environmental Impacts of Stone Quarrying

The respondents who noted that the level of awareness of environmental rules and regulations could be linked to the current environmental impacts of stone quarrying activities witnessed in the study area explained that awareness was attributed to less negative impacts on the environment, for instance, minimal abandoned depleted holes since people would be careful not to harm the environment and would seek for ways of rehabilitating the affected area. Similarly, they would not want to suffer any adverse consequences like being fined or jeopardizing their work if restrictions were imposed on quarrying activities. Some also noted that some quarry workers harm the environment due to ignorance or lack of awareness of the stipulated rules and regulations.

Those who found no link between the two aspects argued that even when the quarry workers were aware of the rules and regulations, they did not adhere or comply with them leading to adverse impacts such as massive destruction of vegetation and trees. This was more severe where stone quarrying was the only source of livelihood. Hence, whether one was aware or not of the rules and regulations, they would engage in the quarrying activities irrespective of whether they harmed the environment. Others noted that without enforcement of the rules and regulations by NEMA officials and management committees, the adverse impacts would still be witnessed even when the quarry workers were well aware of them.

4.7.7 Measures to Enhance Residents' Awareness of Environmental Rules and Regulations on Stone Quarrying

The respondents were asked to suggest the measures to enhance awareness levels of relevant environmental rules and regulations relating to stone quarrying among surrounding communities and quarry workers. Both the quarry workers and households unanimously suggested that educational meetings in form of barazas could be used to educate people on the importance of such rules and regulations and the need for adhering to them. Some also suggested training of the quarry workers and community members by NEMA officials in conjunction with expert volunteers on the technical areas of the current rules and regulations especially those that pertain to environmental conservation. Awareness creation and sensitization campaigns by local leaders, NEMA officials and the leadership of quarry workers' associations and committees was also suggested. Enforcement of the rules and regulations by NEMA was also perceived as an adequate measure which could be used so that other quarry workers could learn from the punishment of non-compliant individuals.

4.8 Mitigation Measures

4.8.1 Measures Currently Used to Mitigate the Negative Impacts of Stone Quarrying

The study explored some of the measures currently used to mitigate the negative impacts of stone quarrying on the environment and the society in the study area. The responses of the quarry workers are given in Table 4.16. The findings show that 5 (7.2%) of the quarry workers indicated that the draining of water in abandoned holes was been undertaken, 11 (15.9%) noted that rehabilitation of already quarried areas was being carried out while 23 (33.3%) and 7 (10.1%) cited tree planting and land reclamation as measures being implemented.

The findings also revealed that 8 (11.6%) of the quarry workers pointed out that removing waste rocks was a measure used, 3 (4.3%) noted not digging too deep to reduce animal accidents as a measure in place while 36 (52.2%) and 5 (7.2%) asserted that not quarrying near rivers and in forests and negotiations with surrounding communities in matters likely to lead to conflict were measures that were currently being used. Nonetheless, 14 (20.3%) of the quarry workers argued that there were no tangible measures to mitigate these adverse impacts since the quarrying activities left behind very unproductive lands and nothing could be done on the once quarrying operations stopped.

Table 4.16: Measures used currently to mitigate the Adverse Impacts of Stone Quarrying

Measures	Frequency	Percent
Draining of water in abandoned holes	5	7.2
Rehabilitation of already quarried areas	11	15.9
Tree planting	23	33.3
Land reclamation	7	10.1
Removing waste rocks	8	11.6
Not digging too deep to reduce animal accidents	3	4.3
Not quarrying near rivers and in forests	36	52.2
Negotiations with communities	5	7.2
None	14	20.3

Source: Field Data (2020)

From the household heads' perspective, the measures that were currently being used to mitigate the negative impacts of stone quarrying on the environment and the society in the study area were, the filling of depleted holes, levelling of the quarried land, as well as the

regulation of the quarrying activities by specifying the places where quarrying should take place. However, some decried that nothing tangible was being done except in the cases where quarry workers were being forced to clear dangerous waste rocks since most were more interested in the incomes generated and not the environment.

On their part, the quarry manager from Sangarau noted that they ensured that quarry workers took a glass of milk every day. They also observed that no minors were allowed to get involved in the quarrying activities to avoid school drop outs and that there was a quarry management committee which ensured order in the quarry operations and that cohesion was maintained between the quarry workers and the surrounding communities. According to the quarry manager, for those persons who could work under the influence of alcohol and other drugs which could endanger their lives and that of fellow workers, local authorities were called to take necessary action. The quarry manager further noted that initiatives to plant and protect trees near the rivers were being undertaken. Draining of stagnant water and fencing of deep holes in the area was also being carried out.

The manager from Ketorit asserted that they normally monitor the tonnes of stones carried by the transporting lorries in order to maintain the roads constructed in the area. They also ensured that no quarrying and cutting down of trees was undertaken near rivers. They also argued that the surrounding communities had been encouraged to graze their animals away from the quarry sites and that pipes and pumps had been bought to pump stagnant water that collected in unfilled holes. The quarry managers further pointed out that they encouraged quarry workers to refill holes that had been dug using waste rocks once quarrying operations were completed. Where there was no economic value for the owners, the quarry manager stated that they encouraged them to close the site. Regarding health and safety, the quarry manager noted that there were no measures in place to address the impacts of the stone quarrying activities in the area apart from personal or individual initiatives. They showed regret that no compensation or health insurance was provided to quarry workers despite the risks that they were exposed to.

4.8.2 Suggested Actions to Efficiently Deal with the Challenges linked to Stone Quarrying

The respondents were further asked to suggest the actions that ought to be undertaken to efficiently deal with the social and environmental challenges associated with stone quarrying in the study area. It can be seen in Table 4.17 that all the quarry workers suggested that

rehabilitation of quarried areas through various means such as tree planting and removal of waste rocks was necessary. They noted that removing the waste rocks with the assistance of the county government would allow farming and enhanced tree planting. The findings also show that 21 (30.4%) of the quarry workers noted that it was necessary to enhance the use of protective gears to minimize illnesses among quarry workers by educating them on the need to adorn them in their daily activities.

The findings reveal that 8 (11.6%) of the quarry workers emphasized the need for promoting the use of improved tools and machines by quarry workers, 15 (21.7%) suggested that fencing quarry sites to reduce accidents was crucial while 3 (4.3%) underscored the need for the establishment of settlement areas by the county government far from quarrying sites to reduce conflicts between quarry workers and surrounding communities. The findings further reveal that 19 (27.5%) of the quarry workers were of the view that rules to protect the environment and society should be vigorously enforced by the relevant authorities, 37 (53.6%) suggested that the county government along with local leaders and volunteers should educate residents on how to use the monies earned from stone quarrying activities in the area to improve their economic and social wellbeing while 10 (14.5%) noted that it was important for quarry workers association's leadership to hold regular meetings with surrounding communities to reach consensus in matters likely to lead to conflicts between the two parties.

Table 4.17: Actions to Efficiently Deal with the Challenges linked to Stone Quarrying as Suggested by Quarry Workers

Measures	Frequency	Percent
Rehabilitation of quarried areas through tree planting, removal of waste rocks etc.	69	100.0
Enhance use of protective gear by educating quarry workers	21	30.4
Promote use of improved tools and machines by quarry workers	8	11.6
Fencing quarry sites to reduce accidents	15	21.7
Establishment of settlement areas far from quarrying sites to reduce conflicts between communities and quarry workers	3	4.3
Enforcing rules to protect the environment and society	19	27.5
Educating people on how to use the monies earned to improve their economic and social well being	37	53.6
Quarry workers' association leadership to hold regular meetings with surrounding communities to reach consensus in matters likely to lead to conflicts	10	14.5

Source: Field Data (2020)

Table 4.18 summarizes the actions to efficiently deal with the social and environmental challenges associated with stone quarrying in the study area as suggested by the household heads. The findings show that 8 (7.8%) of the household heads suggested the permanent closure of quarry sites where alternative sources of income were available since the negative impacts of the activities on the environment and society was inevitable. Those who called for clear boundaries to avoid conflicts between quarry workers and surrounding communities and the rehabilitation of quarried areas or land reclamation with the help of county government were 30 (29.1%) and 99 (96.1%) respectively. The findings also showed that 26 (25.2%) of the household heads emphasized on the fencing quarrying sites, 33 (32.0%) called for implementation of programmes to educate people on the need for protecting the environment and society by NEMA, county and local leadership and other volunteers while 5 (4.9%) of the household heads noted that it was important for all levels of government to implement measures likely to provide alternative livelihood sources for communities in the area.

Table 4.18: Actions to Efficiently Deal with the Challenges linked to Stone Quarrying as Suggested by Household Heads

Measures	Frequency	Percent
Closing the quarry sites entirely where other sources of income were available	8	7.8
Clear boundaries to avoid conflicts between quarry workers and surrounding communities	30	29.1
Rehabilitation of quarried areas/land reclamation with the help of county government	99	96.1
Fencing quarrying sites	26	25.2
Programmes to educate people on the need for protecting the environment and society	33	32.0
County government to implement measures likely to provide alternative livelihood sources for communities in the area	5	4.9

Source: Field Data (2020)

4.9 Hypothesis Testing

4.9.1 Stone Quarrying and the Social Wellbeing of Residents at Tuluongoi Sub-Location, Baringo County

The study sought to test the following null hypothesis;

> *$H0_1$: There is no significant relationship between stone quarrying and the social wellbeing of residents in Tuluongoi Sub-location.*

To achieve this, a Chi-square test was conducted. Cross tabulation analysis between different parameters of stone quarrying and different aspects of the social wellbeing was carried out. The test was conducted based on the data obtained from the quarry workers. In the analysis of the relationship between the hours spent in stone quarrying activities and quarry workers suffering any health and safety condition related to stone quarrying, a Chi-square statistic of (χ^2=13.676a, p= 0.001) was yielded. The computed p-value of 0.001 was less than 0.05. This finding implied that there was a significant relationship between the hours spent in stone quarrying and exposure to bad health and safety conditions associated with stone quarrying which was a measure of the social wellbeing of residents at Tuluongoi Sub-location, Baringo County. The findings reveal that the number of quarry workers who indicated that they had been exposed to bad health and safety conditions associated with stone quarrying was reported at 82.2% and 94.1% when the hours spent in stone quarrying were 6-8 hours and over 8 hours respectively compared to 28.6% when the time spent on stone quarrying was 3-5 hours. These findings agreed with the argument by Mu'awiyyah and Ogunleye (2012) that long workhours meant long exposure time to occupational health and safety hazards at the quarrying site and where the operations were carried out manually, requiring more energy and time to do the same thing, a higher proportion of accidents was reported.

Table 4.19: Time Spent in Stone Quarrying and Exposure to Related Health and Safety Conditions

		Suffered any health and safety condition resulting from stone quarrying				
Stone quarrying		**No**	**Yes**	**Total**	**χ^2**	**p-value**
		n; (%)	**n; (%)**	**n; (%)**		
Hours spent in stone quarrying activities	3-5 hours	5; 71.4	2; 28.6	7; 10.1	13.676a	0.001
	6-8 hours	8; 17.8	37; 82.2	45; 65.2		
	Over 8 hours	1; 5.9	16; 94.1	17; 24.6		
Total		14; 20.3	55; 79.7	69; 100.0		

Source: Field Data (2020)

The study also established that the period of engagement in stone quarrying activities and treatment for stone quarrying related ailments in the past 6 months were significantly related as illustrated by a Chi-square statistic of (χ^2=10.815a, p= 0.029). The findings show that the number of quarry workers seeking for treatment for stone quarrying related ailment in the past 6 months was higher at 81.8% for those who had engaged in stone quarrying activities for over 20 years compared to those who had engaged in these activities for less than a year. These study results agreed with those of Singh et al. (2007) which showed that increased length of working in quarrying sites was a major factor that predisposed or made quarry workers more susceptible to contracting ailments such as respiratory problems and impaired lung function. This previous study noted that exposure duration of more than 15 years was associated with silicosis and many more respiratory problems among stone quarry workers. The findings however, contradicted that of Isara, Adam, Aigbokhaode, and Alenoghena (2016) who found that the prevalence of stone quarrying related diseases was higher among quarry workers who had worked for a duration of 1 - 5 years in the quarries, arguing that the workers who had worked for a longer duration in the quarries would have developed tolerance to the effect of quarry dust and other hazards over time.

Table 4.20: Period of Engagement in Stone Quarrying and Treatment for Stone Quarrying Related Ailments in the past 6 Months

		Treated for stone quarrying related ailment in the past 6 months				
		No	**Yes**	**Total**	**χ^2**	**p-value**
Stone quarrying		**n; (%)**	**n; (%)**	**n; (%)**		
Period of engagement in stone quarrying activities	Less than a year	7; 77.8	2; 22.2	9; 13.0	10.815a	0.029
	1 to 5 years	17; 65.4	9; 34.6	26; 37.7		
	6 to 10 years	8; 40.0	12;60.2	20; 29.0		
	11 to 15years	1; 33.3	2; 66.7	3; 4.3		
	Over 20years	2; 18.2	9; 81.8	11;15.9		
Total		35; 50.7	34; 49.3	69;100.0		

Source: Field Data (2020)

It was also noted that there was a significant relationship between the control of stone quarrying activities and children involvement in stone quarrying activities as shown by Chi-square statistic of (χ^2=3.913a, p= 0.048). The number of quarry workers aware of children involved in stone quarrying activities in the study area was higher at 75.0% where there where stone quarrying activities were uncontrolled compared to 49.0% where the activities were controlled. The findings compare to that of Ata-Era (2016) who found that it was quite

common to find children of school going age heavily engaged in stone quarrying illegally in order to earn money for their families.

Table 4.21: Control of Stone Quarrying and Children Involvement in Stone Quarrying

		Aware of children involvement in stone quarrying activities				
		No	Yes	Total		
Stone quarrying		**n; (%)**	**n; (%)**	**n; (%)**	**χ^2**	**p-value**
Availability of measures to control the stone quarrying activities	No	5; 25.0	15;75.0	20; 29.0	3.913a	0.048
	Yes	25; 51.0	24;49.0	49; 71.0		
Total		30; 43.5	39; 56.5	69; 100.0		

Source: Field Data (2020)

Similarly, a significant relationship was observed between the control of stone quarrying at Tuluongoi Sub-location, Baringo County and displacement of surrounding communities as demonstrated by a Chi-square statistic of (χ^2=4.947a, p= 0.026) that was yielded. The number of quarry workers who noted that there was displacement of the communities surrounding the quarrying sites was higher at 80.0% where stone quarrying in the area was uncontrolled compared to where the operations were controlled at 51.0%. According to Nyakeniga (2009), there is a need for both the government and the community where stone quarrying is done, to come up with decisions and even resources to control stone quarrying activities so that these operations do not pose a danger to the surrounding communities, the lives of quarry workers and even the related negative impacts to the environment.

Table 4.22: Control of Stone Quarrying and Displacement of Surrounding Communities

		Displacement of surrounding communities				
		No	Yes	Total		
Stone quarrying		**n; (%)**	**n; (%)**	**n; (%)**	**χ^2**	**p-value**
Availability of measures to control the stone quarrying activities	No	4; 20.0	16; 80.0	20;29.0	4.947a	0.026
	Yes	24; 49.0	25;51.0	49;71.0		
Total		28; 40.6	41; 59.4	69; 100.0		

Source: Field Data (2020)

The study observed a significant relationship between the impact level of stone quarrying methods used and the development of cracks in the buildings and structures of communities surrounding the quarries considered in this study. This was illustrated by a Chi-square statistic of (χ^2=11.382a, p= 0.010) that was obtained. The number of quarry workers who

noted that there were reported cases of cracks developing in the buildings and structures of surrounding communities was higher at 65.5% and 61.5% where the impact of the methods used was destructive and very destructive respectively compared to where the methods had little impact or no impact at 31.8% and 0.0% respectively. The findings are in line with the observations by Saraya (2016) that rock blasting caused ground vibration affecting the comfort and stability of homes of people living close to the quarrying sites where cracks on the floors and walls of homes and other infrastructural facilities often occurred to different degrees.

Table 4.23: Impact Level of Stone Quarrying Methods used and Development of Cracks in Buildings and Structures of Surrounding Communities

Stone quarrying		Development of cracks in buildings and structures of surrounding communities				
		No	Yes	Total		p-value
		n; (%)	n; (%)	n; (%)	χ^2	
Impact level of the methods used in stone quarrying activities	Do not have any impact	5; 100.0	0; 0.0	5; 7.2	11.382a	0.010
	Little impact	15; 68.2	7; 31.8	22; 31.9		
	Destructive	10; 34.5	19; 65.5	29; 42.0		
	Very destructive	5; 38.5	8; 61.5	13; 18.8		
Total		35; 50.7	34; 49.3	69; 100.0		

Source: Field Data (2020)

It was also established that there was a significant relationship between the impact level of the stone quarrying methods used by quarry workers at Tuluongoi Sub-location, Baringo County and the cases of tension/conflict between the quarry workers and the surrounding communities given a Chi-square statistic of (χ^2=12.711a, p= 0.005). The findings show that the number of quarry workers who indicated that there had been reported cases of tension/conflict between the quarry workers and the surrounding communities was higher at 69.0% and 76.9% where the impact of the methods used was destructive and very destructive respectively compared to where the methods had little impact or no impact at 40.9% and 0.0% respectively. These findings supported that of Nwachukwu et al. (2017) who noted that while quarrying companies and government benefitted from quarrying activities, host communities suffered from the negative impacts which had led to persistent conflicts between the quarry operators and the host communities and that, the common conflicts revolved around self-determination and resource control, land use compensation, infrastructural development, pollution and land degradation and reclamation.

Table 4.24: Impact Level of Stone Quarrying Methods used and Tension/Conflict between the Quarry Workers and Surrounding Communities

Stone quarrying		Tension/conflict between the quarry workers and the surrounding communities				
		No	Yes	Total		p-value
		n; (%)	n; (%)	n; (%)	χ^2	
Impact level of the methods used in stone quarrying activities	Do not have any impact	5; 100.0	0.00	5; 7.2	12.711a	0.005
	Little impact	13; 59.1	9; 40.9	22; 31.9		
	Destructive	9; 31.0	20; 69.0	29; 42.0		
	Very destructive	3; 23.1	10; 76.9	13; 18.8		
Total		30; 43.5	39; 56.5	69; 100.0		

Source: Field Data (2020)

From these findings, it can be deduced that stone quarrying and the social wellbeing of residents at Tuluongoi Sub-location, Baringo County were significantly related. It was on this basis that the null hypothesis that there was no significant relationship between stone quarrying and the social wellbeing at Tuluongoi Sub-location, Baringo County was rejected, an indication that there was a significant relationship between stone quarrying and the social wellbeing of residents at Tuluongoi Sub-location, Baringo County. The findings supported the views of Endalew, Tasew, and Tolahun (2019) that stone quarrying activity often had significant short and long-term social impacts.

4.9.2 Stone Quarrying Activities and the Environmental Degradation witnessed in Tuluongoi Sub-location, Baringo County

The study also explored whether environmental degradation witnessed at Tuluongoi Sub-location, Baringo County was associated with stone quarrying activities in the area. To this end, the following null hypothesis was tested;

> *$H0_2$: Stone quarrying has no significant contribution to environmental degradation in Tuluongoi Sub-location.*

Chi-square tests were conducted to determine whether there was relationship between different indicators of stone quarrying and various aspects of environmental degradation so that the researcher could determine if stone quarrying significantly contributed to the environmental degradation in Tuluongoi Sub-location. As illustrated by the results presented in Table 4.25, planning of stone quarrying activities and the nature of damage to the physical

environment at Tuluongoi Sub-location, Baringo County were significantly related given a Chi-square statistic of (χ^2=14.749a, p= 0.001). The findings showed that the number of quarry workers who indicated that the damage to the physical environment was irreparable were higher at 53.3% where stone quarrying in the area was unplanned compared to where the activities were planned at 14.7%. Similarly, the number of quarry workers who noted short term damage to the physical environment in the study area were higher at 54.2% where stone quarrying activities were organized compared to where the activities were unorganized or unplanned. These findings were consistent with the recommendations by Endalew, Tasew, and Tolahun (2019) that the planning of quarrying operations was necessary because with careful planning it was possible to minimize or control the adverse effects of stone quarrying in many cases.

Table 4.25: Planning of Stone Quarrying and Nature of Damage to the Physical Environment

Stone quarrying		**Nature of damage to the Physical Environment**					
		Short term	**Long term**	**Irreparable**	**Total**		**p-value**
		n; (%)	**n; (%)**	**n; (%)**	**n; (%)**	**χ^2**	
Organization of stone quarrying activities	Planned/ organized	13; 54.2	7; 29.2	4; 14.7	24; 34.8	14.749a	0.001
	Unplanned/ unorganized	6; 13.3	15; 33.3	24; 53.3	45; 65.2		
Total		19; 27.5	22; 31.9	28; 40.6	69; 100.0		

Source: Field Data (2020)

Pertaining to the relationship between the impact level of stone quarrying methods and the severity of suffering from the negative environmental impacts of stone quarrying, a Chi-square statistic of (χ^2=24.609a, p= 0.000) was yielded. Thus, a significant relationship between the two variables was noted. The results demonstrated that the quarry workers who indicated that the suffering from the negative environmental impacts of stone quarrying was very severe was higher where the impact of the methods used in stone quarrying activities were found to be very destructive at 61.5% compared to where the methods did not have any impact at 0.0%. The findings agree with that of Uglow (1999) who found that the effects of stone quarrying can be severe if the screening of current operations and the restoration of quarried areas is not undertaken. The findings are in agreement with those of Baah-Ennumh, Yeboah, and Akularemi (2019) who argued that depending on the method used in stone quarrying, there would be little or a high potential negative effect on the environment as well

as the lives of those living around the quarry sites and that most countries were embracing rules to restrain the adverse impact of quarrying activities.

Table 4.26: Impact Level of Stone Quarrying Methods and the Severity of Suffering from the Negative Environmental Impacts of Stone Quarrying

Stone quarrying		Severity of Suffering from the Negative Environmental Impacts of Stone Quarrying					
		Not severe	Somehow severe	Very severe	Total		p-value
		n; (%)	n; (%)	n; (%)	n; (%)	χ^2	
Impact level of the methods used in stone quarrying activities	Do not have any impact	5; 100.0	0; 0.0	0; 0.0	5; 7.2	24.609a	0.000
	Little impact	16; 72.7	5; 22.7	1; 4.5	22; 31.9		
	Destructive	10; 34.5	7; 24.1	12; 41.4	29; 42.0		
	Very destructive	1; 7.7	4; 30.8	8; 61.5	13; 18.8		
Total		32; 46.4	16; 23.2	21; 30.4	69; 100.0		

Source: Field Data (2020)

The study further found that there was a significant relationship between the level of effectiveness of stone quarrying methods used in promoting proper management of quarries for environmental and social sustainability and the level of **s**everity of suffering from the negative environmental impacts of stone quarrying as supported by a Chi-square statistic of (χ^2=10.079a, p= 0.039) that was computed. It was found that the number of quarry workers who found the suffering from the negative environmental impacts of stone quarrying as very severe for instance, was higher at 50.7% where the methods used were not effective at all compared to where the methods were very effective at 11.6%. The findings supported that of Darwish et al. (2011) who found that with proper management, many of the negative effects of stone quarrying can be minimized or controlled since order in resource exploitation is achieved.

Table 4.27: Management of Quarries for Environmental Sustainability and the Severity of Suffering from the Negative Environmental Impacts of Stone Quarrying

Stone quarrying		Severity of Suffering from the Negative Environmental Impacts of Stone Quarrying					
		Not severe	Somehow severe	Very severe	Total		p-value
		n; (%)	n; (%)	n; (%)	n; (%)	χ^2	
Effectiveness of stone quarrying methods used in promoting proper management of the quarries for environmental and social sustainability	Not effective at all	11; 31.4	9; 25.7	15; 42.9	35; 50.7	10.079a	0.039
	Somehow effective	14; 53.8	6; 23.1	6; 23.1	26; 37.7		
	Very effective	7; 87.5	1; 12.5	0; 0.0	8; 11.6		
Total		32; 46.4	16; 23.2	21; 30.4	69; 100.0		

Source: Field Data (2020)

From these findings, it was inferred that stone quarrying has a significant contribution to environmental degradation witnessed at Tuluongoi Sub-location, Baringo County. Thus, the null hypothesis that stone quarrying has no significant contribution to environmental degradation witnessed in Tuluongoi Sub-location was rejected, an indication that stone quarrying in the area was associated with the environmental degradation observed in the area. The findings were consistent with the conclusion by Nwachukwu, Ojeaga, and Chinelo (2018) that quarry activities considerably resulted in environmental degradation and could be described as an unsustainable practice.

4.9.3 Awareness of Environmental Rules and Regulations on Stone Quarrying and Environmental Degradation witnessed at Tuluongoi Sub-location, Baringo County.

In order to examine the link between awareness of environmental rules and regulations on stone quarrying and environmental degradation witnessed at Tuluongoi Sub-location, Baringo County, the following null hypothesis was specified and tested;

> *$H0_3$: Awareness of environmental rules and regulations on stone quarrying has no significant influence on environmental degradation experienced in Tuluongoi Sub-location.*

Chi-square test was conducted to assist in testing this hypothesis. The findings reveal that awareness of environmental rules and regulations on stone quarrying has a significance influence on environmental degradation experienced in Tuluongoi Sub-location as demonstrated by a Chi-square statistic of (χ^2=15.665a, p= 0.000). According to these findings, the number of quarry workers who noted that the suffering from the negative environmental impacts of stone quarrying activities in the study area was very severe was higher at 85.7% where quarry workers were not aware of environmental rules and regulations on stone quarrying compared to where these quarry workers were aware of the rules and regulations at 14.3%. These findings therefore, called for the rejection of the null hypothesis that awareness of environmental rules and regulations on stone quarrying has no significant influence on environmental degradation witnessed at Tuluongoi Sub-location, Baringo County. Thus, it was inferred that the awareness of environmental rules and regulations on stone quarrying significantly influenced environmental degradation witnessed in the study. Hamza and Kanyama (2016) that the lack of an understanding of environmental implications of stone quarrying and the relevant rules to protect the environment among the local community was one of the challenges affecting the ability to mitigate the effects.

Table 4.28: Awareness of Environmental Rules and Regulations on Stone Quarrying and Environmental Degradation

Stone quarrying		**Awareness of Environmental Rules and Regulations on Stone Quarrying**				
		No	**Yes**	**Total**	**χ^2**	**p-value**
Severity or harshness of the suffering from the negative environmental impacts of stone quarrying activities in the area	Not severe	10; 31.2	22; 68.8	32; 46.4	15.665a	0.000
	Somehow severe	10; 62.5	6; 37.5	16; 23.2		
	Very severe	18; 85.7	3; 14.3	21; 30.4		
Total		38; 55.1	31; 44.9	69;		

Source: Field Data (2020)

CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

In this chapter, the major findings of the study are summarized, the conclusions drawn highlighted and recommendations for practice, policy and further research provided. This is carried out in accordance with the specific objectives of the study.

5.2 Summary of Findings

This study's main objective was to establish the social and environmental effects of stone quarrying in Tuluongoi Sub location, Tenges Division, Baringo County. The study found that men mainly undertook stone quarrying activities in the area while women were mainly engaged in marketing and selling the quarried stones. Where possible, some women employed men to carry out the activities on their behalf. The study also established that stone quarrying in the study area was undertaken largely by the youthful persons who had either obtained education up to the primary or secondary level. This was attributed to the observation that stone quarrying activities did not require advanced abilities or skills. It was also established that quarry workers in the study area were family men as a large proportion were married; their average monthly earnings from these activities ranged from KSh. 10,000 to 50,000. The majority of the quarry workers were found to be residents of the study area and that stone quarrying had attracted quite a considerable number of migrants.

The assessment of the stone quarrying activities in the three quarries considered in this study revealed that most of the households in the Sub-location had at least one member working in these quarries. The major factors that drove individuals to engage in stone quarrying were searching for a source of income or livelihood as many were unemployed, poverty, and lack of alternative sources of income/livelihood since farming was not sustainable. The establishment of quarries in the sub-location was informed mainly by the presence of the required building rocks. The fact that stone quarrying was the only alternative source of livelihood for residents, and that the land in the area was unproductive for agriculture. The increase in demand for building rocks was also considered as a major factor for the setting up of these quarrying sites.

It was observed that a large proportion of the quarry workers had engaged in stone quarrying for a significant time and that a majority of them spent 6 or more hours a day in carrying out these activities. Stone quarrying activities in the area were carried out majorly using hand tools, and in a few cases, blasting was used. A majority of the quarry workers took part in digging or excavating the stones. Other activities undertaken by the quarry workers included wedging, crushing/breaking of stones, blasting, grinding, heating of the stones, disposal of waste rocks, and loading stones to vehicles. Others engaged in the exploration, arranging the stones and in removing dust from the stones.

From the perspective of a large proportion of the respondents, the stone quarrying activities in the considered quarries were unplanned or unorganized. The majority of the quarry workers had received informal training on quarrying-related operated and handling of the tools. Nevertheless, the training received was not considered adequate in promoting proper and sustainable stone quarrying activities, as noted by a majority of the household heads. The findings revealed that a majority of the quarry workers in the area did not adorn protective gear when carrying out their operations. Only a few were using gas masks, gloves, and gumboots, which were also largely considered not efficient in protecting them when undertaking the activities.

Overall, a large proportion of the respondents argued that some measures were in place to control stone quarrying activities in the study area. While some found the measures to be somehow or very efficient, a considerable number noted that the existing measures were not efficient at all. The measures available were mainly steered by committees formed to control quarry operations. According to the respondents who found the control measures in place inefficient, the committee members did not pay much attention to the environment. At times, they did not adhere to or enforce the rules they set to ensure that stone quarrying activities were adequately controlled.

The study further noted that the stone quarrying methods used in the area were largely not effective in promoting proper quarry management for environmental and social sustainability. The argument behind this finding was that majority of the quarry workers were more interested in the benefits drawn from the quarries at the expense of the environment and left the waste unattended to. Many, especially those who were temporarily employed in the quarries, did not care about the impacts of their activities on the community or the environment. Regarding the nature of the impact of methods used in stone quarrying

activities in the study area, it was observed that a large proportion of the respondents found these methods destructive even though considerable other noted that the methods had little impact since only simple tools were used. Quarry workers' commitment to the acquisition of modern stone quarrying tools and techniques that would promote efficient stone quarrying operations in the area was found to be low.

5.2.1 Social Effects of Stone Quarrying in Tuluongoi Sub location, Tenges Division

The first objective of the study was to examine the social effects of stone quarrying in Tuluongoi Sub location, Tenges Division, Baringo County. The study observed that many respondents considered stone quarrying activities in the area a health and safety hazard not only for the quarry workers but also for the local residents. Nearly half of the household heads noted that at least one member of their household had suffered from ailments that were linked to the stone quarrying operations in the area. Some of the affected household members had sought treatment for such diseases 2 to 3 times, and some even more than 3 times within the last one year. Some of the ailments the household members had sought treatment for included fatal accidents, chest problems, hearing problems, Malaria, respiratory infections (such as coughs, pneumonia), and physical injuries requiring medical treatment.

As for the quarry workers, slightly more than half of them indicated that once in a while or more often visited hospitals for treatment of ailments caught while working in the quarries under study while more than 70 percent of these quarry workers indulged in self-medication to treat such ailments. The study observed that nearly 60 percent of the sampled quarry workers had sought treatment for ailments related to stone quarrying in the past 6 months once; some had been treated 2 to 3 times while others were treated more than 3 times. The ailments for which the quarry workers had sought treatment for included fatal accidents, headache/fever, eye problems, skin irritation, chest problems, Malaria, muscle pains, respiratory infection, and physical injuries that required medical treatment. The study further established that there had been reported cases of death within the quarries under study.

The study confirmed that, to some extent, children were involved in stone quarrying activities in the study area. While some of the respondents believed that children's involvement in stone quarrying had no effect on school enrolment, others argued that this trend had led to increased numbers of school dropouts and absenteeism, which was linked to poor performance. Those who noted that school enrolment had not been affected observed that children worked in these quarries during weekends and holidays and were mainly involved in

loading the stones on lorries to keep them busy and get some money for upkeep and support the parents in paying for school fees.

It was also noted that stone quarrying in the study area had led to the displacement of surrounding communities to some extent. Due to rolling stones, those households at the base of the quarries were forced to relocate to other areas. Others moved due to the discomfort arising from noise and dust pollution, cracks, loss of grazing land, and the destruction of the area's scenic value. Generally, stone quarrying activities in the three quarries were found to have supported the provision of social amenities such as clinics, schools, and boreholes, which improved the social wellbeing of the surrounding communities as indicated by nearly 70 percent of the household heads.

The study found that there were reported cases of development of cracks in the buildings and structures of the residents linked to stone quarrying. Such cases had been noted mostly in places where blasting and intensive quarrying was taking place. In such incidences, cracks that were small in size progressed to huge cracks that endangered the lives of residents and their properties. In other cases, these cracks led to the accumulation of water in houses and toilets, which eventually sunk. It was also noted that stone quarrying activities in the study area had led to some level of migration and quarrying villages around the community. Cases of conflict between the quarry workers and surrounding communities were also reported, and these were attributed mainly to boundary disputes regarding where quarrying activities should be confined to. The associated impacts include the destruction of farms, noise and development of cracks in the surrounding buildings, quarrying too close to homes, mass wastage and landslides, falling stones, destroyed fences, and blockage of animal pathways. The study found that the chi-square tests conducted showed that stone quarrying and the social wellbeing of residents at Tuluongoi Sub-location, Baringo County were significantly related.

5.2.2 Environmental Effects of Stone Quarrying in Tuluongoi Sub location, Tenges Division

The second objective of the study was to establish the effects of stone quarrying on the physical environment in Tuluongoi Sub location, Tenges Division, Baringo County. Overall, it was established that stone quarrying activities in the Sub location had adverse effects on the physical environment in the study area. Only about 10 percent of the respondents observed some positive effects of these activities on the environment, citing that these activities had

flattened some previously hilly areas, reduced the habitation of harmful snakes in the area, while others noted that part of the land that had remained unexploited for a long time had been put into uses. Others reported the emergence of certain tree species that were growing in the quarries and that the activities had encouraged the planting of trees in previously neglected areas.

The majority of the respondents indicated that they had observed damage to the physical environment due to stone quarrying activities in the area. The damage observed ranged from short-term damage to irreparable damage, and according to most of the respondents, the observed damage occurred mainly on a daily basis. The responses given pertaining to the severity or harshness of the suffering from the negative environmental impacts of stone quarrying activities in the study area were varied as some respondents believed that the suffering was not severe, others argued that the severity was moderate while others found the suffering to be very severe. The leading damages to the physical environment as highlighted by the quarry workers were the destruction of original vegetation cover and crops, loss of aesthetic value, permanent alteration of original landform, land degradation, as well as the loss of topsoil and disruption of animal habitats. Other damages observed by the quarry workers were soil erosion and river siltation, noise pollution and vibration, dust pollution, accumulation of water in abandoned pits, contaminated water resources, alteration of watercourses, landslides, and mass wasting and presence of abandoned holes and stone waste.

Based on the household heads' views, the study established that intensified quarrying activities in the area had led to the clearing of indigenous trees and other plants. Crops that were originally planted in the areas could not survive, and that animal fodder was no longer available. Pertaining to the atmosphere, minimal to intense noise and dust pollution had been witnessed. Noise pollution was attributed to blasting activities and was more intense where households lived very close to the quarries. The noise and vibration from such blasting activities scared small children and cattle. The vibrations led to the development of cracks in buildings and structures, while dust pollution that was witnessed in the dry seasons led to poor air quality and visibility. The findings revealed that stone quarrying activities had greatly destroyed the area's aesthetic value and that residents no longer found the area attractive. This was attributed to the huge piles of waste rocks that had been left unattended to, abandoned holes, cleared vegetation, and massive erosion coupled with the flattening of hilly areas.

The study observed that the major effects of stone quarrying on landscape, land stability, and topsoil took massive soil erosion, regular landslides, and changed the landscape. The soil erosion witnessed in the area was linked to loose soil since there were no stones left to hold it together, and during rainy seasons, the soil was swept away more so along the river banks. Weakened land resulted in landslides, and the flattening of the hilly areas completely changed the study area's landscape. The main effect of stone quarrying activities on water resources was increased water contamination, coupled with changed watercourses and dried up rivers. The water contamination was linked to siltation, which resulted from soil erosion, which impacted the water uses. Dried up rivers meant that some residents could no longer easily access water for their daily uses.

The majority of the household heads indicated that stone quarrying activities in the area had altered the original landform and use. It was highlighted that grazing lands had become rocky, leading to injuries for their cattle, agriculture was no longer viable, that hills in the area had been flattened, and that the land was full of humps of waste from quarrying activities. As stated by some of the household heads, open pits acted as water points during rainy seasons, while others asserted that some idle land was now being put to use. It was also noted that the presence of abandoned unfilled holes after the closure of quarrying activities became breeding sites for mosquitoes during the rainy seasons and during the dry seasons due to the accumulation of water in them. Stone quarrying activities in the study areas were further found to have decreased land size, especially where waste stones were illegally pushed into other people's lands. Overall, the study found that stone quarrying has a significant contribution to environmental degradation witnessed at Tuluongoi Sub-location, Baringo County.

5.2.3 Awareness of Environmental Rules and Regulations on Stone Quarrying

The third objective of the study was to determine the level of awareness of environmental rules and regulations governing stone quarrying among residents and quarry workers in Tuluongoi Sub location, Tenges Division, Baringo County. The study findings revealed that even though a number of the quarry workers and the household heads were aware of at least one environmental rule and regulation regarding stone quarrying, their comprehension of the requirements of the rules and regulation was not adequate as only a few quarry workers observed that their understanding of the current environmental rules and regulations was good.

Some of the rules that the quarry workers said they were aware of include; the requirement not to destroy vegetation, trees when quarrying; that after quarrying, the land ought to be reclaimed; that they should not dig more than eight feet deep; that they were prohibited from quarrying near water sources and to avoid siltation; that rehabilitation of quarries and filling up of holes was necessary and that they needed to use environmentally friendly tools. They also asserted that they were aware that planting trees should be undertaken after quarrying. They were supposed to limit noise and vibration from their activities and could not quarry in the forest and hills.

As for the household heads, they cited that they were aware that they were not to destroy vegetation or cut trees when quarrying, that they were not to quarry near water catchment areas, and that depleted holes needed to be filled after quarrying activities. When presented with various statements that related to environmental rules and regulations, it was established that a majority of the quarry workers and the household heads were not aware that an environmental impact assessment should be performed before quarrying in a given place. Also, they were unaware that all quarry sites must be fenced; that depleted quarries should be rehabilitated by the landowners or quarry owners, and all persons working at the quarry sites should be provided with protective gear and first aid kits. Moreover, quarrying operations should be done 50m away from homes, and warning signs should be erected at each quarry site's entry point.

Further investigation revealed that stone quarrying activities in the study area were not carried out strictly as per the relevant environmental rules and regulations, as argued by most of the respondents. While some rules were being followed, most of them were ignored by the quarry workers, while others adhered to these rules when they were forcefully compelled to. It was argued by most of the quarry workers that even where quarry workers were aware of the relevant rules and regulations, they did not adhere to them. This behaviour was mainly linked to the fact that most of these quarry workers were more interested in the income from these activities and did not care about the environment. Furthermore, with little enforcement of these rules and regulations, the quarrying activities were carried out anyhow.

Regarding whether there was a linkage between the awareness/understanding of environmental rules and regulations and the current environmental impacts of stone quarrying, a large proportion of the respondents noted that the two were linked. It was underscored that awareness of these rules and regulations was linked to less negative impacts

on the environment and that quarry worker would be careful not to harm the environment besides seeking for ways of rehabilitating the affected area. Others did not want to suffer any adverse consequences like being fined or risk losing their source of livelihoods. It was also argued that some quarry workers harmed the environment due to ignorance or unawareness of stipulated rules and regulations. Those of a contrary view underscored that even when the quarry workers were aware of the rules and regulations, they did not adhere to or comply with them, thus the adverse environmental effects witnessed in the area. Others observed that without enforcement of the rules and regulations by NEMA officials and management committees, the adverse impacts would still be witnessed even when the quarry workers were well aware of them.

Measures to enhance the level of awareness of environmental rules and regulations among surrounding communities and quarry workers, as suggested by the respondents, included the setting up of educational meetings where people could be educated about the requirements of the various rules and regulations and the need for compliance or adherence to them combined with awareness creation and sensitization campaigns by local leaders, NEMA officials and the leadership of quarry workers' associations and committees. Enforcement of the rules and regulations by NEMA was also perceived as an adequate measure that could be used so that other quarry workers could learn from the punishment of non-compliant individuals. It was further discovered that the awareness of environmental rules and regulations on stone quarrying has a significant influence on environmental degradation experienced at Tuluongoi Sub location, Tenges Division, Baringo County.

5.2.4 Measures to Mitigate the Negative Social and Environmental Effects of Stone Quarrying

The study also sought to suggest measures to mitigate the negative social and environmental effects of stone quarrying in Tuluongoi Sub location, Tenges Division, Baringo County. The study found that the draining of water in abandoned holes, rehabilitation of already quarried areas, tree planting, land reclamation, removing waste rocks, not digging too deep to reduce animal accidents, not quarrying near rivers and in forests, and holding negotiations with communities were the measures currently used to mitigate the adverse effects of stone quarrying on the physical environment and the society in the study area as highlighted by the quarry workers. From the perspective of the household heads, the current measures in place were the filling of depleted holes, levelling of the quarried land, as well as the regulation of

the quarrying activities by specifying the places where quarrying should take place. Nevertheless, some of the household heads decried that nothing tangible was being done currently to mitigate these effects except in the cases where quarry workers were forced to clear dangerous stone waste.

From the responses given by the quarry managers, the quarry manager from Sangarau noted that they ensured that quarry workers took a glass of milk every day and cases where some worked under the influence of alcohol and other drugs which could endanger their lives and that of fellow workers, local authorities were called to take necessary action. The quarry manager also noted that there was a quarry management committee which ensured order in the quarry operations and that cohesion was maintained between the quarry workers and the surrounding communities. The quarry manager further noted that initiatives to plant and protect trees near the rivers were being undertaken. Draining of stagnant water and fencing of deep holes in the area was also being carried out.

The other manager interviewed stated that the tonnes of stones carried by the transporting lorries were normally monitored, and they also ensured that no quarrying and cutting down of trees was undertaken near rivers. They also argued that the surrounding communities had been encouraged to graze their animals away from the quarry sites and that pipes and pumps had been bought to pump stagnant water that collected in unfilled holes. Attempts were made to encourage quarry workers to refill holes that had been dug using waste rocks once quarrying operations were completed. Where there was no economic value for the owners, the quarry manager stated that they encouraged them to close the site. As it pertains to the health and safety, the quarry manager noted that there were no measures in place to address the impacts of the stone quarrying activities in the area apart from personal or individual initiatives. They showed regret that no compensation or health insurance was provided to quarry workers despite the risks that they were exposed to.

The actions to efficiently deal with the social and environmental challenges associated with stone quarrying as suggested by the quarry workers included the rehabilitation of quarried areas through tree planting, removal of waste rocks, enhanced use of protective gear by educating quarry workers, promotion of the use of improved tools and machines by quarry workers and fencing quarry sites to reduce accidents. They also suggested establishing settlement areas far from quarrying sites to minimize conflicts between communities and quarry workers, enforcement of rules to protect the environment and society besides educating area residents on how to use the monies earned to improve their economic and

social wellbeing. The quarry workers also suggested that quarry workers' association leadership needed to hold regular meetings with surrounding communities to reach consensus in matters likely to lead to conflicts.

On their part, the household heads suggested that it was necessary to close the quarry sites entirely if other sources of income were available; that clear boundaries to avoid conflicts between quarry workers and surrounding communities needed to be demarcated, and that rehabilitation of quarried areas/land reclamation with the help of county government was crucial. They also suggested the fencing of quarrying sites, initiation of programmes to educate people on the need for protecting the environment and society, and that county government ought to implement measures likely to provide alternative livelihood sources for communities in the area.

5.3 Conclusions

Based on the study findings, it was concluded that stone quarrying in Tuluongoi Sub location, Tenges Division, Baringo County was quite intensive due to the long hours spent by quarrying and that these operations were mainly carried out manually. These activities were carried out mainly by men. It was also concluded that the stone quarrying operations in the area were largely unplanned or unorganized, and even though quarry workers understood the need for wearing protective gear, their utilization was very low. The study also concluded that committees formed within the quarries were the major means available to control the stone quarrying in the area and that they were efficient only to some extent.

The study concluded that the quarry workers in the area did not receive any formal training on the various aspects of stone quarrying and relied on observation or on-job training, which was informal in nature. The study concluded that the impact of stone quarrying operations in the area ranged from no impact to be very destructive and the methods used were only efficient to some extent in promoting proper quarry management for increased environmental and social sustainability. The acquisition of modern techniques and technologies in stone quarrying by quarry workers in the area was low.

The study concluded that stone quarrying operations in Tuluongoi Sub location had different repercussions on the social wellbeing of quarry workers and that of surrounding communities, and the two were significantly related. While these operations promoted the social welfare of this population by supporting the provision of social amenities, positive social change, and migration, the operations had considerable adverse effects on this

population. The operations were considered a health and safety hazard for both the quarry workers and residents, it had led to the displacement of some households, cracks had developed in the buildings and structures of some households, and that the operations had led to some fatalities and also brewed conflict between the quarry workers and surrounding communities. The study concluded that there were no much variation in the stone quarrying related ailments that residents and quarry workers contracted even though the quarry workers were more exposed to such diseases compared to the residents living nearby. The health-seeking behaviour among quarry workers was also low.

The study concluded that stone quarrying activities in Tuluongoi Sub location, Tenges Division, Baringo County, had done much more harm than good to the physical environment in the area. It was concluded that the damage to the physical environment in the area was clearly evident and touched different aspects of this environment, such as original vegetation covers and crops, the atmosphere, aesthetic value, landscape, land stability, and topsoil, among others.

The study concluded that the harm to the physical environment witnessed in the area occurred mostly daily, and it varied from short term harm or damage to irreparable damage. The study also concluded that the suffering from the harm or damage that had occurred to the physical environment in the area was generally severe. There was low compensation to the surrounding communities for the adverse environmental effects of stone quarrying. The study further concluded that stone quarrying significantly contributes to environmental degradation in Tuluongoi Sub location, Tenges Division, Baringo County.

The study concluded that awareness of environmental rules and regulations on stone quarrying was needed, especially among the residents. The study concluded that while a number of the quarry workers and surrounding communities were aware of some of these rules and regulations, their level of understanding of the requirements of these rules and regulations was generally poor. The study concluded that currently, the stone quarrying operations in Tuluongoi Sub location, Tenges Division, Baringo County were not carried out in compliance or adherence to the laid down environmental rules and regulations and that the focus was more on the benefits drawn from the activities at the expense of the physical environment. It was also concluded that the enforcement of the available environmental rules and regulations on stone quarrying was low, and there was a significant association between the level of awareness of environmental rules and regulations and current environmental impacts of stone quarrying witnessed in the area.

The study further concluded that the current measures to mitigate the negative impacts of stone quarrying on the environment and the society in Tuluongoi Sub location, Tenges Division, Baringo County centred on the rehabilitation or reclamation of land in the quarried sites and negotiations between quarry workers and the surrounding communities. However, these measures were not tangible as quarry workers implemented them when compelled to.

5.4 Recommendations

The study recommends that quarry workers prioritize the acquisition and use of efficient protective gear to minimize the chances of contracting ailments and the accidents linked to stone quarrying activities. Through their association, they could work on a plan to acquire such gears and reach out to organizations or individual volunteers who can educate them on managing quarrying operations so that their health and safety are safeguarded. Furthermore, through these associations, they could invest in acquiring improved tools and technologies that will ensure that productivity is enhanced while encouraging adequate mitigation of the health and environmental impacts of their operations. They can use their collective power to secure loans from financial institutions or even funding from well-wishers.

The study recommends that the NEMA officials deployed to the county should take an active role in enforcing compliance and adherence to environmental rules and regulations on stone quarrying in the area. In conjunction with other stakeholders, they should organize forums and meetings to educate and sensitize both the quarry workers and surrounding communities on the details of available rules and regulations and how to easily observe them cost-effectively. The officials should ensure that quarry workers and owners are compelled to successfully carry out decommissioning of quarries once operations are completed.

Given the popularity of quarry management committees in the area, the county government, NEMA, and other organizations can be encouraged to empower the members of these committees through capacity development and any other form of support so that they can discharge their duties effectively so that the adverse social and environmental effects of stone quarrying in the area are minimized. These committees working together with the quarry workers' association, should devise ways of ensuring proper planning, control, and management of stone quarrying operations so that quarry workers and owners are compelled to act responsibly during and when the operations are closed.

The study recommends that local leadership, together with the quarry management, educate the residents on how to invest the monies obtained from stone quarrying operations wisely and in other activities to ensure that the stone quarrying operations in the area are not intensive. They should also advise against negative social lifestyle changes such as alcoholism. In partnership with other development partners, the county government can establish empowerment programmes for quarry workers not to have to engage in quarrying activities for an extended period. This will go a long way in reducing quarrying operations in the area. The county government should ensure that the proceeds from the stone quarrying operations in the area are used first to develop the area.

The study further recommends that the Ministry of Mining drafts an adequate county mining policy framework to ensure control of quarrying activities carried out on a small-scale so that the negative effects of these operations are minimized.

The study recommends for the establishment and implementation of a policy framework on stakeholder education and sensitization by the Ministry of Mining and NEMA so that the existing gaps regarding the awareness and understanding of the various requirements stipulated in various environmental rules and regulations can be made clear to small scale quarry workers and surrounding communities. The officials posted at the county level should conduct surveys to determine the knowledge and awareness gaps so that proper strategies to educate, sensitize and create awareness of environmental rules and regulations on stone quarrying among these groups of people are formulated.

5.5 Suggestions for Further Research

The study recommends for:

A study to investigate the individual and institutional factors influencing the awareness of and compliance with the various environmental rules and regulations in as far as small scale stone quarrying is concerned.

A comprehensive study to explore the effectiveness of planning and control of stone quarrying operations in Baringo County is also necessary.

A study to examine the challenges faced by quarry workers and communities in mitigating the adverse effects of stone quarrying in Baringo County and other regions where small scale stone quarrying operations are being carried out in the country can also be undertaken.

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APPENDICES

Appendix I: Questionnaire for Quarry Workers

Dear Respondent,

I am a postgraduate student from the University of Nairobi undertaking a study to **establish the Socio and Environmental Effects of Stone Quarry in Tuluongoi Sub location, Tenges Division, Baringo County** as a requirement to fulfil my master's degree. The study is purely for educational purposes and any responses you give will be treated confidentially. Your honest response will be highly appreciated.

Section A: Background Information

1. Gender
   a. Male [ ] b. Female [ ]

2. Indicate your age bracket (years)
   a. 20 and below [ ] b. 21-30 [ ]
   c. 31-40 [ ] d. 41-50 [ ]
   e. 51-60 [ ] f. Above 60 [ ]

3. Highest level of education:
   a. None [ ] b. Primary [ ]
   c. Secondary [ ] d. College/Tertiary [ ]
   e. University [ ] f. Other (specify) _____

4. Marital Status:
   a. Single [ ] b. Married [ ] c. Separated [ ]
   d. Windowed [ ] e. Divorced [ ]

5. How much on average, do you earn per month from stone quarrying activities?
   a. Below 10,000 [ ]
   b. 10,000-20,000 [ ]
   c. 21,000-30,000 [ ]
   d. 31,000-40,000 [ ]
   e. 41,000-50,000 [ ]
   f. Over 50,000 [ ]

6. Place of Origin
   a. Indigenous (Area resident) [ ]
   b. Migrant [ ]

7. What are the three major factors that drove you to stone quarrying?

_____

8. Apart from stone quarrying, what other income diversifying activities are you involved in?

_____

Section B: Stone Quarrying

9. For how long have you been engaged in the stone quarrying activities here?
   a. Less than a year [ ] b. 1 to 5 years [ ] c. 6 to 10 years [ ]
   d. 11 to 15years [ ] e. 16 to 20years [ ] f. Over 20years [ ]

10. How many hours a day do you engage in stone quarrying activities here?
   a. 2 hours or less [ ] b. 3-5 hours [ ]
   c. 6-8 hours [ ] d. Over 8 hours [ ]

11. Which **method(s)** do you use in quarrying stones here?
   a. Hand tools [ ] b. Machine quarrying [ ] c. Blasting [ ]

12. Which **activity or activities** are you involved in within the quarry?

a. Digging or excavating [ ] b. Blasting [ ]
c. Crushing/breaking stones [ ] d. Grinding [ ]
e. Heating [ ] f. Wedging [ ]
g. Disposal of waste rocks [ ] h. Loading stones to vehicles [ ]
i. Others (Specify) _____

13. How would you describe the stone quarrying activities in this area?

a. Unplanned/unorganized [ ]
b. Planned/organized [ ]

14. Have you received any training on stone quarrying and the tools used?

a. Yes [ ] b. No [ ]

15. If yes in 14, what was the type of training received?

a. Informal [ ]
b. Formal [ ]

16. If yes in 14, what are some of the skills acquired during the training?

_____

17. Do you have any protective gear that you use during your quarrying activity?

a. Yes [ ] b. No [ ]

18. If yes in 17, which specific protective gear do you use?

_____

19. If yes in 17, describe the level of adequacy or efficiency of the protective gear used in protecting you during quarrying activities?

a. Not efficient [ ] b. Somehow efficient [ ] c. Very efficient [ ]

20. Are there any measures in place to control the stone quarrying activities undertaken in this area? a. Yes [ ] b. No [ ]

21. If yes in 20, how efficient are these measures?

a. Not efficient at all [ ]
b. Somehow efficient [ ]
c. Very efficient [ ]

22. Are the stone quarrying methods used here effective in promoting proper management of the quarries for environmental and social sustainability?

a. Not effective at all [ ]
b. Somehow effective [ ]
c. Very effective [ ]

23. How can you describe the impact of the methods used in stone quarrying activities here?

a. Do not have any impact [ ]
b. Little impact [ ]
c. Distractive [ ]
d. Very distractive [ ]

24. To what extent are the workers in this stone quarry embracing modern and more suitable techniques and technologies in stone quarrying?

a. Small extent [ ] b. Moderate extent [ ] c. Large extent [ ]

Section C: Social Effects of Stone Quarrying

25. Do you think stone quarrying operations in this area are a health and safety hazard to the quarry workers and the surrounding communities?

a. Yes [ ] b. No [ ]

26. Have you suffered any health and safety condition arising from the stone quarrying activities in this area?

a. Yes [ ] b. No [ ]

27. How often do you visit the hospital for treatment of ailments caught while working in this quarry?

a. Rarely [ ] b. Once in a while [ ] c. More often [ ]

28. Are there times when you have undertaken self-medication in relation to ailments caught while working in this quarry? a. Yes [ ] b. No [ ]

29. For the past 6 months, have you sought any form of treatment for health problems associated with quarrying activities? a. Yes [ ] b. No [ ]

30. If yes in 27, how many times did you seek for treatment?

a. Once [ ] b. 2 to 3 times [ ] c. More than 3 times [ ]

31. If yes in 27, which of the following **ailment (s)** have you been treated for or taken self-medication?

a. Fatal accidents	[ ]	b. Headache/fever	[ ]
c. Eye problems	[ ]	d. Skin irritation	[ ]
e. Chest problems	[ ]	f. Hearing problems	[ ]
g. Malaria	[ ]	h. Muscle pains	[ ]

i. Respiratory infection (e.g. coughs, pneumonia) [ ]

j. Physical injuries requiring medical treatment [ ]

k. Others (Specify) _____

32. Are there any reported cases of deaths that have occurred within the quarries in this area?

a. Yes [ ] b. No [ ]

33. Are you aware of any children involved in stone quarrying activities around this area?

a. Yes [ ] b. No [ ]

34. If yes 31, is it having any impact on school enrolment? Explain

_____

_____

35. Rate the level of **displacement of communities** due to the stone quarrying in this area?

a. No displacement [ ]
b. Low [ ]
c. Average [ ]
d. High [ ]

36. To what extent has the stone quarrying activities supported the provision of **social amenities** e.g. clinics, boreholes for betterment of the wellbeing of the society in this area?

a. Not at all [ ]
b. Small extent [ ]
c. Moderate extent [ ]
d. Large extent [ ]

37. On average, how many cases have been reported in relation to development of **cracks in the buildings** of surrounding communities in this area?

a. None [ ] b. A few [ ] c. Many [ ] d. Very many [ ]

38. In your opinion, what is the general magnitude of cracks for the reported cases and their impacts on lives and properties in these communities?

_____

39. Give your assessment of the level of migration of people to this area and formation of mining villages around this community?

a. Low [ ] b. Average [ ] c. High [ ]

40. Have you witnessed any cases of tension or conflict between the quarry workers and the surrounding communities in this area? a. Yes [ ] b. No [ ]

If yes, what are the main causes of the conflicts?

_____

Section C: Environmental Effects of Stone Quarrying

41. Have you observed any damage to the physical environment being caused by the stone quarrying activities in this area?

a. Yes [ ] b. No [ ]

42. If yes in 41, how would describe the damage?

a. Short term [ ] b. Long term [ ] c. Irreparable [ ]

43. If yes in 41, how frequently does the environmental damage occur?

a. Daily basis [ ] b. Occasionally [ ] c. Cumulative [ ]

44. Describe the **severity or harshness** of the suffering from the negative environmental impacts of stone quarrying activities in this area?

a. Not severe [ ] b. Somehow severe chemo [ ] c. Very severe [ ]

45. Have you witnessed the following damages on the environment as result of quarrying operations?

Damages	**Yes**	**No**
Destruction of original vegetation cover and crops		
Disruption of animal habitats		
Soil erosion and river siltation		
Noise pollution and vibration		
Dust pollution		
Loss of aesthetic value (i.e. loss of visual scenic value)		
Land degradation and loss of top soil		
Accumulation of water in abandoned pits		
Contaminated water resources.		
Alteration of water courses		
Permanent alteration of original land form		
Landslides and mass wasting		
Abandoned hole and waste stone fills		

46. What other damages to the physical environment as result of stone quarrying have you observed in this area?

_____

47. In your opinion, has stone quarrying in any way positively impacted the physical environment in this area?

a. Yes [ ]
b. No [ ]

If yes, what are some of the positive effects observed?

_____

Section D: Awareness of Environmental Rules and Regulations on Stone Quarrying

48. Are you aware of any environmental rules and regulations regarding stone quarrying?

a. Yes [ ]
b. No [ ]

49. If yes in 48, rate your level of understanding/comprehension of the current environmental rules and regulations regarding stone quarrying?

a. Poor [ ]
b. Average [ ]
c. Good [ ]
d. Excellent [ ]

50. If yes in 48, what are some of the environmental rules and regulations regarding stone quarrying that you are aware of?

_____

51. Indicate whether you are aware of the following statements relating to environmental rules and regulations on stone quarrying.

Statement	**Unaware**	**Aware**
1. An environmental impact assessment should be performed prior to quarrying begins in a given place.		
2. All quarry sites must be fenced.		
3. Depleted quarries should be rehabilitated by the land owners.		
4. All persons working at the quarry sites should be provided with protective gear and first aid kits.		
5. Quarrying operation should be done 50m away from homes.		
6. Warning signs should be erected at the entry point of each quarry site.		

52. In your opinion, can the level of awareness of environmental rules and regulations be linked to the current environmental impacts of stone quarrying activities witnessed in this area?

a. Yes [ ] b. No [ ]

Explain you answer

_____

53. Generally, do you think stone quarrying in this area is done according to the relevant environmental rules and regulations? a. Yes [ ] b. No [ ]

Explain your answer

_____

54. Suggest the measures which can be undertaken to make the quarry workers more aware of relevant environmental rules and regulations relating to stone quarrying in this area?

_____

_____

Section D: Mitigation Measures

55. What are the current measures being used currently to mitigate the negative impacts of stone quarrying on the environment and the society in this area?

_____

56. In your opinion, what actions ought to be undertaken to efficiently deal with the social and environmental challenges associated with stone quarrying in this area?

_____

_____

Thank you for your participation!

Appendix II: Questionnaire for Household Heads

Dear Respondent,

I am a postgraduate student from the University of Nairobi undertaking a study to **establish the Socio and Environmental Effects of Stone Quarry in Tuluongoi Sub location, Tenges Division, Baringo County** as a requirement to fulfil my master's degree. The study is purely for educational purposes and any responses you give will be treated confidentially. Your honest response will be highly appreciated.

Section A: Background Information

1. Gender

   a. Male [ ]
   b. Female [ ]

2. Indicate your age bracket (years)

   b. 25 and below [ ] b. 26-35 [ ]
   d. 36-45 [ ] d. 46-55 [ ]
   f. 56-65 [ ] f. Above 65 [ ]

3. Highest level of education:

   a. None [ ] b. Primary [ ]
   c. Secondary [ ] d. College/Tertiary [ ]
   e. University [ ] f. Other (specify) _____

4. Marital status:

   a. Single [ ] b. Married [ ] c. Separated [ ]
   d. Windowed [ ] e. Divorced [ ]

5. Number of people who belong to this household _____

Section B: Stone Quarrying

6. Does any member of your household work in the quarry?

   a. Yes [ ]
   b. No [ ]

7. According to you, which of the following factor (s) have influenced the establishment of stone quarries in your community?

Factor	**Yes**	**No**
Presence of the required building rocks		
The land is unproductive for agriculture		
Advice from geologists		
Increased demand for building blocks		
The only alternative source of livelihood		

8. In your opinion, do you think there is proper planning of the stone quarrying activities in the quarries in this area?

   a. Yes [ ] b. No [ ]

   Explain your answer

   _____

9. Do you think the people engaged in quarrying activities in this area are well trained and skilled to undertake proper and sustainable stone quarrying activities?

   a. Yes [ ] b. No [ ]

10. What are your comments on the nature of protective gears if any that are used by quarry workers in this area?

    _____

11. Are there any measures in place to control the stone quarrying activities undertaken in this area?

    a. Yes [ ] b. No [ ]

12. If yes in 11, how efficient are these measures?

    d. Not efficient at all [ ] b. Somehow efficient [ ] c. Very efficient [ ]

    Explain your answer in 12

    _____

13. Are the stone quarrying methods used by quarry workers around here effective in promoting proper management of the quarries for environmental and social sustainability?

    a. Not effective at all [ ]
    b. Somehow effective [ ]
    c. Very effective [ ]

    Explain your answer in 13

    _____

14. How can you describe the impact of the methods used in the quarrying activities here?

    e. Do not have any impact [ ]
    f. Little impact [ ]
    g. Distractive [ ]
    h. Very distractive [ ]

15. Do you think quarry workers in this area are committed to acquiring the suitable techniques and technologies that promote efficient stone quarrying?

    a. Yes [ ]
    b. No [ ]

Section C: Social Effects of Stone Quarrying

16. Do you think stone quarrying operations in this area are a health and safety hazard to the quarry workers and the surrounding communities?

    a. Yes [ ] b. No [ ]

17. Has any member(s) of your household suffered illnesses associated with quarrying operations?

    a. Yes [ ] b. No [ ]

18. If yes in 17, how many times on average have the household member(s) sought for treatment for ailment related to stone quarrying activities in this area for the past one year?

    b. Once [ ] b. 2 to 3 times [ ] c. More than 3 times [ ]

19. If yes in 17, which of the following **ailment (s)** were they treated for?

    a. Fatal accidents [ ] b. Headache/fever [ ]
    c. Eye problems [ ] d. Skin irritation [ ]
    e. Chest problems [ ] f. Hearing problems [ ]
    g. Malaria [ ] h. Muscle pains [ ]
    i. Allergy
    j. Respiratory infection (e.g. coughs, pneumonia) [ ]
    k. Physical injuries requiring medical treatment [ ]
    l. Others (Specify) _____

20. Are there any reported cases of deaths that have occurred within the quarries in this area?

    a. Yes [ ] b. No [ ]

21. Are you aware of any children involved in stone quarrying activities around this area?

    a. Yes [ ] b. No [ ]

22. If yes 21, is it having any impact on school enrolment? Explain

_____

23. Has there been any **displacement of communities** due to the stone quarrying in this area?
    a. Yes [ ] b. No [ ]
24. If yes in 23, explain your answer

_____

25. Based on your experience, has stone quarrying activities supported the provision of social amenities e.g. clinics, boreholes for betterment of the wellbeing of the society in this area?
    a. Yes [ ] b. No [ ]
    Explain your answer

_____

26. Has there been any reported cases relating to the development of **cracks in the buildings** of surrounding communities in this area?
    a. Yes [ ] b. No [ ]
27. In your opinion, what is the general magnitude of cracks for the reported cases and their impacts on lives and properties in these communities?

_____

28. Give your assessment of the level of migration of people to this area and formation of mining villages around this community?
    a. Low [ ] b. Average [ ] c. High [ ]
29. Has there been any cases of tension or conflict between the quarry workers and the surrounding communities in this area?
    a. Yes [ ] b. No [ ]
    If yes, what are the main causes of the conflicts?

_____

30. What are the other ways in which stone quarrying has affected the social welfare/well-being of surrounding communities here?

_____

Section D: Environmental Effects of Stone Quarrying

31. In your opinion, has stone quarrying in any way positively impacted the physical environment in this area?
    a. Yes [ ] b. No [ ]
    If yes, what are some of the positive effects observed?

_____

32. Have you observed any damage to the physical environment being caused by the stone quarrying activities in this area?
    b. Yes [ ] b. No [ ]
33. If yes in 34, how would describe the damage?
    b. Short term [ ] b. Long term [ ] c. Irreversible [ ]
34. If yes in 34, how frequently does the environmental damage occur?
    b. Daily basis [ ]
    c. Occasionally [ ]
    d. Cumulative [ ]
35. Describe the severity or harshness of the suffering from the negative environmental impacts of stone quarrying activities in this area?
    b. Not severe [ ]
    c. Somehow severe [ ]
    d. Very severe [ ]

36. In your opinion, how has stone quarrying affected the following aspects of the physical environment in this area?

a. Original vegetation cover and crops

_____

c. Atmosphere (in terms of noise, vibration, dust)

_____

d. Aesthetic value (visual scenic value)

_____

e. Landscape, land stability and top soil

_____

f. Water resources (water quality and water courses)

_____

g. Alteration of original land form and use

_____

h. Abandoned holes and waste stone fills

_____

i. Other aspects (specify)

_____

Section E: Awareness of Environmental Rules and Regulations on Stone Quarrying

37. Are you aware of any environmental rules and regulations regarding stone quarrying?
a. Yes [ ] b. No [ ]

38. If yes in 40, rate your level of understanding/comprehension of the current environmental rules and regulations regarding stone quarrying?
a. Poor [ ] b. Average [ ] c. Good [ ] d. Excellent [ ]

39. If yes in 40, what are some of the environmental rules and regulations regarding stone quarrying that you are aware of?

_____

40. Indicate whether you are aware of the following statements relating to environmental rules and regulations on stone quarrying.

Statement	**Not Aware**	**Aware**
1. An environmental impact assessment should be performed prior to quarrying begins in a given place.		
2. All quarry sites must be fenced.		
3. Depleted quarries should be rehabilitated by the land owners.		
4. All persons working at the quarry sites should be provided with protective gear and first aid kits.		
5. Quarrying operation should be done 50m away from homes.		
6. Warning signs should be erected at the entry point of each quarry site.		

41. Do you think stone quarrying in this area is done according to the relevant environmental regulations? a. Yes [ ] b. No [ ]

Explain you answer

_____

42. In your opinion, can the level of awareness of environmental rules and regulations be linked to the current environmental impacts of stone quarrying activities witnessed in this area?

    a. Yes [ ] b. No [ ]

    Explain you answer

    _____

43. Suggest the measures to enhance awareness levels of relevant environmental rules and regulations relating to stone quarrying among surrounding communities and quarry workers?

    _____

Section D: Mitigation Measures

44. What are the current measures being used currently to mitigate the negative impacts of stone quarrying on the environment and the society in this area?

    _____

45. In your opinion, what measures ought to be undertaken to efficiently deal with the social and environmental challenges associated with stone quarrying in this area?

    _____

Appendix III: Key Informant Interview Schedule

Healthcare Provider

- Have you received patients with illness associated with quarrying operations?
- Do you think the quarrying operations are a threat to human health?
- Do you have any statistics? Who are mostly affected?
- What is the severity of the illnesses?
- Do you have any recommendation in order to reduce the scores?

NEMA Officer

- Are the quarrying operations in Tuluongoi sub location a threat to humans, animals and the environment?
- Do you have any regulations governing the establishment of quarries and rehabilitation of abandoned quarries?
- Do the benefits generated from the quarrying operations supersede the negative effects on health and environment?
- What measures should be taken in order to minimize the impacts of stone quarrying in Tuluongoi?

Quarry Managers

- How has stone quarrying benefitted the residents?
- Do you observe all the occupational, health and safety regulations?
- Are the quarrying operations a threat to human health and the environment?
- How has the topography changed before and after the establishment of the quarries?
- Do you have measures to address the impacts of stone quarrying?

Official from the Ministry of Mining

- Is the community or quarry owners aware of the existing environmental principles, rules and regulations governing stone quarrying?

Appendix IV: Consent Form

Research Title: A master's research project on the social and environmental effects of stone quarrying in Tuluongoi sub location, Tenges Division, Baringo County.

Researcher: Caroline Kibii, 0725098222, P.O box 7391-00200, Nairobi

Institution: University of Nairobi

Department of Geography and Environmental Studies

About the study

The study is being conducted to establish the possible social and environmental effects of stone quarrying in Tuluongoi sub location between November 2019 and December 2020 within Tuluongoi sub location.

The study is for educational purposes; privacy and confidentiality is assured. No personal contacts or names shall be collected at any given point in this study. At no point shall the findings be used for personal gains.

Your participation is voluntary, and you are free to withdraw at any given point. You're requested to given your honest opinions.

Once the research is complete, the findings shall be readily available for any individual for reference point.

Interviewee:

I _____, agree to participate in the research project titled **social and environmental effects of stone quarrying in Tuluongoi sub location, Tenges Division, Baringo county**, conducted by _____who has (have) discussed the research project with me.

I have received, read and kept a copy of the information letter. I have had the opportunity to ask questions about this research and I have received satisfactory answers. I understand the general purposes, risks and methods of this research.

Name: (please print)

Signature: _____ Date: _____

Appendix V: Research Approval

UNIVERSITY OF NAIROBI

Department of Geography and Environmental Studies

19th August 2019

The Director,
National Commission for Science Technology & Innovation
NACOSTI Building, Off Waiyaki Way
P.O. Box 30623-00100,
Nairobi
Kenya.

RESEARCH PERMIT: CAROLINE JEPCHUMBA KIBII-C50/5264/2017

This is to confirm that the above named is a Masters student at the Department of Geography and Environmental Studies, University of Nairobi. She is pursuing Masters of Arts degree in Environmental Planning and Management

She is currently undertaking a research project titled: **"Assessment of socioeconomic and Environmental effects of stone quarrying in Tuluongoi sub location Tenges Division Baringo County"**

Any assistance accorded to her will be highly appreciated.

CHAIRMAN
Department Of Geography
and Environmental Studies
UNIVERSITY OF NAIROBI

Dr. Boniface Wambua
Chair, Dept. of Geography and Environmental Studies

Appendix VI: Research Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **248030**

Date of Issue: **12/September/2019**

RESEARCH LICENSE

This is to Certify that Ms.. Caroline Kibii of University of Nairobi, has been licensed to conduct research in Baringo on the topic: Assessment of socioeconomic and environmental effects of stone quarrying in Tuluongoi sublocation, Tenges Division, Baringo County for the period ending : 12/September/2020.

License No: **NACOSTI/P/19/1042**

248030

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

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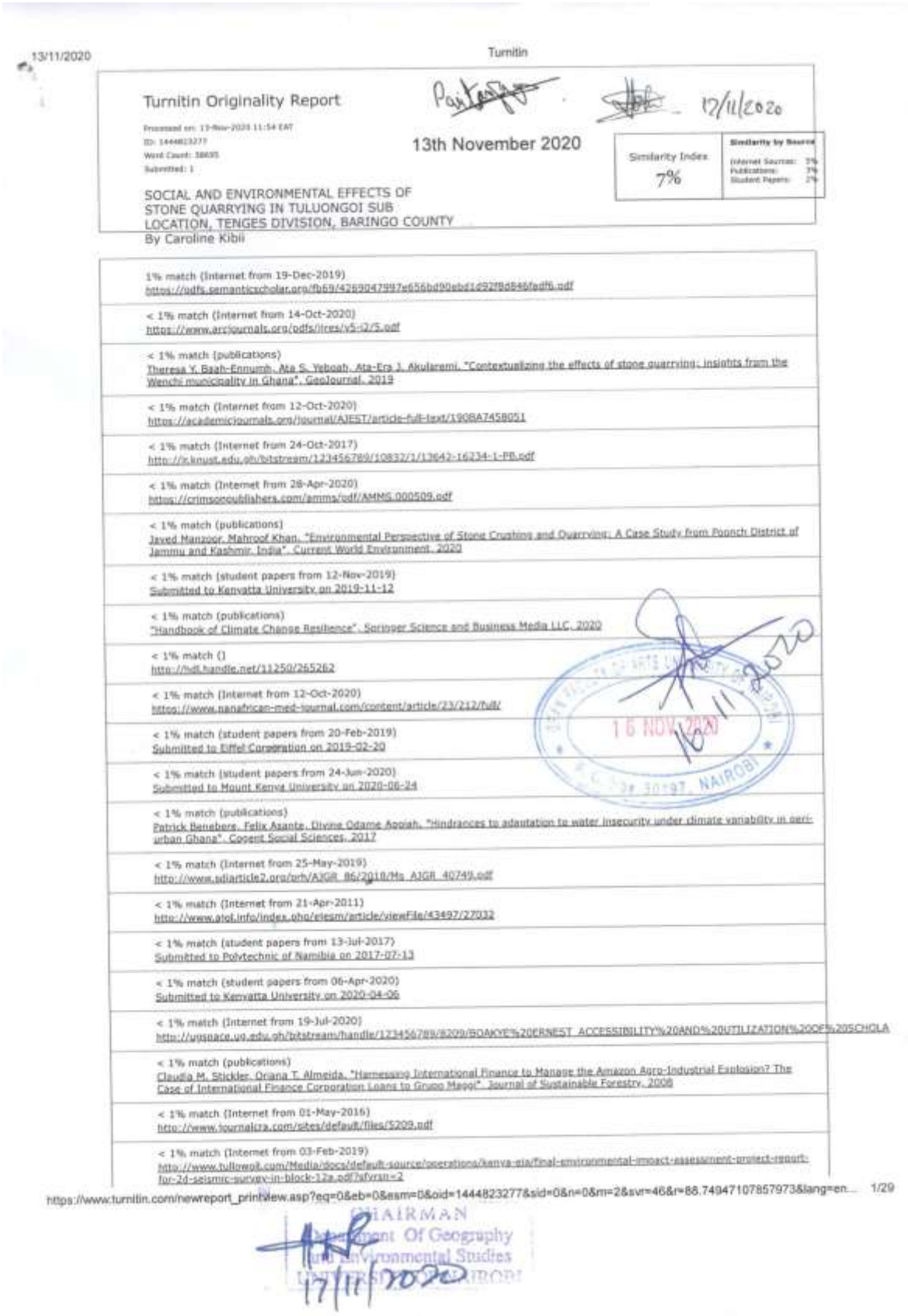

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Appendix VIII: Declaration of Originality Form

UNIVERSITY OF NAIROBI

Declaration of Originality Form

This form must be completed and signed for all works submitted to the University for examination.

Name of Student KIBII CAROLINE JEPCHUMBA

Registration Number C50/5264/2017

College COLLEGE OF HUMANITIES & SOCIAL SCIENCES

Faculty/School/Institute ARTS

Department GEOGRAPHY & ENVIRONMENTAL STUDIES

Course Name MA in ENVIRONMENTAL PLANNING & MANAGEMENT

Title of the work

Social and environmental effects of stone quarrying in Tulwongoi Sublocation, Tenges Division Baringo County

DECLARATION

1. I understand what Plagiarism is and I am aware of the University's policy in this regard
2. I declare that this Project (Thesis, project, essay, assignment, paper, report, etc) is my original work and has not been submitted elsewhere for examination, award of a degree or publication. Where other peoples work, or my own work has been used, this has properly been acknowledged and referenced in accordance with the University of Nairobi's requirements.
3. I have not sought or used the services of any professional agencies to produce this work
4. I have not allowed, and shall not allow anyone to copy my work with the intention of passing it off as his/her own work
5. I understand that any false claim in respect of this work shall result in disciplinary action, in accordance with University Plagiarism Policy.

Signature

Date 17/11/2020