Int Journal of Social Sciences Management and Entrepreneurship 5(2): 1-11, 2021

ISSN 2411-7323

© **SAGE GLOBAL PUBLISHERS** **www.sagepublishers.com**

ENVIRONMENTAL EFFECTS OF DIMENSION STONE QUARRYING ACTIVITIES IN NDARUGO AREA OF KIAMBU COUNTY, KENYA

[1] Wangela Solomon, [2] Dr. Parita Shah

[1]Student, University of Nairobi; Email Wangelas@yahoo.com
[2]Lecturer, University of Nairobi

ABSTRACT

Mining and quarrying activities is one of the devolved units of the County Government. This means the future and benefits of dimension stone quarrying lies on the Kiambu County Government in terms of supervision, regulation, and collection of revenue. It is on these bases that the study was conducted to unearth the effects of dimension stone quarrying activities in consideration to legal frame works in Ndarugo area in Kiambu County, Kenya. The study employed descriptive survey design because it relied on people's opinions about different issues as stated on the questions. Using three randomly selected quarries with a population of 90 respondents, observation schedules, questionnaires, photographs, and interviews, were conducted to collect data from a stratified random sample of 34 respondents, some working, and others residing around the quarrying area. Qualitative data from interviews and observation schedules were analyzed using content analysis while that obtained from questionnaires were analyzed using descriptive tools such as SPSS to generate percentages and tabulations. The research found that 78% of the respondents depend on the quarrying sector either direct or indirect to earn their livelihood. Moreover, quarrying activities provided 83% of construction materials for infrastructural development. On the other hand, quarrying activities affected 87.5% of plants growing nearby either by producing dust or uprooting them on the first stage. It also turned 70.8% of land into pools of water and derelict ugly landscape in addition to causing 41.7% of healthy related problems. The study concluded that quarrying activities in Ndarugo area of Kiambu County have both positive and negative effects. The quarry companies are licensed to carry out their activities in Ndarugo area. The study recommends that quarrying companies should promote environmental, health and education to all the workers on safety measures and achieve sustainable development. It also suggests that existing laws need enforcement by having more National Environment Management officers on the ground.

Key Words: environmental effects, stone quarrying activities

Background to the study

Stone quarrying is the process of extracting dimension stone, rock, sand, gravel, construction aggregates, or other minerals from the ground in order to use them as construction material or to sell them for commercial purposes (Sinclair, 2012). Construction aggregates and dimensional stones obtained through quarrying are are very critical since they facilitate constructions activities which entail construction of airports, schools, hospitals, factories among others. Stone quarrying in Ndarugo area has generated construction materials to its large hinterland, created employment opportunities to people and generated revenue to Kiambu county government.

Despite the benefits of quarrying activities, it has negative environmental effects which include emission of dust, land disturbance, noise pollution, ground vibrations as well as loss of biodiversity (Atieno, 2015). Quarrying activities also pose great health concern to the workers on site and around the quarry sites. Long-term exposure and inhalation of dust from the quarry leads to many respiratory diseases including asthma and lung cancer (Ozcan and Musaoglu, 2012). In Ndarugo area, the common negative effects of dimensional stone quarrying includes; loss of biodiversity, land dereliction, water pollution, air pollution, and health related problems to both the quarry workers and the area residents.

In most African countries, a lot of effort has been put to ensure environmental sustainability. This includes establishing bodies responsible for environmental sustainability, enacting laws and by-law, as well as engaging non-governmental organizations. Besides all these effort, stone quarrying are experiencing some challenges. In Ndarugo area, although most of the quarry pits are approved by NEMA a lot need to be done. Most of the quarry pits collapse after exploitation of the aggregates and stones and there are no measures taken to rehabilitate them since they have no economic value to the quarrying companies. There is a lot of dust emission and water pollution from quarrying activities. Most of workers have no safety attires posing them to great health risk. The effects of stone quarrying spill over to the neighborhood posing challenge to the area residents. Some pits have experienced landslides resulting into death of people. The open quarry pits form pools of stagnant water especially during rainy seasons and thus being a health hazard and a breeding site for mosquito. It is therefore essential to focus on the environmental effects of stone quarrying activities.

Statement of the problem

Over the past century, there has been a rapid growth on stone quarrying activities globally as a result of high demand for construction materials (Fugiel, *et al* 2017). This growth has been facilitated by the high level of urbanization locally and globally. For instance, over 800,000 people in developing nations especially in Africa depend on quarrying activities for survival (Wang and Zhang, 2016). Kenya is experiencing radical change especially with the growth of real estate. This study therefore sought to establish the environmental effects of dimension stone quarrying activities in Ndarugo area.

Various studies have been conducted on environmental effects of quarrying activities in different parts. For instance Langer (2012) focused on the environmental effects of quarrying activities and revealed that quarrying is associated with loss of habitat, dust emission, sedimentation, and abandonment of the mined site. In addition, Fugiel, *et al*, (2017) researched on the environmental effects of artisanal quarrying activities and revealed that quarrying activities led to air pollution, cause terrestrial acidification, and deterioration of human health. Nevertheless, none of these studies focused on environmental effects of stone quarrying activities in Ndarugo area. To fill the highlighted gaps, the current study sought to environmental effects of dimension stone quarrying activities in Ndarugo area.

Research Objective

i. To assess environmental effects of stone quarrying activities in Ndarugo area

Research Question

i. What are the environmental effects of stone quarrying activities in Ndarugo area?

Justification of the study

The findings of this study benefits the government and policy makers, the management of NEMA, academicians and other researchers. To the government of Kenya and policy makers, this study provides information on the effects of stone quarrying activities on the environment. This information can be used in formulation of policies to protect the environment. To the management of the NEMA, the study provides information that can be used in formulating strategies to conserve the Environment in Ndarugo area.

The study is also important to the academicians since it provides information that can be used as a reference material by students doing their research on the influence of stone quarrying activities on the environment. To other researchers, the study forms a basis upon which further research can be done on quarrying activities and its impact on the environment.

Literature Review

This section presented the reviewed literature on environmental effects of stone quarrying. The section is organized to global regional and local perspective. A geological survey in the USA conducted by Langer (2012) revealed that quarrying activities lead to change in geomorphology and transformation of useful land to unsuitable ugly visual scene. Langer (2012) further observed that quarrying is associated with loss of habitat, dust emission, sedimentation, and abandonment of the mined site. Moreover, Langer (2012) contends that most of the negative effects of quarrying activities are observable and can be alleviated to acceptable levels. Another study conducted by Erickcek (2016) in Richland Township in USA proved that there is a significant correlation between property distance from quarry site and property sale price. The study revealed that building properties adjacent to the quarry sites experience up to 30% reduction in sale price with 1% increase for every 10% increase in distance from quarrying operations.

A study conducted by Fugiel, *et al*, (2017) in four European countries namely Great Britain, Poland, Norway and Germany revealed that quarrying activities led to air pollution, cause terrestrial acidification, and deterioration of human health. According to Devi and Rongmei (2015), quarrying activities in India led to disturbance of landscapes and distortion of land topography resulting to agriculturally unproductive terrains. Moreover quarrying created pools of water in abandoned quarry pits that forms breeding site for vectors like mosquitoes, as well as deforestation and degradation of the ecosystem.

Lebanon had been the most forested country among its neighbors but since quarrying activities started in the early 1990s after the end of the fifteen-year civil war, it is leading to the disappearance of its famed biblical cedars trees. This is due to continuous deforestation caused by the quarry Mafia in the forested mountainous regions (Diab, 2017). This has caused environmental problems due to the unsustainable approach of destruction of forests that has affected the weather and climate of the country (Diab, 2017).

In Egypt, Mohamed and Abuo (2013) established that vibrations resulting from blasting causes the structures and buildings near the blast sites to shake, develop cracks on even collapse as well as busting of pipelines. It is based on this finding that most countries have regulation and guidelines that are used to ensure that all vibration levels within a quarry site are kept within a specific limit.

A study conducted in Nigeria by Nwibo and Ugwuja (2012) found that the quarry workers had various respiratory problems such as chest pain, coughing, wheezing and shortness of breath. The study revealed that about 98.3% of the workers did not practice safety measures to prevent themselves from inhaling the dust. Therefore, these workers were exposed to dust for long hours and for many days, which increased their susceptibility to respiratory problems. Similarly, Ugbogu, *et al*. (2009) conducted a study in Ghana to investigate the occurrence of respiratory and skin problems among stone crushing workers. The findings of the study revealed that 85% of the workers had respiratory symptoms and 70% had skin infections. The study further found out that there was minimal use of proctective gear and clothing, despite high awareness among the workers on the effect of dust on their health.

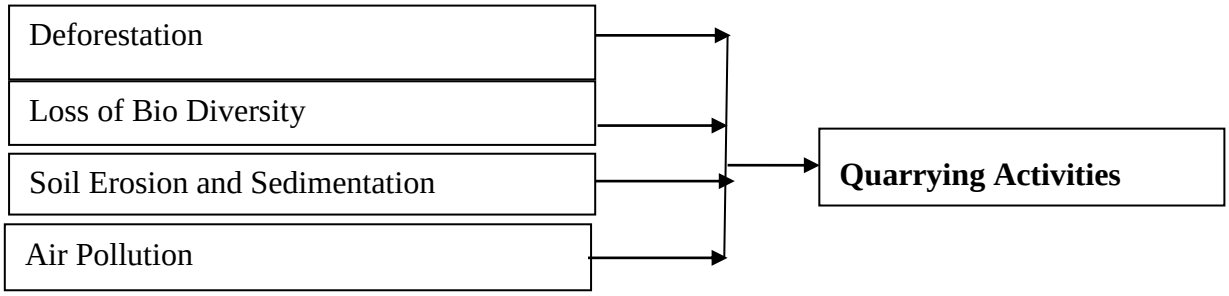
Another negative impact related to dust generation from quarry sites is loss of biodiversity. Research by Oyinloye and Olofinyo (2017) in Nigeria revealed that air polluton has negatively affected vegetation since it leads to death of leaf parts wich limits the process of photosynthesis.This therefore leads to falling of premature leaves which may even lead to death of the plant. Oyinloye and Olofinyo (2017) voted that there was a declining trend in crop production on farms that were closer to quarry sites. The low crop output was due to dust particles from quarrying activities which accumulated on crop leaves thereby disrupting photosynthesis processes. Similarly, a study conducted in Malawi by Missanjo *et al.,* (2015) revealed that trees species diversity and chlorophyll content increased at an increasing ground distance away from the quarry sites. Plants that were near quarry sites had little chlorophyll content due to dust accumulating on their leaves.

Theoretical framework

A theory is a combination of formal statements and ideas with an aim of giving an explanation, prediction and understanding of a certain phenomenon. In most cases, theories are formulated to challenges the existing knowledge as well as the enrich the body of knowledge within the limits of certain assumptions. This research was anchored on general systems theory. Systems theory was developed by Ludwig von Bertalanffy in 1940's. The theory focuses on systems which are interrelated and interdependent. In addition, under systems theory, the parts can either be human made or natural. Under systems theory every part is limited in terms of space as well as time, further, the parts are influenced by their surroundings and defined by their purpose as well as their structure. According to Mohamed and Abuo (2013) if a system expresses synergy, it can exceed the total number of its parts. Under the systems theory if one part is changed then the whole system will be affected. This implies that predicting the pattern and behavior of the system is possible. The growth and adaptation of a system relies on the level of engagement of the system to its environment. This research adopted systems theory to assess the environmental effects of stone quarrying activities.

Conceptual framework

Conceptual framework is a diagramatic representation of the relationsip between the dependent and the independet variables (Kothari, 2006). In this case the independent variable was the dimension stone quarrying activities while the dependent variable was environmental effects. Figure 1.1 below show the relationship between the variables.

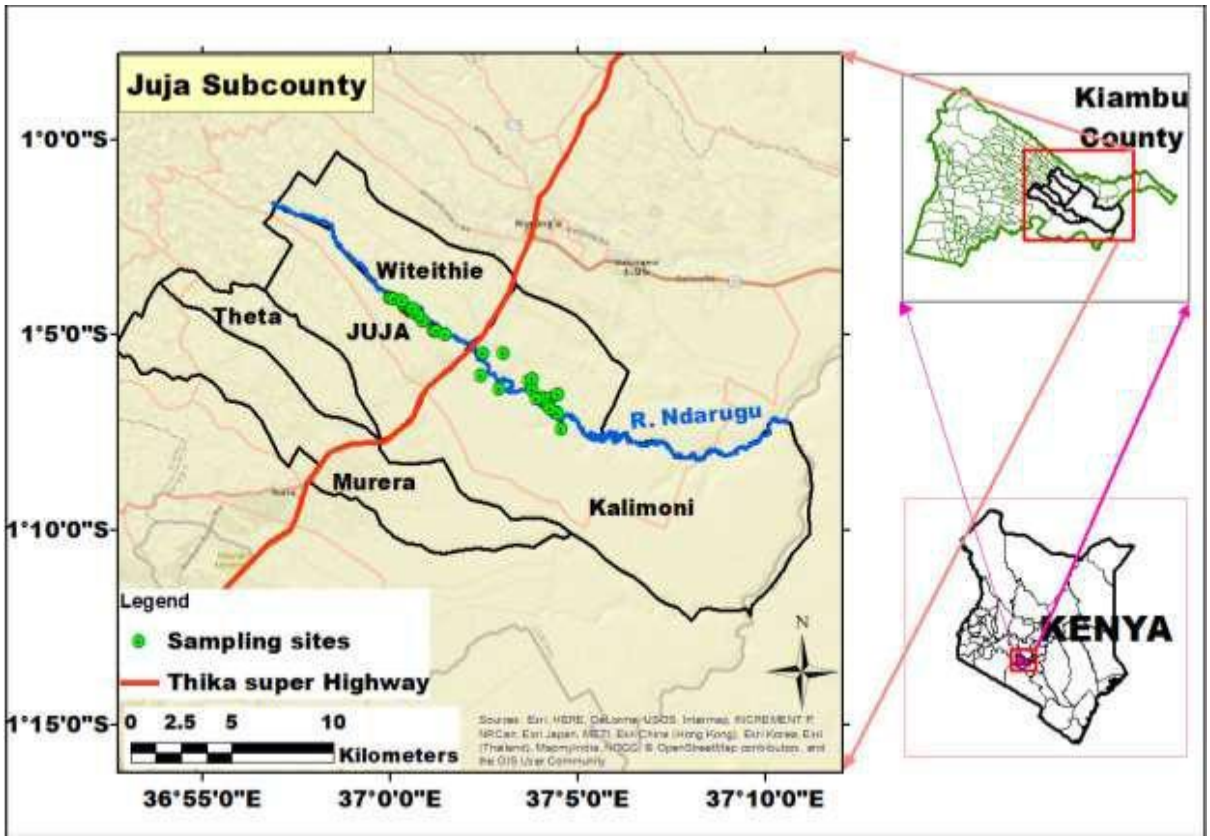


Environmental Effects **Quarrying Activities**

AREA OF STUDY

This research was conducted in in Ndarugo area which is found in Juja sub-county in Kiambu County, Kenya. This area is located in the northern sides of Nairobi about 36km and 12km from thika. As shown in the Map below, the red line shows the Thika Superhighway. This high divides the quarrying site into two sections and it ensures that the quarry products are transported easily. The quarry sites are indicated by the green dots in the Map.

Figure 1: Location of the study



Source: (Researcher 2021).

RESEARCH METHODOLOGY

Introduction

This section present the methods and procedures utilized to achieve research objectives. This chapter covers design of the research, target population, sampling frame, Size of the sample and Sampling Technique, data collection methods and procedures and data analysis and presentation.

Research Design

Research design is defined as the methods and steps followed in obtaining the data required. It a project's general operational patter or framework specifying the source data and the kind of information to be collected, (Egbert, 2015). The explanatory research design, which is also referred to as casual research design is the research design that the study will utilize. This research design involves structuring the objectives of the study to identify the casual association between variables or elements under investigation. Bhattacherjee (2018), claims that causal research can be performed to check the effects of specific variations on existing norms, given processes among others. Explanatory research studies aims at showing the patterns of relationship between variables by analyzing situation or specific problem.

Target Population

Creswell (2014), argues that population is a set of individuals, elements, services, event, group of things or households that are well defined which are being investigated. Egbert (2015) also defined population to be a whole set of units from which the information to be investigated is to be used for derivations to be made. This research targeted the quarry workers and people residing in the area where quarrying activities take place. Further, the target group of interest also comprised of NEMA officers and local authority. The total group of interest comprised of 90 respondents from Ndarugo area.

Sampling frame

A sampling frame refers to the register, list of record of elements or individuals from which a sample is obtained. Russell (2013) claims that a register of all the individuals within a population that can be included in a sample is the sampling frame, and may include institutions, households or individuals. Sampling frame is a rundown of all individuals in a population who can be sampled. Greenfield and Greener (2016) argues it is a physical representation of the entire elements in the population from which the sample is retrieved. The sampling frame comprised of 9 quarrying sites along Thika road.

Sample Size and Sampling Technique

Sample is also part of target population from whom research data is to be gathered. Sampling is the process where a group of people from a study population are selected. Russell (2017) indicates that having the needed sample size and selecting a representative sample through the use of an appropriate and suitable sampling technique is very important. Sampling focuses on the selection of some of the study units form the target population. The study adopted census sampling method since the target population was small. Therefore all the respondents participated in the study

Data Collection and Procedures

The study used primary data. The primary data was collected using questionnaires (Stokes & Wall, 2017). The study utilized a semi-structured questionnaire and interview guides. Structured questions were used to save money and also time and make research simpler because the data can be analyzed in its immediate form. According to Fraenkel (2014), questionnaire is an economical technique for gathering information from many respondents, and it promotes anonymity.

Data Analysis and Presentation

A semi structured questionnaire generated qualitative and also quantitative data, which will be analysed separately by employing various techniques. Thematic analysis which is commonly used in a set of texts, such as interview transcripts was used to analyse qualitative data. The researcher evaluates the data carefully to establish similar themes – ideas, topics and patterns of meaning that arises repeatedly (Greenfield & Greener, 2016). Thematic analysis involves generating themes, naming and defining themes reviewing themes, and writing up. Descriptive statistics was used in data analysis with the help of SPSS. Descriptive statistics entails frequencies, percent and standard deviation. The study results were presented through use of tables and figures.

Ethical Consideration

Legal considerations are mandatory guidelines that a researcher is expected to adhere to before collecting data or conducting a study (McNabb, 2015). Indeed, this study is founded on ethics to ensure sustainability and acceptance by the relevant audience. The research observed confidentiality of information, human dignity, beneficence, and justice. Further, before the data collection exercise, a research permit was sought from the university.

RESULTS AND DISCUSSION

The sample size for this study was 90 respondents. The researcher therefore issued 90 questionnaires to all the respondents. From the 90 questionnaires 81 were completely filled and returned hence a response rate of 91%. The response rate was considered as suitable for making inferences from the data collected. As indicated by Metsamuuronen (2017) that, a response rate above 50% is considered adequate for data analysis.

Descriptive Statistics

The Environmental Effects of Quarrying Activities

The respondents were requested to rate various statements on the influence of dimensional stone quarrying on the environment. The results were as shown in Table 1.1.

As shown in the results, the respondents agreed that loss of bio diversity has occurred as a result of dimensional stone quarrying activities (M= 0.972, SD= 0.972). In addition, the respondents agreed that increased soil erosion and sedimentation has been as a result of dimensional stone quarrying activities, (M= 4.152, SD= 0.608). Further, the respondents agreed that quarrying has facilitated deforestation in Ndaguro area (M= 4.130, SD= 0.972).

The respondents agreed that quarrying in the area has led to destruction of property (M= 4.133, SD= 0.751). In addition, the respondents agreed that as a results of quarrying activities there is

high level of air pollution, (*M*= 3.980, *SD*= 0.897). Further, the respondents agreed that as a result of quarrying activities there has been reduction in crop production in the area (*M*= 3.958, *SD*= 0.636).

Plate 1.1 Air Polution Near Silverstone quarry site

Source: Researcher 2021

As shown in the results, the respondents agreed that quarrying activities have affected farming activities in their area (*M*= 3.915, *SD*= 0.776). In addition, the respondents agreed that quarrying has facilitated change in land use system, (*M*= 3.909, *SD*= 0.898). Further, the respondents agreed that dimensional stone quarrying has led to loss of habitat (*M*= 3.786, *SD*= 0.789). Nevertheless, the respondents disagreed with the statement indicating that there are better strategies put in place to control quarrying activities in the area (*M*= 3.786, *SD*= 0.789).

Plate 1.2: Silverstone quarry site in Ndaguro Area

Source: Researcher 2021

Table 1. 1: The Environmental Effects of Stone Quarrying Activities in Ndarugo

	Mean	Std. Deviation
Quarrying activities have affected farming activities in our area	3.915	0.776
As a result of quarrying activities there has been reduction in crop production in the area	3.958	0.636
Quarrying has facilitated deforestation in Ndaguro area	4.130	0.972
Loss of bio diversity has occurred as a result of dimensional stone quarrying activities	4.212	1.005
Increased soil erosion and sedimentation has been as a result of dimensional stone quarrying activities	4.152	0.608
There are better strategies put in place to control quarrying activities in the area	1.673	0.983
Quarrying in the area has led to destruction of property	4.133	0.751
As a results of quarrying activities there is high level of air pollution	3.980	0.897
Dimensional stone quarrying has led to loss of habitat	3.786	0.789
Quarrying has facilitated change in land use system	3.909	0.898

Source: Researcher 2021

Summary of the findings

The study found that loss of bio diversity has occurred as a result of dimensional stone quarrying activities. In addition, it was found that increased soil erosion and sedimentation has been as a result of dimensional stone quarrying activities. Further, the study revealed that quarrying has facilitated deforestation in Ndaguro area

The study found that quarrying in the area has led to destruction of property. In addition, it was revealed that as a results of quarrying activities there is high level of air pollution. Further, findings revealed that as a result of quarrying activities there has been reduction in crop production in the area

The study found that quarrying activities have affected farming activities in their area. In addition, it was found that quarrying has facilitated change in land use system. Further, the study established that dimensional stone quarrying has led to loss of habitat. Nevertheless, the respondents disagreed with the statement indicating that there are better strategies put in place to control quarrying activities in the area.

Conclusions

- This study therefore concludes that dimensional stone quarrying has a negative effect on the environment. Findings established that as a result of quarrying activities Ndaguro area is characterized by increased soil erosion and sedimentation and deforestation.
- In addition, the study concludes that quarrying in Ndaguro area has led to destruction of property. In addition, it was revealed that as a results of quarrying activities there is high level of air pollution. Further, findings revealed that as a result of quarrying activities there has been reduction in crop production in the area

- Further, the study concludes that quarrying activities have affected farming activities in their area. In addition, it was found that quarrying has facilitated change in land use system. Further, the study established that dimensional stone quarrying has led to loss of habitat. Nevertheless, the respondents disagreed with the statement indicating that there are better strategies put in place to control quarrying activities in the area

Recommendations

i. This study recommends that the local authority is Ndaguro area should ensure all quarrying companies in the area are registered and adhere to the directives established by the national environmental authority

ii. The study found that quarrying activities in Nduguro area have led to increased soil erosion and sedimentation and deforestation. This study therefore recommends that the management of National environmental management authority should formulate and implement strategies to control quarrying activities in Ndaguro area.

Suggestions for further studies

This study was limited to the effects of dimensional stone quarrying on the environment hence further study is recommended on the quarry post-closure practices. In addition, this study recommends further research on the influence of quarrying activities on the economy.

REFERENCES

Abayomi, D., & Kehinde, I. (2014). Environmental Effect of Quarrying Activities in Oba-Ile, Akure, Ondo State, South-West Nigeria. *International Journal of Engineering Research & Technology, 3*(1), 1103-1113.

and what we Face Today. Klaus Krippendorff, USA: University of Pennsylvania

Asante, F., Abass, K., & Afriyie , K. (2014). Stone Quarrying and Livelihood Transformation in Per-Urban Kumasi. *Research in Humanities and Social Sciences, 3*(4), 32-39.

Ashby, R. (1968). Information Theory: A Bit of History, Some Solutions to Problems,

Atieno, J. (2015). *Dust Pollution and its Health Risks among Rock Quarry Workers in Kajiado County, Kenya.* Nairobi, Kenya: Kenyatta University.

Bertalanffy, L. (1950). An Outline of General System Theory. *The Journal for Philosophy of Science, VOL 1*.

Birabwa, E. (2006). *Small Scale Stone Quarrying: its Contribution to People's Livelihoods: A case study of Kasenge Parish, Nama sub-county, Mukono District Uganda.* The Norwegian University of Science and Technology.

Blischke, W. R., & Murthy, P. (2011). *Reliability: Modeling, Prediction, and Optimization.* Hoboken, New Jersey: John Wiley & Sons.

Fugiel, A., Burchart-Korol, D., Czaplicka-Kolarz, K., & Smolinski, A. (2017). Environmental Impact and Damage categories caused by Air Pollution Emissions from Mining and Quarrying sectors of European Countries. *Journal of Cleaner Production, 143*(2), 159-168.

Government of Kenya . (2007). *The Occupational Safety and Health Act, 2007.* Nairobi, Kenya: The Government printer.

Government of Kenya. (1999). *Environmental Management and Co-ordination.* Nairobi, Kenya:The Government printer.

Kenya Institute of Management. (2009). *Fundamentals of Management Research Methods.* Nairobi, Kenya: Macmillan Kenya Limited.

Kindiga, S. (2017). Environmental and Land Impacts of Quarrying Along Ngong River in Embakasi. Master Thesis, University of Nairobi.

Kothari, C. R. (2006). *Research Methodology: Methods & Techniques* (2 ed.). New Delhi, India: New age International Publishers.

Martins, S. T., & Mendes, L. M. (2015). Acoustic Characterization of Sugarcane Bagasse Particleboard Panels. *Materials Research, 18*(4), 821-827.

Mbandi, I. (2017). Assessment of the Environmental Effects of Quarrying in Kitengela Subcounty of Kajiado in Kenya. Nairobi, Kenya: Master Thesis, University of Nairobi .

Missanjo, E., Ndalama, E., Sikelo, D., & Kamanga-Thole , G. (2015). Quarry Dust Emission Effects on Tree Species Diversity in Chongoni Forest Reserve and Vegetation Characteristics in Adjacent Villages, Dedza Malawi. *International Journal of Information Research and Review, 2*(3), 511-515.

Mogambi, F. L., & Mohamed, Y. M. (2016). Impact of Stone Quarrying on the Environment and the Livelihood of Communities in Mandera County, Kenya. *Journal of Scientific Research & Reports, 10*(5), 1-9.