

**SCHOOL OF PUBLIC HEALTH**

**COLLEGE OF HEALTH SCIENCES**

**UNIVERSITY OF GHANA**

**ASSESSMENT OF ENVIRONMENTAL AND HEALTH EFFECTS OF STONE  
QUARRY ACTIVITIES AT BUOKU IN THE WENCHI MUNICIPALITY.**

**BY**

**ADOM DARKO MAXWELL**

**ID :10600450**

**A DISSERTATION SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON,  
IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF  
MASTER OF SCIENCE IN OCCUPATIONAL HYGIENE**

**JULY, 2017**

## DECLARATIONS

### Candidate's Declaration

I, **Adom Darko Maxwell**, hereby declare that, except for reference to other people's work which has been duly acknowledged, this thesis consists of my own work produced from research undertaken under supervision and that no part has been presented for any degree elsewhere.

Signature..... Date.....

Student: **ADOM DARKO MAXWELL**

Signature..... Date.....

Supervisor: **DR. URI SELORM MARKAKPO**



## **DEDICATION**

I dedicate this work to almighty God for his protection and guidance during the conduct of the activities that led to the completion of the work. I also dedicate this work to my family, especially my parents, for their support.



## **ACKNOWLEDGEMENTS**

I am most grateful to my supervisor, Dr. Uri Selorm Markakpo for his guidance encouragement, support and especially for his patient at all stages of this study. I am also grateful to all my friends who help me when I needed them most.



## ABSTRACT

**Background Information:** Quarrying comprises diverse activities and operations that produce high level of noise and dust particles in the environment within which it is practised. The main objective of this study was to assess environmental and health effects stone quarry activities at Buoku in the Wenchi Municipality. The study adopted a cross-sectional survey design. Probability sampling techniques such as; cluster sampling, stratified sampling, and simple random sampling techniques were used to select a sample of 323 respondents from the community for the study. Measurements were done for dust concentration levels in samples of air from various locations at the quarry site and the surrounding community. Eight sampling locations were identified where the Dust Measuring Device KM 3887 was mounted. Four of the sampling locations were at the quarry site and the other four were in the community. Structured questionnaires were used to collect data from selected community members at Buoku on some environmental effects and respiratory symptoms associated stone quarry activities at the Buoku quarry site. The environmental effects observed included cracks in buildings and plots of land near quarry site and air and water pollution by dust particles while respiratory symptoms assessed included chronic chest pains, difficulty in breathing chronic sneezing, and sore throat. Descriptive and inferential analysis were done using Stata version 14.

**Results:** The results showed that the concentrations of dust particles within air samples collected from various locations at the quarry site were higher than the Environmental Protection Agency (EPA) standard of  $70 \mu\text{g}/\text{m}^3$  and ranged between 81.2 to  $182.7 \mu\text{g}/\text{m}^3$ . Also, the total suspended particles within samples of air collected from the various locations within the quarry site were generally, higher than the EPA standard of 230

$\mu\text{g}/\text{m}^3$  and ranged from 239 to  $632.2 \mu\text{g}/\text{m}^3$ . The study also found that the various respiratory infections that were associated with the quarry activities include; cough, catarrh and shortness of breath. Other related respiratory infections that were observed also included frequent sneezing and sore throat. The study found a significant association ( $p < 0.05$ ) between exposure to dust particles from the quarry activities and respiratory symptoms such as; cough, shortness of breath and catarrh. Another observation from the study shows that, quarry activities in the Bouku community have adversely affected certain nearby farmlands and probably contributed to the reasons why they cannot support crop cultivation. In addition, the present study shows that quarry dust particles in the atmosphere make the environment cloudy, enter eyes of community members and make visibility poor.

**Conclusion:** The results of the study noted that the dust concentration level in the community was slightly lower as compared to the EPA standard. In the quarry site, however, the dust concentration levels observed were higher compared to the EPA standards. The study also, found significant relationships between the dust emissions from the quarry activities and dust related health challenges, with exception of catarrh which was not significantly associated with amount of dust particles in the atmosphere. Finally, several buildings observed within the quarry community had cracks in them as typified by buildings occurring in quarry communities elsewhere. Therefore the study recommended that, regular environmental audit and monitoring of quarrying activities should be enforced in order to ensure adherence to the standards and limits of the concentrations of the dust generated from the different stages of their operations, the EPA need to visit the site of the quarry and put in place regulations to ensure that the

level of noise and dust concentrations are within the allowed limits. Operating beyond these limits have consequences on the whole environments and especially the health of the workers in the quarry.



**TABLE OF CONTENT**

TITLE PAGE .....	i
DECLARATIONS .....	ii
DEDICATION .....	iii
ACKNOWLEDGEMENTS .....	iv
ABSTRACT .....	v
TABLE OF CONTENT .....	viii
LIST OF TABLE .....	xi
LIST OF FIGURES .....	xii
LIST OF ABBREVIATIONS .....	xiii
CHAPTER ONE .....	1
INTRODUCTION .....	1
1.1 Background of the Study .....	1
1.2 Problem Statement .....	2
1.3 Justification of the Study .....	4
1.4 Research Question .....	4
1.5 Objectives of the Study .....	5
1.5.1 General objective .....	5
1.5.2 Specific objectives .....	5
CHAPTER TWO .....	6
LITERATURE REVIEW .....	6
2.0 Introduction .....	6
2.1 Concept of Quarry .....	6
2.2 Quarry Process .....	8
2.2.1 Drilling or channeling and wedging .....	8
2.2.2 Blasting and Cutting of rocks .....	9
2.2.3 Crushing .....	10
2.3 Concentration of Dust Particles at Stone Quarry .....	10

2.4 Health/Respiratory Problems Associated with Stone Quarry Activities.....	12
2.5 Impact of Stone Quarry Activities on Buildings and Farms .....	17
2.6 Environmental impact of Quarrying .....	19
2.6.1 Vibration Effects.....	20
2.6.2 Noise.....	20
2.6.3 Air quality.....	21
2.7 Policy and regulatory implications .....	21
2.9 Conceptual Framework.....	22
<b>CHAPTER THREE .....</b>	<b>24</b>
<b>METHODOLOGY .....</b>	<b>24</b>
3.1 Introduction.....	24
3.2 Study Area .....	24
3.3 Research Design.....	26
3.4 Study Population .....	27
3.5 Sample Size.....	27
3.6 Sampling Technique .....	28
3.7 Study Variables .....	29
3.7.1 Dependent.....	29
Environmental effect of quarrying .....	29
Air pollution by dust, Noise pollution, Cracks in building, Water pollution by dust, Cloudiness of atmosphere .....	29
Respiratory symptoms .....	29
Chronic cough, Chest pains, Sore throat, Chronic cold, Chronic sneezing .....	29
, Difficulty in breathing .....	29
3.7.2 Independent variable.....	29
Quarrying blasting, crushing, grinding of rock, policy on quarry .....	29
3.8 Research Instruments .....	29
3.9 Data Collection Procedure .....	30
3.10 Data Analysis and Plan.....	33
3.11 Ethical Considerations.....	33
<b>CHAPTER FOUR.....</b>	<b>35</b>

RESULTS .....	35
4.0 Introduction.....	35
4.1 Presentation of Results.....	35
4.1.1 Demographic and Personal Characteristics .....	35
Table 4.1.1: Demographic Characteristics of the Respondents.....	36
4.1.2 Assessment of atmosphere of quarry site and surrounding community for quarry dust concentration.....	37
4.1.3 Prevalence of respiratory symptoms associated with quarry Activities .....	38
4.1.5 Association between experimental group (worker) and control group (non workers) with some respiratory symptoms.....	40
4.1.5 Impact of quarry dust on eye and visibility.....	42
Impact of quarry activities on selected buildings.....	48
4.1.7 The Need for Rehabilitation or Relocation .....	49
CHAPTER FIVE .....	51
DISCUSSION OF RESULTS .....	51
5.1 Introduction.....	51
5.2 Demographic characteristic of respondent.....	52
5.3 Assessment of dust particles in the atmosphere of the quarry site and the surrounding community.....	53
5.4 Respiratory symptoms associated with quarry dust exposure among participants	54
5.5 Impact of quarry activities on the environment .....	55
CONCLUSION AND RECOMMENDATIONS .....	57
6.1 Introduction.....	57
6.2 Conclusion.....	57
6.3 Recommendations.....	58
REFERENCES .....	60
RESEARCH QUESTIONNAIRE .....	68

**LIST OF TABLE**

Table 4.1.2: Concentration of dust particles in the atmosphere at quarry site and the surrounding community ..... 37

Table 4.1.3: Association of Dust exposure with presentence of respiratory symptoms among respondent. .... 39

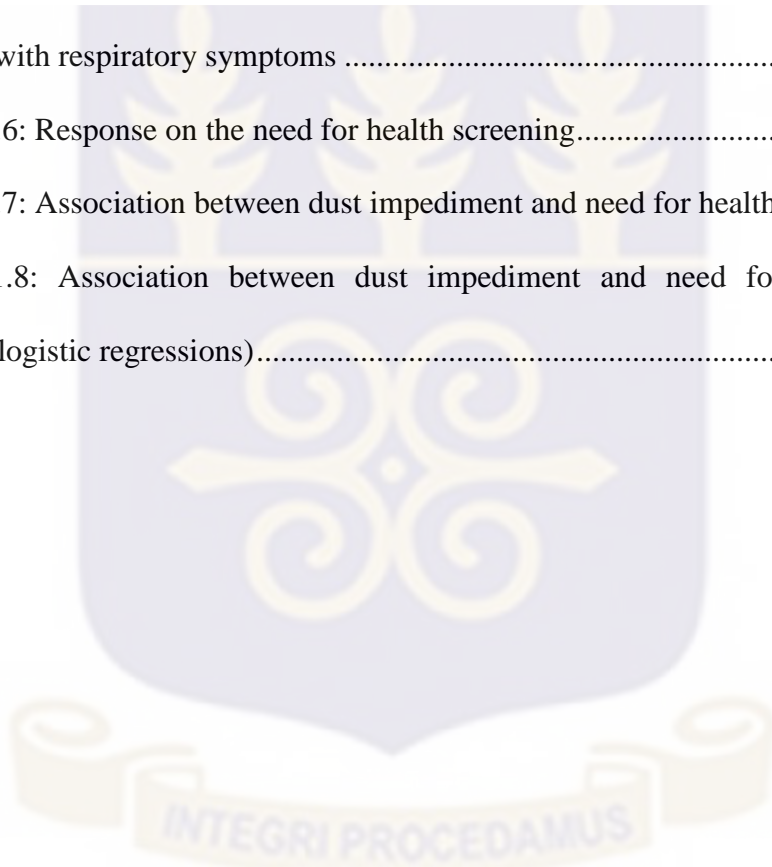
Table 4.1.4: Response to respiratory symptoms ..... 40

Table 4.1.5: Association between experimental group (worker) and control group (non-workers) with respiratory symptoms ..... 41

Table 4.1.6: Response on the need for health screening..... 43

Table 4.1.7: Association between dust impediment and need for health screening ..... 45

Table 4.1.8: Association between dust impediment and need for health screening (multiple logistic regressions)..... 46



**LIST OF FIGURES**

Figure 1.1: Conceptual Framework ..... 22

Figure 2.2: Map of the Wenchi Municipality Showing the Buoko Township ..... 26

Figure: 3.1 Photos of some locations sampled for TSP and PM<sub>10</sub>..... 32

Figure: 3.2: Photos of some locations sampled for TSP and PM<sub>10</sub> ..... 32

Figure 4.1: Impact of quarry dust on eye and visibility..... 43

Figure 4. 2: The Need for Rehabilitation or Relocation ..... 50



## LIST OF ABBREVIATIONS

A	Agree
AQL	Air Quality Location
CDDC	Commodity–Dependent Developing Countries
D	Disagree,
EPA	Environmental Protection Agency
FR	Flow rate,
ICMM	International Council on Mining and Metals
$m_1$	Initial milligram,
$m_2$	Final milligram,
PM	Particulate Matters
SA	Strongly Agree.
SD	Strongly Disagree,
SPSS	Statistical Package for Social Sciences
T	Time
U	Undecided,
UNDP	United Nation Development Plan
WHO	World Health Organization

## CHAPTER ONE

### INTRODUCTION

#### 1.1 Background of the Study

Quarrying involves diverse activities and operations that produce high level of noise and dust particles in the environment within which it is practised (Oyinloye & Ajayi, 2015). During quarrying rocks are blasted using dynamites and machines of various sizes and capacities are used in transporting, crushing and grading of quarry materials (Elizabeth, 2006). These processes are often characterized by noise and dust causing related environmental pollution (Gizaw, Yifred, & Tadesse, 2016)

According to (Banez, Mae-Ajaon, Bilolo and Dailyn, 2010) quarrying is carried out through diverse methods. The type of rock and the equipment that is used in the process determine the method that is utilized. There are instances that require explosives to blast rocks after which they are broken into smaller pieces for the market through the process of crushing (Nartey, Nanor, & Klake, 2012). During quarrying holes are drilled into rock masses by power drills. Explosives are inscribe into the holes and then detonated to split the rock dunks for further breaks down(Eshiwani, 2014). In wedging process, however, chisels or power drills are used to create spaces in the rock masses following which wedges are inserted to split the rock apart(Nyakeniga, 2009). This is used for marble, sandstone, limestone and other related rocks that one can reckon as softer. Small scale quarrying on the other hand does not required any heavy machinery(Sayara, Hamdan, & Basheer-salimia, 2016a). These are normally the case for small scale in quarrying. Here instruments like pickaxe, shovel, wheelbarrows, among others, are used.

Quarry, irrespective of the type, can have a negative impact on the environment and the health of workers as well as individuals in the surrounding communities, particularly those who live within 1km distance away from quarrying site (Nanor, 2011). Most of the health hazards are usually respiratory diseases caused by inhalation of dust particulates in polluted air. Dust emitted from the quarry site may also pollute water and food and make them unwholesome for consumption (Co, 2016). Finally, quarrying dust may also make the atmosphere cloudy to obscure visibility lead to eye infections and also produce loud noise that leads to hearing loss (WHO, 2008). There is the need for this reason, intension research to be conducted on quarry operations in order to develop effective ways of minimizing the deleterious effect of quarry activities in our communities

(Co, 2016) notes that quarrying serves as a means for acquiring most of the supplies for construction and other related activities. Construction stuffs like granite, slate, and marble are all obtained traditionally from quarrying (Sayara et al., 2016a). Ceramic tiles are also produced as a result of quarrying activities. Despite the benefits associated with it, quarrying also tend to present some vital implications to the environment and its inhabitants as noted by Okafor (2006). The practice of blasting and crushing has been identified as the main source of noise and air pollution in quarrying environments (Sayara et al., 2016a).

## **1.2 Problem Statement**

Quarrying involves the use of explosives to blast rocks and heavy machinery to drill, split and break large chunks of rock into smaller bits. These activities lead to the release of mass of dust particles into the atmosphere leading to air pollution (Adeola & Abstract, 2009). Other environmental impacts of quarrying include ecological disturbance,

destruction of natural flora, land and water pollution, instability of soil and rock masses as well as landscape degradation (Adeola & Abstract, 2009). Quarrying also leads to contamination of water bodies by harmful chemicals, oil and rock mineral particles (Sayara, Hamdan, & Basheer-salimia, 2016b), leading to water-borne disease in situations where these sources of water are not properly treated before consumption.

The use of explosives and heavy machinery during quarrying produce loud environmental noise that causes hearing loss, stress, high blood pressure, sleep disturbance and loss of productivity among people exposed to these environmental hazards (Adeola & Abstract, 2009). Apart from these, dust and chemical emissions during quarrying lead to chronic respiratory conditions such as cough, pulmonary tuberculosis, silicosis, difficulty in breathing, chest pains, decreased lung capacity and lung cancer due to prolonged inhalation of dust particles in the polluted air (Adjei-Boateng; Makori, Nandi, Thuo, & Wanyonyi, 2012; Nartey et al., 12).

Furthermore, the blasting of rocks in the quarrying process leads to vibrations and shock waves that affect the structural integrity of most buildings in the environment, leading to their collapse (Sayara et al, 2016 Eshiwani, 2014). Even though the Buoko community in the Wenchi Municipality experiences all the adverse environmental and health effects enumerated above as a result of quarry activities virtually no remedial measures are in place to minimize the degradation of the environment and improve the health of the community members. Also, though there are legislative instruments to regulate the activities enshrined in stone quarry operations such legislations are apparently not being enforced. Lastly, existing literature shows that several studies have been conducted on

stone quarry activities elsewhere, however, very few of such studies have been conducted in Ghana, and virtually none has been conducted in the Buoko community.

Assessment of environmental and health effects of stone quarry activities at the Buoko stone quarry site therefore, would generate additional evidence based data needed to improve legislative instruments for regulating stone quarry activities in Ghana as a whole. It would also augment existing literature on the subject and help improve the awareness of community members about the association between stone quarrying and certain chronic respiratory conditions.

### **1.3 Justification of the Study**

The environmental and respiratory symptom associated would produce baseline data necessary for the formulation of policies to regulate quarry activities in the study area that will assist in the minimizing the adverse effect in terms of the environment and health of the people at risk. Also, it would help produce critical evidence – base scientific information needed to devise measures to protect the health of people involved in quarry activities. Finally, the finding of this study would generate critical scientific information for the improvement of quarry activities globally.

### **1.4 Research Question**

- What are the concentration levels of dust particles at the Buoko Stone Quarry site?
- What are the respiratory problems associated with quarry activities in the Buoko community?

- What is the impact of quarry activities on selected buildings and farms near the Buoku Quarry site?

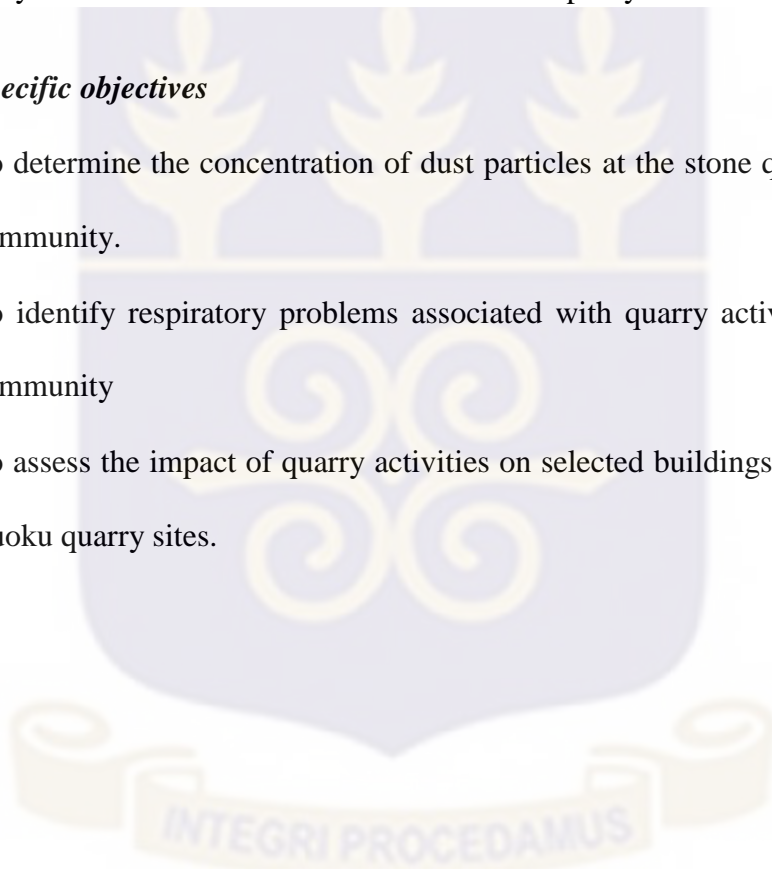
## **1.5 Objectives of the Study**

### ***1.5.1 General objective***

The general objective of this study is to assess the environmental and health effects of stone quarry activities at Buoku in the Wenchi Municipality.

### ***1.5.2 Specific objectives***

- To determine the concentration of dust particles at the stone quarry in the Buoko community.
- To identify respiratory problems associated with quarry activities in the Buoko community
- To assess the impact of quarry activities on selected buildings and farms near the Buoku quarry sites.



## CHAPTER TWO

### LITERATURE REVIEW

#### 2.0 Introduction

This chapter reviewed relevant literature in relation to environmental and health effects of stone quarry activities. The literature review was organised according to the objectives of the study as stated in chapter one. The purpose of the literature review was to identify gaps in existing works in which the present study intended to address.

#### 2.1 Concept of Quarry

Quarrying is the process of obtaining quarry resources, usually rocks, found on or below the surface of the soil (Banez et al., 2010). The difference between mining and quarrying is that quarries extract nonmetallic rocks and aggregates while mines extract the site from metal mineral deposits. Some of the stones extracted by quarrying are sandstone, limestone, perlite, marble, scrap, slate, granite, rock salt and rock phosphate. Quarrying like many other human activities has a significant impact on the environment. In particular, it is often necessary to explode rocks with explosives to extract the materials, but this method of extraction generates noise pollution, air pollution, biodiversity and destruction of habitat (Banez et al., 2010).

Quarrying is process that takes different steps. The first step in quarrying is to survey an area to locate an ore (Ellis's, 2008). This involves physically going out into the field and looking for different types of minerals and fossils to give you an indication of where you might find a mineralized body. The company that intends to carry out quarrying activities

obtains licenses from the relevant department. Next is exploration of the area, which consists of finding and determining the extent and value of mineral-rich ore, using a variety of methods, including practical work, field work, remote sensing (Eshiwani, 2014). This is done in different ways, depending on the type of quarry and what you want to remove from the ground. Once the professional activity is completed, there is a need for an ecological reconstruction, which involves reclaiming the site of the quarry so that the land can be used in the future. It means returning the land as much as possible to your previous condition, after the extraction has been done (Ayodele & Lameed, 2010).

Impact propagation can range from barely perceptible to highly invasive, and the nature of the impact can also vary widely depending on the work of the quarry, the extraction method and the characteristics of the quarry site(Elizabeth, 2006). One of the most common complaints from the public about the crushed stone industry located near population centers is blast noise (Eshiwani, 2014). Blasting can occur daily or as rarely as once or twice a year. In the case of Bouku, this is due to the method used in the quarries and the proximity of the quarries and the effects that occur in different parts of the community.

Rock crushing is a worldwide phenomenon that has raised concerns around the world(Gizaw et al., 2016). Quarry is an important activity because it provides a large part of the materials used in traditional hard floors, such as granite, limestone, marble, sandstone, slate and even clay to make tiles and ceramics. However, like many other human-based activities, quarrying activities have a significant impact on the environment (Okafor, 2006).

There are two types of quarries: quarries of crushed stone and quarries of dimension and / or construction stone. Crushed stone refers to rock that has been divided into small irregular fragments of specific particle size. Crushed stone quarries produce aggregates for the construction industry and cement plants, while dimensioned stone quarries produce building blocks and ornamental stones for construction (Sullivan, 2006). This type of operation includes drilling, blasting, crushing and screening. The overload is removed to expose the surface of the rock(Oyinloye & Ajayi, 2015). The rock is drilled in preparation for blasting. When blasting explosives are used to break rocks into fragments that are then transported and fed to a crushing plant to be crushed, they are sifted, washed and stored (Langer et al., 2004).

## **2.2 Quarry Process**

The extraction involves more activities that generate significant amounts of noise, dust and waste. As a result, the use of machinery to transport materials and the processing of materials to crush and calibrate materials all contribute to air pollution and even greater noise affects the environment. Such extraction of raw materials from their natural habitats for quarrying, drilling and harvesting greatly affects the natural environment and constitutes a hazard to humans, the agricultural and terrestrial crops among the residents around the quarry (Eshiwani, 2014). The major activities that are involved in stone quarry are identified and discussed below.

### ***2.2.1 Drilling or channeling and wedging***

According to Gale and Groat (2001), channel cutting, and Drilling and Broaching are amongst the oldest methods of quarrying. There is a channeling machine that is mostly used to develop a channel through the rocks by using multiple chisel-edged cutting bars.

The process ensures that there is an aspect of chopping simultaneously with the drilling and broaching. The broaching tool then chisels and chops the web between the drill holes, freeing the block. In this regard the channel cutting, and drilling and broaching can be noted to be slow. The cutting instrument needs to be sharpened at points in time.

The processes of Channeling and wedging in the quarrying industry are the utilization of machines that cut channels through rocks that provide sufficient room for a wedge to be inserted. When the wedge is in place, the rock is then torn apart by using the fracture that has been created in it. This process is mostly used when quarrying for softer products like sandstone and marble among others (Feldman, 2006). In order to ensure that products are not destroyed, the cutting process is combined with other lubricants and coolants like water to maximize efficiency. Line drilling and sawing, according to Gale and Groat (2001), can be considered too be modern compared to others. This process entails the drilling of overlapping holes utilizing a drill that has a mushroom head. This assist in positioning the drill and align holes (Lameed & Ayodele, 2010).

### ***2.2.2 Blasting and Cutting of rocks***

This process entails blasting of the rocks which makes it very easy to be carried by using simple instruments like shovels. For rocks that are soft, they stand the chance of being degraded when they are subjected to blasts (MWANGI, 2014). In cases where rocks cannot be accessed directly with shovels, blasting becomes the most appropriate alternative(Elizabeth, 2006). When the blasting process is over it gives room for the crushing process since by then the rocks will be smaller to go through that process(Nyakeniga, 2009). The pressure and energy that is unleashed by the explosives planted in the rocks causes them to break up. Blasting is occurred by the release of noise,

dust and gasses that are harmful and add up to their adverse effects created in the environment which include destruction of farmland development of cracks in building and cloudiness of the atmosphere around the community (Elizabeth, 2006).

### **2.2.3 Crushing**

Gale and Groat (2001) noted that crushing involves the use of equipment such as “vibrating feeder, jaw crusher, vibrating screen impact crusher or cone crusher, belt conveyor and centrally electric controlling system”. In the process the large materials are carried into a jaw crusher in an even manner. These are progressively transferred by vibrating feeder through a hopper for the primary crushing. “The material is transported to influence crusher or cone crusher by belt conveyor for secondary crushing after the initial crushing”. After this process, the crushed material is then conveyed to a vibrating screen for separation which is followed by the screening process.

### **2.3 Concentration of Dust Particles at Stone Quarry**

Dust can be defined as a fine powder that consists of very small pieces of a particular substance. The main sources of dust in a quarry operation are drilling, crushing and road haulage. The workers are at risk of inhaling the emitted dust, which is injurious to their health. Inhalation of the dust can cause severe health problems including respiratory and pulmonary problems, while dust deposition causes skin and eye problems (Mengesha & Bekele, 1998).

Local communities can potentially be affected by dust up to 1 km from the source, although concerns about dust are most likely to be expressed within 100 meters (Gizaw et al., 2016). Deposited dust gives rise to the greatest number of complaints to quarries from

local communities, particularly for contrasting colours that are more noticeable on deposition. Settled particles may show up particularly on clean or polished surfaces such as cars, windows and window ledges, or surfaces that are usually expected to remain free from dust. The impacts from quarrying activities on the health of the people are quite significant as blasting vibrations have also resulted in cracks in several buildings exposing the occupants to danger. Other potential quarrying effects which are of concern to environmentalists include biodiversity loss, land degradation, nuisance effects, reduced plant growth (Nartey, Nanor & Klake, 2012).

Particulates are the tiny solid or liquid particles that are suspended in air and which are usually individually invisible to the naked eyes (Baird, 1992). The particulates include soot, smoke, ash from fuel (mainly coal) combustion, dust released during industrial processes like quarrying and other solids from accidental and deliberate burning of vegetation (Montgomery, 1992).

Quarrying generates a lot of particulate matter (dust) with diameter 1 - 75  $\mu\text{m}$  (micron). Particles with aerodynamic diameters of less than 50  $\mu\text{m}$  (termed Total Suspended Particulate matter, or TSP) can become suspended in the atmosphere, and those with aerodynamic diameters of less than 10  $\mu\text{m}$  termed PM<sub>10</sub> (inhalable particles) can be transported over long distances (Nickling & Boas, 1998) and enter the human respiratory system (Ferris, Speizer & Spengler, 1999).

Total Suspended Particulate Matter (TSP) is the concentration of all particles in the atmosphere. Particles with an aerodynamic diameter of less than 2.5  $\mu\text{m}$  (respirable particles) are most effective for light scattering and have a significant effect on visibility or visual intrusion (Malm, 1999), alteration and terrestrial radiative equilibrium

(Charlson, Schwartz, Hales, Cess, Coakley, Hansen and Hofmann, 1992). Inhaled PM<sub>4</sub> and PM<sub>2.5</sub> penetrate deep into the lungs and are able to make their way to deep air sacs in the lungs where they can settle and cause respiratory problems (Zheng, Dionisio, Arku, Quaye, Hughes and Vallarino, 2011). Air pollutants such as dust are unhealthy particles (solids, liquid gas mixtures) that can harm both living and non-living things (Ward, Peterson and Hao, 1992).

Variable degrees of air, water and land pollution occur during mineral development depending on the stage and scale of activities. While only minor pollution occurs during mineral exploration, more intense air and water pollution emanates from the exploitation stages, especially if carried out on a large scale. In Nigeria, the greatest pollution effect comes from the large-scale exploitation of oil, limestone and rocks used in construction works (UNESCO, 1995).

#### **2.4 Health/Respiratory Problems Associated with Stone Quarry Activities**

The quarrying is an age long economic activity in areas endowed with natural resources such as marble, lime stone and gypsum. Workers in the quarry industries are exposed to various hazards resulting from the inhalation of air borne particulates and these poses a lot of danger to their health and safety. Airborne particulates pose a potential health risk to quarry employees in the form of respiratory, dermal, ocular irritation and damage Urom SE, Antai AB, Osim EE. (2004) chronic exposure to dust generated from crushing of granite rocks impairs lung function and causes some respiratory and non-respiratory symptoms in quarry workers. A particular concern in some quarries is the inhalation of dust containing silica which can lead to silicosis, an irreversible lung disease resulting in

inflammation of the lungs and breathing difficulties which progresses even when exposure.

A very high degree of respiratory morbidity is associated with this industry. Fine rocks and mineral dust of all kinds have been shown to be carcinogenic when inhaled (Montgomery, 1992). The control of particulate pollution is a health and aesthetic issue. Increasing attention is being paid to the impacts of dust on human health, as finer particles can be inhaled and exhaled into the lungs and cause damage. It is generally recognized that dust up to 10  $\mu\text{m}$  can be inhaled beyond the larynx and dust up to 4  $\mu\text{m}$  can be breathed into the lungs.

Potential health impacts are almost exclusively related to the presence of airborne dust, including respirable particles, ie those with a diameter of less than 10  $\mu\text{m}$  (PM10). Cardiovascular systems (Banez et al., 2010). According to Banez et al. (2010), inhalation of dust may cause "pneumoconiosis", a term for a group of lung diseases.

Dust from quarry sites is a major source of air pollution, although its severity depends on factors such as local microclimates, dust concentration in ambient air, dust particle size and chemistry (Sayara, 2016a). The quarries of limestone dust are very alkaline, while the coal mines produce acid dusts. Air pollution is not only a nuisance in terms of surface deposits and possible health effects, especially for people with respiratory problems, but dust can also have physical effects on surrounding plants leaves and cuticles (Guach, 2001).

In India, quarries have affected many workers in the mining industry. According to (Azad and Ashish, 2006), the extraction and crushing of stone is known as extremely dangerous work, in which workers are exposed to many debilitating risks and diseases for

occupational health. Most of the time, migrant workers are engaged in this highly unorganized industry. The most common exposure is silica dust, which causes silicosis in exposed workers.

Silicosis is a disabling, non-reversible and sometimes fatal lung disease caused by overexposure to respirable crystalline silica (Province, 2015). Silica is the second most common mineral in the earth's crust and is a major component of sand, rock and ores. Overexposure to dust containing microscopic particles of crystalline silica can cause scar tissue to form in the lungs, which reduces the lungs' ability to extract oxygen from the air. In addition to silicosis, the inhalation of crystalline silica particles has been associated with other diseases, such as bronchitis and tuberculosis. Some studies also indicate an association with lung cancer. The disease does not cure, but it is 100% preventable if employers, workers, and health professionals' work together to reduce exposures by using appropriate protective equipment (Nartey et al., 2012).

Other health risks could be due to noise pollution, heavy manual work, minor or major injuries and workplace accidents, as well as long working hours. The lack of basic sanitation, drinking water and shelter compounds the poor working conditions. As mining and crushing operations are both a danger to the environment and to humans, they require continuous monitoring of the workplace as well as workers. Mining operations result in deforestation, loss of vegetation, soil erosion, changes in groundwater levels and pollution, which can lead to ecological imbalance (Impacts, 2016).

Aigbedion (2005) large amounts of dust from the Nigerian limestone quarries are discharged daily into the air. Similarly, a lot of air-borne particulate matters are generated by the numerous stone crushing industries in the country. When the air is laden with such

dust, it causes health hazards for some people. For example, pollution studies around Sagamu and Ewekoro cement works in Ogun State have shown that several people are suffering from eye pain, and asthmatic attack due to the dust-laden air that prevails within a few kilometers radius of the factories.

The dust particulates that result from the disintegration of solid can cause air pollution when it remains in the atmosphere for long. The particulates may cause interference with the respiratory functions, it is susceptible to persons with respiratory disease, young and elderly and to vegetation it may led to reduction in plant growth by physical blockage of light when deposited on the leaf surface.

The process involved in stone quarry activities yield several diseases that can be attributed to environmental factors. The blasting digs up rocks coupled by a large noise and vibration of the ground, thereby increasing lot of dust in both air and water. In addition large craters generated from open quarry become major breeding grounds for mosquitoes, thereby increasing the incidence of malaria in the locality(Lameed & Ayodele, 2010). Vector borne diseases such as malaria and schistosomiasis are the common mini related diseases observed in the area over the last the common mining related diseases observed in the area over the last 10 years according to a data collected by the Third World Network from the District Health Directorate. Respiratory tract diseases especially pulmonary tuberculosis and silicoses, disease of the eye especially acute conjunctivitis; and Mental cases are also mining related diseases(MWANGI, 2014).

The analysis that has been done above is enough grounds to note that quarrying activities are related to upper respiratory diseases. There are also associated diseases such skin conditions, and acute conjunctivitis among other relate infections (Akabzaa, 2000).

It has been noted that there are airborne hazards in the mining industry. Gases like engine exhaust and some chemical vapors come as a result of quarry activities. Research indicates that free crystalline silica is the commonest compound that is within the crust of the earth. This particle is the commonest that poses threat to the health of workers in quarries and the surrounding community (Access, 2016).

The effects associated with dust emission resulting from quarrying activities have both micro-spatial and household dimensions. Air pollution and vibrations resulting from quarry activities have an impact on human health. With regard to the environmental impact of the quarry, most studies have indicated the negative effect of quarrying on the environment. Damage associated with biodiversity is the biggest problem (Anard, 2006). By biodiversity, reference is made to all living species, plants, animals and sites of micro-organic anomic found at different career sites (Anard, 2006).

Air pollution has many sources. There is pollution from power plants and cement plants. Nevertheless, high volumes of emissions are caused by the quarry. In the study by Nwibo et al. (2012), they noted that most studies have associated the career with respiratory infections and negative effects. Conditions such as bronchitis, lung cancer and chronic silicosis have all been identified with career activities. These conditions can be disabling and have fatal consequences on an individual's health. In the study of Urom *et al.* (2004), they noted that among career workers, most symptoms associated with breathing problems include; dyspnea, catarrh, chest pain and productive cough.

In a related study, Ghotkar *et al.* (2012) noted a prevalence of 32.86 respiratory problems among quarry workers. Safety was related to the worker's exposure level and age. Work-related lung problems are noted as the deposition of dust in the lungs of an individual.

The type of dust and, as noted earlier, the level of exposure affects the severity of dust particles on an individual's health.

Black smoke, noise and vibration are pollutants from quarry activities that result from airborne particles resulting from blasting in quarry operations. When the waste tips of the quarry are heavy and bulky, they can contribute to the formation of dust suspended in the air. This normally exceeds the normal level required (Akabzaa, 2000).

### **2.5 Impact of Stone Quarry Activities on Buildings and Farms**

One of the greatest negative impacts of quarries on the environment is the degradation of biodiversity (Anand, 2006). Biodiversity refers essentially to the range of living species, including fish, insects, invertebrates, reptiles, birds, mammals, plants, fungi and even micro-organisms. Biodiversity conservation is important because all species are interconnected, even if this is not immediately visible or even known, and our survival depends on this delicate balance that exists in nature (Anand, 2006).

Quarrying activity has the potential to destroy habitats and the species they support (Mabogunje, 2008). Although habitats are not directly removed by excavation, they may be indirectly affected and damaged by environmental impacts such as changes in groundwater or surface water that cause some habitats or water bodies dry up. Even noise pollution can have a significant impact on some species and affect their successful reproduction. Nevertheless, with careful planning and management, it is possible to minimize the effect on biodiversity and, in fact, quarries can also provide a good opportunity to create new habitats or restore existing ones (Tanko, 2007).

Quarrying activities also leads to the production of large quantities of waste(Quartey & Pupilampu, 2012). Some types of quarries do not produce large amounts of permanent

waste, such as sand and gravel quarries, while others will produce significant amounts of waste such as clay and silt (Wang, 2007). However, there is still potential for damage to the environment, especially with water contamination. The activity releases dust that is deposited not only on the soil, plants and trees, but also on the surface water used for drinking and other household chores.

The uncontrolled expansion of quarries in Senegal has resulted in coastal erosion, reduced available farmland, and skin and lung problems for quarry workers and people living nearby. The effects have forced the government to stop issuing more permits to people who want to participate in extractive activities in the affected areas of the country (Oyinloye & Ajayi, 2015). A common negative effect of quarrying activities is the destruction of natural landscape, creating an open space in the ground and generating piles of waste rock that cannot be easily removed. These phenomena are amply demonstrated in many parts of Nigeria, where mines or commercial quarries have already occurred or are underway (Tanko, 2007).

Vegetation in the area around the quarry is also affected because dust blocks the leaves and their growth is disrupted. Recent studies of the environmental impact of the limestone mining and cement industry in Sagamu, Nigeria, have revealed a decline in kola nut production in plantations located a few kilometers from the cement plant (Aigbedion, 2005, Adekoya, 2003). This phenomenon is associated with dust pollution, because a large amount of dust is released into the air mainly by the cement plant. The particulate matter eventually settles on the leaves and flowers of kola nuts as well as on the soil that supports the plants. The overall effect of this is that the photosynthesis and fruiting capacity of the kola nut tree is altered with a consequent decrease in kola nut

production.

Most of the effects of dust particles on plants include the potential to block and damage stomata, so photosynthesis and respiration are affected. Other effects are shading that can lead to reduced photosynthetic capacity, leaf surface wear and cuticle wear (Igbal & Shafiq 2001). Pollutants such as dust, gaseous emissions and atmospheric particles will be produced and deposited on the plants. This will undoubtedly affect the physiological activities of plants, especially those around the quarry site, such as photosynthesis and respiration. The implication of these is that some of the plants may have retarded growth while others may be eliminated.

## **2.6 Environmental impact of Quarrying**

The activities of blasting have a negative effect on the surrounding communities. As noted earlier blasting can induce a shock wave that can cause devastating harm on buildings and other structures in the community (Sayara, 2016b). Aside creating cracks in buildings, it can actually collapse the buildings. In some of the case, there is a resultant effect of death or permanent damage as a result of these cracks (Impacts, 2016).

When an explosive is blown up, large amount of energy is released. By the very design of explosives, they are able to transpose rocks at various quarry sites (Nartey et al., 2012). The rest of the build in energy that is released comes to the earth's surface and some suspends unto the atmosphere (Impacts, 2016). The ground shaking that characterizes blasting can be attributed to emanating waves. The disturbance then comes in the form of air or noise. If explosives are not designed better it results in fly rocks (MWANGI, 2014). These are an uncommon problem with plans that have designed with the outmost care and execution.

### **2.6.1 Vibration Effects**

There is cacophony from operations of all surface mines in the area. Vibration effects of blasts conducted at a number of open pits in the locality have been a major expostulation of residents. The frequent blasting that is characterized with the operations of quarrying in most of the cases results in ground vibrations that causes cracks in many buildings in mining localities. (Akabzaa, 2000)

### **2.6.2 Noise**

Noise normally comes about as a result of the activities that is related to the stone. Quarry operations by its very nature demands some form machinery and equipment that produce a lot of noise(Gizaw et al., 2016). The source of noise in most quarry sites is dependent on a number of factors. The climatic condition at a point can be considered as well as the landscape. The effect of the noise on the receiver can also be affected by the frequency and distance from the source of noise (Langer, 2001).

In some cases, the vegetation of a location can also reduce the sound levels. The ability of sound to travel in cold weathers is higher than warm dense air. In trying to determine how tolerant an individual is to a new noise, there need to be an adjustment in the existing ambient levels. In an urban or industrial environment, ambient noise may camouflage noise from a quarry operation since the environment itself has so many different noise at play. The same cannot be said of rural communities in which there are less noise (Province, 2015).

### **2.6.3 Air quality**

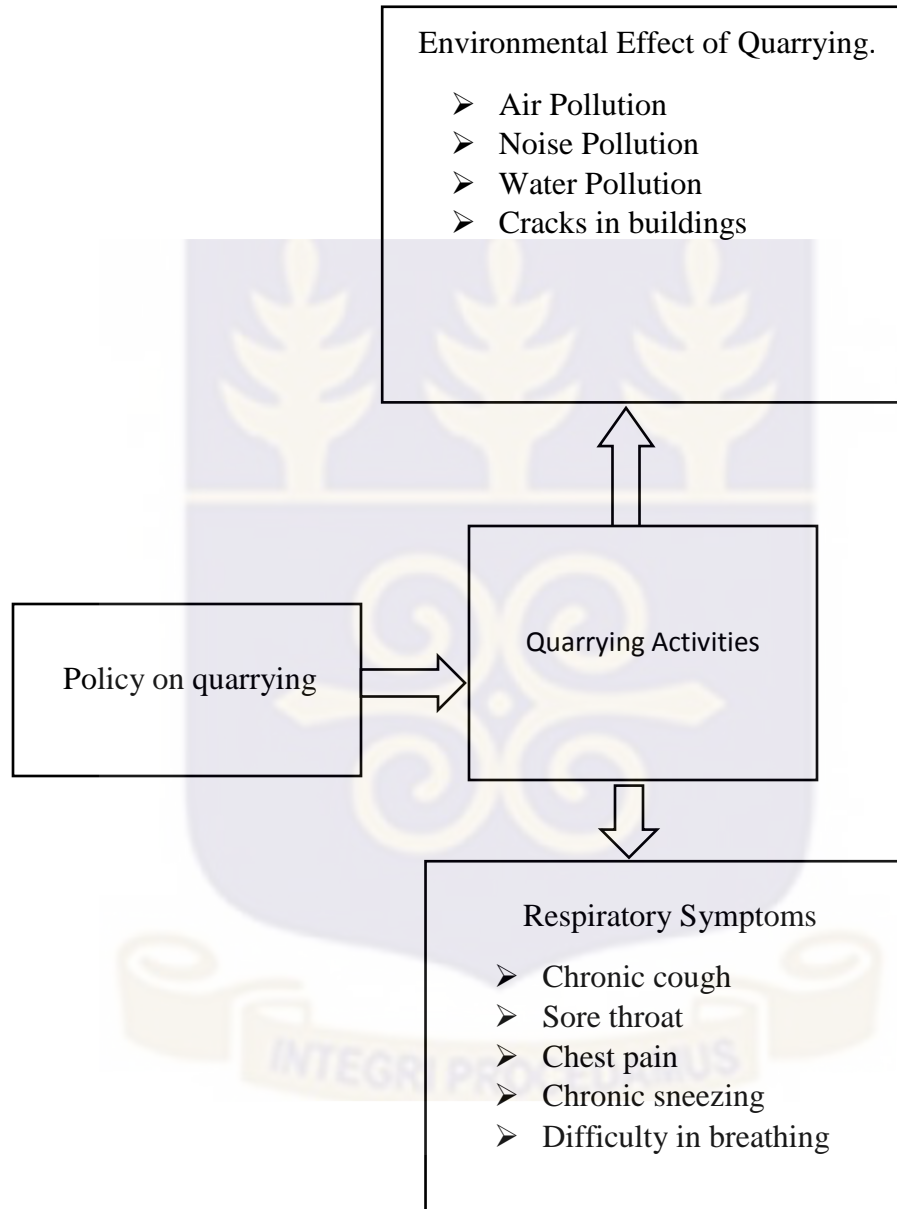
Dust can have a substantial impact on air quality. Generally the impacts diminish as distance from the source increases and the most acute impacts are likely to occur in enclosed spaces (for example the processing plant) or in close proximity to major sources (Sayara et al., 2016b). Impacts resulting from air quality degradation can include those related to health (although these are typically linked to occupational rather than environmental exposure), visual intrusion and, most commonly, nuisance for surrounding communities and businesses (Adeola & Abstract, 2009).

### **2.7 Policy and regulatory implications**

In order to address the issues related to the pollution that is associated with quarry activities, there is the need to put in place the right policy and regulations to ensure that the benefits associated with quarrying can be obtained not at the expense of the environment and the health of community members. Quarrying is done along a value chain system. The country in which quarrying is done needs to ensure that there is a well-structured value chain system to ensure that each player in the industry is identified. When this is done, the pre-requisites needed to ensure the right regulations can be noted and its related regulations instituted (Province, 2015).

The community who stand to lose the most with the operations of the quarry cannot be left out in the consultative process. When this is done well, it will enable the policy and regulatory direction to benefit a host of players. The measures can assist in providing the needed financial assistance to local entrepreneurs, developing the infrastructural potential of the communities and the setting up of bodies to ensure that the best practices are maintained and operations benefit all stakeholders (Eshiwani, 2014).

## 2.9 Conceptual Framework



**Figure 1.1: Conceptual Framework**

The figure 1 above represents the researcher's conceptual frame work of the effects of quarrying to the environment; the policies in place will influence the quarrying activities in the industry. The activity of the quarrying presents itself in two ways: the environmental effect which includes air Pollution, Noise Pollution, Water Pollution in Cracks in buildings and the health Respiratory Symptoms includes Chronic cough, Sore throat, Chest pain, Chronic sneezing, Difficulty in breathing



## CHAPTER THREE

### METHODOLOGY

#### 3.1 Introduction

This chapter focuses on tools which was used to conduct the study. It comprise the research design, target population, sample and sampling techniques, research Instruments and data collection procedures as well as data analysis.

#### 3.2 Study Area

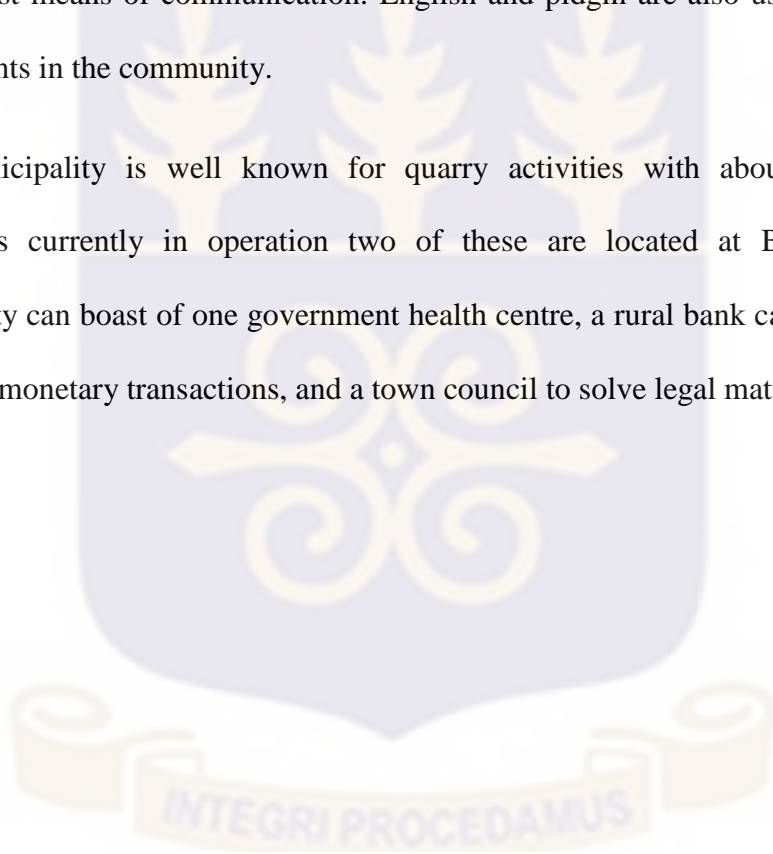
The Wenchi Municipality is located in the Brong Ahafo Region, One of the twenty-two administrative districts of the Brong Ahafo Region of the Republic of Ghana. The Administrative capital of the Municipality is Wenchi. The Wenchi Municipality can be found geographically on latitudes 7°30' and 8°05' North and longitudes 2o 15' West and 1o 55' East. The municipality occupies a land size of about 1,145 square kilometers. The Municipality is bordered on the West by the Techiman Municipal. To the south of the municipality is the Kintampo South District. To the northwest and east of the municipality is the Tain District and Sunyani West Districts respectively. Statistics from the 2010 Population and Housing Census indicated that the municipality has about 89,739 inhabitants. This represents about 3.9 percent of the Brong Ahafo region's entire population. The male population in the municipality stands at about 49.1 percent with the rest of 50.9 percent being females. The population is mostly rural in nature about sixty percent (60%) of the population (Ghana Statistical Service, 2010).

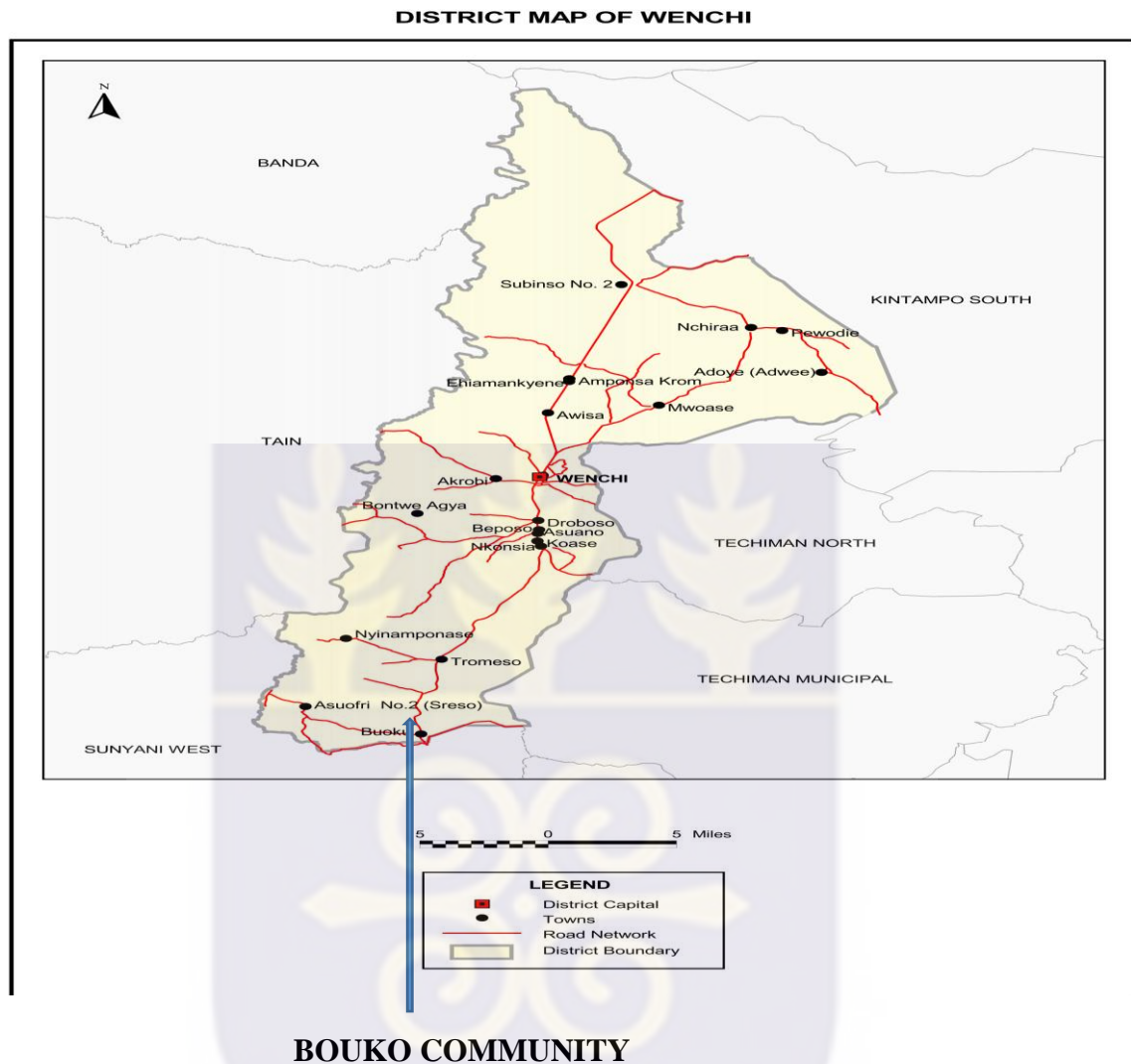
More than (57.8%) are engaged Agriculture. This is followed by sales and service industry then craft and trade, and some technical and professional employments.

Construction is mainly done with cement or concrete in the major towns. Mud and bricks are however the mainly materials when it comes to the villages and hamlets (Ghana Statistical Service, 2010).

The real inhabitants in Wenchi are the Bono. This, notwithstanding, does not deny the presence of other tribes such as Fante, Asante, and people from the northern part of Ghana perhaps due to its proximity with the northern sector. Bono and Twi are the commonest means of communication. English and pidgin are also used by few literates and students in the community.

The Municipality is well known for quarry activities with about four (4) quarry companies currently in operation two of these are located at Bouku. The bouku community can boast of one government health centre, a rural bank called (Capital Rural bank) for monetary transactions, and a town council to solve legal matters.





**Figure 2.2: Map of the Wench Municipality Showing the Buoko Township**

### 3.3 Research Design

A cross-sectional survey design was adopted for the study. Quantitative and qualitative methods of data collection were employed using questionnaire. Cross sectional study comprises survey in relation to data collected predominantly by the use of questionnaire or structured interview method. In using this design, the researcher was able to collect data on more than a single case at a single point in time especially with the topic under

study. Also, this design allows for a level of objectivity and reliability to be obtained. The cross-sectional survey design was employed because it helps the researcher to solicit the needed information to arrive at a tangible conclusion

### 3.4 Study Population

The study population was adult inhabitants of Buoko located in the Wenchi Municipality. The population which was considered for the study was adults residing in Buoko for at least three months at the time of the study and were of sound mind. The estimated population of Buoko as per the 2010 population and housing census was 2000.

### 3.5 Sample Size

The sample size for the study was 323 respondents which comprised the community members of Buoko. The sample size was calculated based on the total population size of 2000 (Ghana Statistical Service, 2010). The sample size was calculated at 95% confidence level and 5% margin of error. The sample size was arrived at using the formula below:

$$ss = \frac{Z^2 * (p) * (1-p)}{c^2}$$

$$ss = \frac{1.96^2 * 0.5 * (1-0.5)}{0.05^2}$$

$$ss = 323$$

Where:

$Z = 1.96$  for 95% confidence level

$p = 50\%$  which is 0.5

$c =$  confidence interval or margin of error which is 0.05

### **3.6 Sampling Technique**

The research employed probability sampling techniques such as cluster sampling, stratified sampling and simple random sampling technique to select the subjects for the study. First of all, cluster sampling was used to group the community into clusters according to the known suburbs within it. These locations were further stratified into households and popular community meeting places. This was done by way of stratified sampling. From the strata that were noted, a simple random sampling technique was conducted to select the sample size. This was done using 'yes' and 'no' coded pieces papers in a covered container. Based on the probability of being selected or otherwise members of, the population were made to pick a folded paper from the container. Those who chose pieces of papers with the 'yes' inscriptions formed part of the study. Those who selected the 'no' cards were excluded from the study.



### **3.7 Study Variables**

#### *3.7.1 Dependent*

##### **Environmental effect of quarrying**

Air pollution by dust, Noise pollution, Cracks in building, Water pollution by dust, Cloudiness of atmosphere

##### **Respiratory symptoms**

Chronic cough, Chest pains, Sore throat, Chronic cold, Chronic sneezing  
, Difficulty in breathing

#### *3.7.2 Independent variable*

Quarrying blasting, crushing, grinding of rock, policy on quarry

### **3.8 Research Instruments**

Research instruments used include the following as recommended by Kombo and Tromp (2006). The questionnaire was structured into different sections. The section A collected information on demographic characteristics such as, gender, occupation, etc. of the respondents of the study. The section B collected data on quarry activities and their effect on the health of respondents and lastly the section (C) collected data on the impact of quarry activities on buildings and farmlands.

Furthermore, in relation to measuring of dust concentration in the study area, the researcher used a Dust Measuring Device KM 3887. This served as the instrument for detecting accurately the levels of air pollution in the eight (8) Air Quality Locations

(AQL) the measurements were done and was compared with the EPA standard of air quality which is  $70 \mu\text{g}/\text{m}^3$  at any industrial area and  $65 \mu\text{g}/\text{m}^3$  within a community where a company is located.

Where; SD=Strongly Disagree, D=Disagree, U= Undecided, A=Agree, and SA=Strongly Agree.

### **3.9 Data Collection Procedure**

Questionnaire were administered to the sampled population by the researcher. This was with the aid of research assistants. The purpose and individual questions were explained to the respondents before administration of questionnaires in order to ensure accuracy of answers. The aim was to prevent or avoid any avenue that can compromise the quality of responses.

The research team established good rapport with respondents throughout the questionnaire distribution and collection periods to enable them feel comfortable to give independent and accurate information. The questionnaire was pretested before its administration to respondents.

#### ***Determination of the concentration of dust particles***

In measuring the dust concentrations, filter papers were used by the researcher. These filters have pore sizes that were noted to be less than 10 microns. These were used to collect particulates. These were first stabilized in a desiccator for a 24-hour period. The filters were then pre-weighed with an electronic balance (AG104 Mettler Toledo). The filters were then fitted into the PM10 samplers which draw air at a rate of  $5.000 \text{ m}^3$  per minute. Loaded filters with PM10 were removed and conditioned in a desiccator for 24

hours to ensure there was no moisture effect on the air particulate weight before re-weighing (M2). The study considered eight (8) site locations. Four (4) of these locations were at the quarry site and the other four (4) in the community. The mass concentration of the sampled particulates was then calculated using the equation below:

$$PM10 \text{ mass concentration } \left( \frac{\mu g}{m^3} \right) = \frac{\text{Sample particular matter (PM10) mass}}{\text{Flow rate } \left( \frac{l}{min} \right) \times \text{Time}}$$

$$= \frac{(M_2 - M_1) \times 10^6}{FR \times T}$$

Where;  $m_1$  = Initial milligram,  $m_2$  = Final milligram, FR = Flow rate, T = time, and PM = Particular matter.

#### ***Identification of respiratory problems associated with quarry activities***

In order to identify the various respiratory problem among the community members, they were given questionnaire to complete. The questionnaire contained questions regarding the various respiratory conditions that they experience in the community. The respondents were asked to indicate the kind of respiratory condition(s) that they ever experienced or they have been experiencing frequently.

#### ***Assessing the impact of quarry activities on selected buildings and farms***

The researcher personally observed the buildings in the community and farms near the quarry sites to identify the various impact of activities on the building. In doing this, the researcher listed the potential impact of the quarry activities using a checklist. Upon visiting nearby farms and buildings, any sign of the various impacts that the researcher spotted. The impacts that the researcher looked out for were cracks in buildings and

collapse of buildings waste farmlands. There were follow up questions in the questionnaire to confirm the actual cause of the damage on the building and farmlands.



**Figure: 3.1** Photos of some locations sampled for TSP and PM<sub>10</sub>



**Figure: 3.2:** Photos of some locations sampled for TSP and PM<sub>10</sub>

### **3.10 Data Analysis and Plan**

In general, the collected responses were analyzed with the Statistical Package for Social Sciences (SPSS) version 23.0 and STATA version 14. The SPSS was used for the coding and was exported to STATA for the final analysis. The responses obtained from completed questionnaires were first of all checked for accuracy and consistency. In the case of open-ended questions, they were grouped based on the responses given by the respondents. Regression analysis was done to determine the relationship between dust in the community and the prevalence of upper respiratory tract infections/diseases. The relationship between blasting and vibrations and its effect on buildings too was looked at and finally the relationship between quarrying activities and waste farmlands was also determined.

### **3.11 Ethical Considerations**

The following ethical issues were considered to ensure that the participants of the study are protected in all aspect required of academic research like this.

In order to ensure that the study causes no harm of any sort, the proposal for the study was first submitted to the School of Public Health, University of Ghana Studies for their approval. To ensure that the study protocols were ethically sound in relation to health-related research, the study proposal was also submitted for Ethical approval from the Ghana Health Service Ethical Review Committee before the collection of data needed for the study. The study ensured that no harm of any sort was done to the respondents of the study as a result of the conduct of this study. The data collected was used only for the purpose of academic research as explained to the respondents of the study. Academic dishonesty in terms of plagiarism was avoided in the study. Frantic effort was put in place

to ensure that all those whose studies were used as a point of reference were dully acknowledged both in text and at the Reference part of the study.



## CHAPTER FOUR

### RESULTS

#### 4.0 Introduction

The main objectives of this study is to assess some environmental effects and respiratory symptoms associated with stone quarry activities at Buoku in the Wenchi Municipality. The methodology used for the study was discussed in the previous chapter, the results of the study are presented in this chapter. The researcher in an attempt to collect data relevant to the study sampled 323 respondents from the quarry community in Bouku. Data on some environmental effects and respiratory symptoms associated with quarry activities in the community were ascertained using questionnaire and Dust Measuring Device KM 3887.

#### 4.1 Presentation of Results

##### 4.1.1 Demographic and Personal Characteristics

Table 4.1.1 below summarizes the distribution of demographic characteristics of respondents. In relation to sex 187 (58%) of respondent were female while 136 (42%) were male. Majority of the respondents were within the ages (26-36). A total of 183 (57%) of the respondents were married, 174 (54%) were Christian and 152 (47%) were secondary school graduates. Finally, relation to occupation, 96 (30%) of the respondents were farmers, 75 (23%) were traders and 75 (23%) work at the quarry company.

Table 4.1.1: Demographic Characteristics of the Respondents

<b>Demographic of Respondents</b>	<b>Frequency</b>	<b>Percentage</b>
<b>Sex</b>		
Male	136	42
Female	187	58
<b>Total</b>	<b>323</b>	<b>100</b>
<b>Age</b>		
15-25	60	19
26-36	100	31
37-47	90	28
48-58	73	23
<b>Total</b>	<b>323</b>	<b>100</b>
<b>Marital Status</b>		
Married	183	57
Single	76	24
Divorced	53	16
Widow	11	3
<b>Total</b>	<b>323</b>	<b>100</b>
<b>Religion</b>		
Christian	174	54
Muslim	64	20
Traditionalist	85	26
<b>Total</b>	<b>323</b>	<b>100</b>
<b>Educational Status</b>		
Tertiary	33	10.22
Secondary	152	47.05
Primary	84	26.1
No Education	54	16.72
<b>Total</b>	<b>323</b>	<b>100</b>
<b>Occupation of Respondents</b>		
Farmer	96	30
Trader	75	23
Teacher	32	10
Quarryman	54	17
Non-Employed	66	20
<b>Total</b>	<b>323</b>	<b>100</b>

#### 4.1.2 Assessment of atmosphere of quarry site and surrounding community for quarry dust concentration

The Table 4.1.2 below summarizes the result of assessment of air in the surroundings of the quarry site and the community for the dust particle. As shown, generally all the sample locations within the quarry site had higher levels of dust particles which were above the recommended Environmental Protection Agency (EPA) standards of (70  $\mu\text{g}/\text{m}^3$ ) with the highest concentration of dust (182.7  $\mu\text{g}/\text{m}^3$ ) being recorded at location AQL3 and the minimum of (81.3  $\mu\text{g}/\text{m}^3$ ) at location AQL 7. Also, the results show that all the communities around the quarry site recorded lower concentration of dust particle in the ambient air with the highest concentration of (68.8  $\mu\text{g}/\text{m}^3$ ) at location (QL2) and (52.9) in location AQL6

*Table 4.1.2: Concentration of dust particles in the atmosphere at quarry site and the surrounding community*

Dust Particles Concentration	Dust Concentration ( $\mu\text{g}/\text{m}^3$ )	
	Location ID	TSP (Total Suspended Particles)
<b>Quarry Site</b>		
AQL1	103.5	256.4
AQL3	182.7	632.2
AQL5	121.0	239
AQL7	81.2	192.0
<b>Surrounding Community</b>		
AQL2	68.8	153.2
AQL4	67.4	178.1

AQL6	52.2	190.2
AQL8	54.9	234.0
EPA(Standard)	70	230
IFC/WB (2000)	150	700

#### *4.1.3 Prevalence of respiratory symptoms associated with quarry Activities*

Table 4.1.3 summarizes analysis done on dust related diseases that the respondents suffered from. The results indicate that, 93.19% (301) of respondents normally suffer from Cough, 69.97% (226) from Sneezing, 79.6% (227) from Catarrh, 70.28% (227) from Sore throat, 66.50% (215) from short breath, 83.3% (269). Again, regression analysis was conducted using a chi-square test at 95% confidence level and 5% significance level to determine the associated between dust exposure and respiratory infections encountered by community members. The findings indicate that there was a significant association ( $p < 0.05$ ) between dust exposure and the occurrence of respiratory infections such as; chronic cough, catarrh, and short breath with probability values (p-values) of 0.001, 0.000, and 0.000 respectively. In other words, the probability values were less than the alpha value ( $p < 0.05$ ). The study however, revealed that there was no significant association ( $p > 0.05$ ) between dust exposure and the occurrence of respiratory infections such as; chronic sneezing, and sore throat with p-values of 0.090 and 0.213 respectively. In other words, the probability values were greater than the alpha value ( $p > 0.05$ ).

Table 4.1.3: Association of Dust exposure with presentence of respiratory symptoms among respondent.

Variable	Responses	Dusty air		Total	P-value
		Yes (%)	No (%)		
<b>Chronic Cough</b>	Yes	258(95.90)	43(79.6)	301(93.2)	<0.001
	No	11(4.1)	11(20.4)	22(6.8)	
	Total	269(100.0)	54(100.0)	323(100.0)	
<b>Chronic Sneezing</b>	Yes	183(68.1)	43(79.6)	226(69.9)	<0.090
	No	86(31.9)	11(20.6)	97(30.1)	
	Total	269(100.0)	54(100.0)	323(100.0)	
<b>Catarrh</b>	Yes	173(64.3)	54(100.0)	227(70.28)	<0.000
	No	96(35.6)	0(000)	96(2.7)	
	Total	269(100.00)	54(100.0)	323(100.0)	
<b>Sore throat</b>	Yes	183(68.1)	32(59.2)	215(66.50)	<0.213
	No	86(31.9)	22(40.7)	108(33.4)	
	Total	269(100.0)	54(100.0)	323(100.0)	
<b>Short breath</b>	Yes	247(91.8)	22(40.7)	269(83.3)	<0.000
	No	22(8.2)	32(59.3)	54(16.7)	
	Total	269(100.0)	54(100.0)	323(100.0)	

Table 4.4 reports the respondents' response to the respiratory symptoms. From the results, 55.7% responded positively to catarrh, 24.8% responded yes to chronic cough, 15.5% responded positively to chronic sneezing and headache as well, sore throat was recorded yes with 31% by respondents. 26.3% respondents also claimed that they get short breath, 27.9% respondents responded positively to heart problems while 24.8% respondents reported with yes to eye problem.

*Table 4.1.4: Response to respiratory symptoms*

Attribute	Frequency	Percent
<b>Chronic cough</b>		
Yes	80	24.8
No	243	75.2
<b>Chronic sneezing</b>		
Yes	50	15.5
No	273	84.5
<b>Catarrh</b>		
Yes	180	55.7
No	143	44.3
<b>Sore throat</b>		
Yes	100	31.0
No	223	69.0
<b>Short breath</b>		
Yes	85	26.3
No	238	73.7
<b>Heart problem</b>		
Yes	90	27.9
No	100	31.0
No response	133	41.2
<b>Headache</b>		
Yes	50	15.5
No	199	61.6
No response	74	22.9
<b>Eye problem</b>		
Yes	80	24.8
No	243	75.2

*4.1.5 Association between experimental group (worker) and control group (non workers) with some respiratory symptoms*

The results suggested that the non-workers and the workers with chronic cough have P-value ( $P < 0.474$ ), chronic cough and chronic sneezing ( $P < 0.445$ ), chronic cough and catarrh (0.527), chronic cough and short breath ( $P < 0.475$ ). Also, chronic sneezing and

chronic cough ( $P < 0.452$ ) and the other respiratory symptoms among non-workers and workers were all insignificantly related.

*Table 4.1.5: Association between experimental group (worker) and control group (non-workers) with respiratory symptoms*

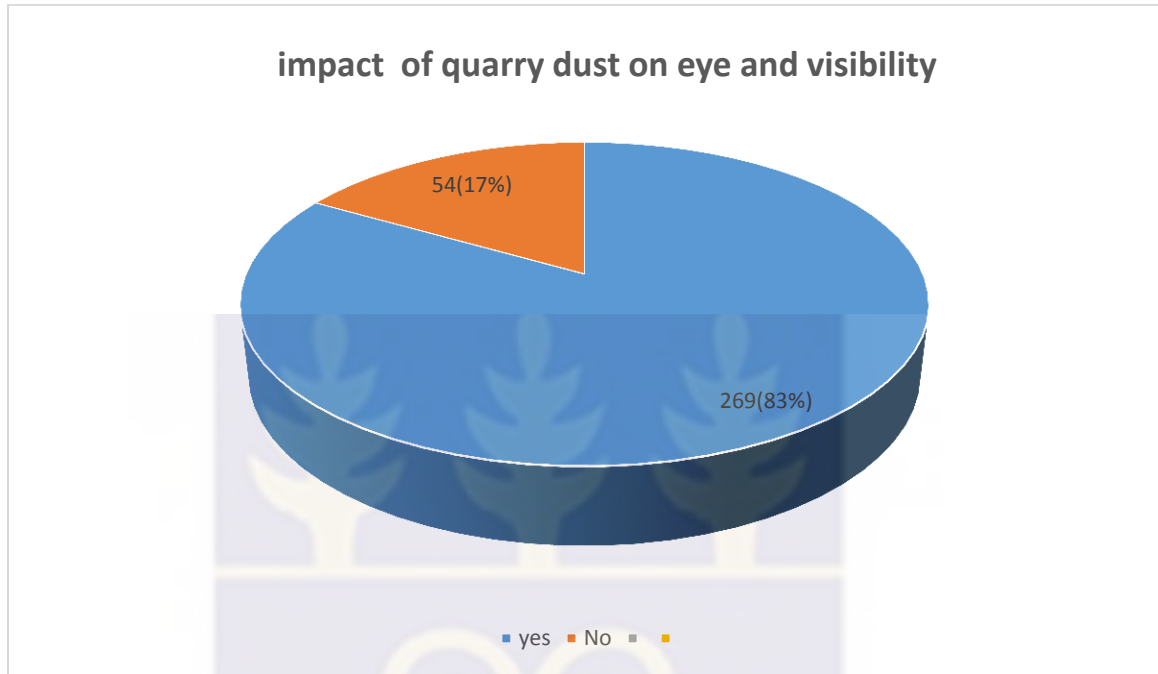
experimental group(worker) and control group	Chronic cough		P value
	Yes	No	
Attribute	Yes	No	
<b>Chronic cough</b>			
Yes	74	6	0.474
No	227	16	
	<b>Chronic sneezing</b>		
<b>Chronic cough</b>			
Yes	57	23	0.445
No	169	74	
	<b>Catarrh</b>		
<b>Chronic cough</b>			
Yes	56	24	0.527
No	171	72	
	<b>Short breath</b>		
<b>Chronic cough</b>			
Yes	66	14	0.475
No	203	40	
	<b>Chronic cough</b>		
<b>Chronic sneezing</b>			
Yes	46	4	0.452
No	255	18	
	<b>Chronic sneezing</b>		
<b>Chronic sneezing</b>			
Yes	36	14	0.452
No	190	83	
	<b>Catarrh</b>		
<b>Chronic sneezing</b>			
Yes	35	15	0.542
No	192	81	
	<b>Short breath</b>		
<b>Chronic sneezing</b>			
Yes	41	9	0.464
No	228	45	

	<b>Chronic cough</b>		
<b>Catarrh</b>			
Yes	168	12	0.539
No	133	10	
	<b>Chronic sneezing</b>		
<b>Catarrh</b>			
Yes	126	54	0.542
No	100	43	
	<b>Catarrh</b>		
<b>Catarrh</b>			
Yes	126	54	0.501
No	101	42	
	<b>Short breath</b>		
<b>Catarrh</b>			
Yes	150	30	0.547
No	119	24	
	<b>Chronic cough</b>		
<b>Short breath</b>			
Yes	79	6	0.544
No	222	16	
	<b>Chronic sneezing</b>		
<b>Short breath</b>			
Yes	59	26	0.499
No	167	71	
	<b>Catarrh</b>		
<b>Short breath</b>			
Yes	60	25	0.53
No	167	71	
	<b>Short breath</b>		
<b>Short breath</b>			
Yes	71	14	0.546
No	198	40	

#### 4.1.5 Impact of quarry dust on eye and visibility

Figure 4.1 below summarizes the responses of participants concerning dust obscuring visibility in the community. Most of the respondents out of 323 from the community 269

(83%) said yes which indicate that dust in the community affect eyes and hinder their visibility and 54 representing (17%) said No.



**Figure 4.1: Impact of quarry dust on eye and visibility**

Table 4.6 reports the respondents' response to the need for health screening. From the results, 30.34% strongly agreed that haulage trucks covered with sheets, 56.35% agreed, 9.91% disagreed and 3.41% strongly disagreed. For dusty haul roads, 33.44% strongly agreed that dusty haul road impede dust, 23.22% agreed, and 43.34% disagreed that haul road impede dust.

*Table 4.1.6: Response on the need for health screening*

Attribute	Frequency	Percent
<b>Haulage trucks covered with sheets</b>		
Strongly agree	98	30.34
Agree	182	56.35

Disagree	32	9.91
Strongly disagree	32	3.41
<b>Dusty Haul Roads Watered Regularly</b>		
Strongly agree	108	33.44
Agree	75	23.22
Disagree	140	43.34
<b>Nose Mask Worn Especially during Rock blasting</b>		
Strongly agree	86	26.63
Agree	129	39.94
Disagree	22	6.81
Strongly disagree	86	26.63
<b>Exposed Surface must be watered regularly</b>		
No Response	10	3.10
Strongly Agree	65	20.12
Agree	87	26.93
Disagree	140	43.34
Strongly Disagree	21	6.50
<b>Reduction of Drop height belts using sleeves</b>		
Strongly agree	96	29.72
Agree	172	53.25
Disagree	44	13.62
Strongly disagree	11	3.41
<b>Provision of Channels to drain Quarry run-offs</b>		
Strongly agree	173	53.56
Agree	75	23.22
Disagree	53	16.41
Strongly disagree	22	6.81
<b>Rehabilitation/ relocation of community members</b>		
Strongly agree	96	29.72
Agree	162	50.15
Disagree	43	13.31
Strongly disagree	22	6.81

Table 4.1.7: Association between dust impediment and need for health screening

Attribute	Dust impedes sight		P value
	Yes (%)	No (%)	
<b>Haulage trucks covered with sheets</b>			
Strongly agree	87 (81.6)	11(16.4)	0.001
Agree	150 (151.6)	32(30.4)	
Disagree	32(26.7)	0(5.3)	
Strongly disagree	0(9.2)	11(1.8)	
<b>Dusty Haul Roads Watered Regularly</b>			
Strongly agree	86 (89.9)	22(18.1)	0.001
Agree	75(62.5)	0(12.5)	
Disagree	108 (116.6)	32(23.4)	
<b>Nose Mask Worn Especially during Rock blasting</b>			
Strongly agree	75(71.6)	11(14.4)	0.069
Agree	107 (107.4)	22(21.6)	
Disagree	22 (18.3)	0(3.7)	
Strongly disagree	65(71.6)	21(14.4)	
<b>Exposed Surface must be watered regularly</b>			
No Response	10 (8.3)	0(1.7)	0.001
Strongly Agree	43 (54.1)	22(10.9)	
Agree	87(72.5)	0(14.5)	
Disagree	108 (116.6)	32(23.4)	
Strongly Disagree	21 (17.5)	0(3.5)	
<b>Reduction of Drop height belts using sleeves</b>			
Strongly agree	85(80.0)	11(16.0)	0.001
Agree	129(143.2)	43(28.8)	
Disagree	44 (36.6)	0(7.4)	
Strongly disagree	11(9.2)	0(1.8)	
<b>Provision of Channels to drain Quarry run-offs</b>			
Strongly agree	87 (81.6)	11(16.4)	0.001
Agree	150 (151.6)	32 (30.4)	
Disagree	32(26.7)	0(5.3)	
Strongly disagree	0(9.2)	11(1.8)	
<b>Rehabilitation/ relocation of community</b>			

<b>members</b>			
Strongly agree	96 (80.0)	0(16.0)	0.001
Agree	119 (134.9)	43(27.1)	
Disagree	43 (35.8)	0(7.2)	
Strongly disagree	11 (18.3)	11(3.7)	

#### 4.1.8 Association between dust impediment and need for health screening

The results suggest that the covering of trucks with sheets ( $P<0.001$ ), dusty haul roads ( $P<0.001$ ), exposed surface ( $P<0.001$ ), reduction of drop height belt ( $P<0.001$ ), provision of channels to drain quarry ( $P<0.001$ ), and rehabilitation of community members ( $P<0.001$ ), were all significantly related to dust impediment. On the other hand, wearing of noise mask was not significant.

*Table 4.1.8: Association between dust impediment and need for health screening (multiple logistic regressions)*

Attribute	AOR	(95% CI)	
<b>Haulage trucks covered with sheets</b>			
Strongly agree	Ref.		
Agree	0.21	0.32	1.02
Disagree	0.21	0.44	0.95
Strongly disagree	1.21	1.16	1.25
<b>Dusty Haul Roads Watered Regularly</b>			
Strongly agree	Ref.		
Agree	0.06	0.02	0.15
Disagree	0.11	0.25	0.33
Strongly disagree	0.89	0.68	1.09
<b>Nose Mask Worn Especially during Rock blasting</b>			
Strongly agree	Ref.		
Agree	0.20	0.09	0.31
Disagree	0.02	0.67	0.12
Strongly disagree	1.20	1.13	1.27
<b>Exposed Surface must be watered regularly</b>			

No Response	Ref.		
Strongly Agree	0.04	0.06	0.14
Agree	0.13	0.30	0.45
Disagree	0.12	0.01	0.23
Strongly Disagree	1.13	1.05	1.23
<b>Reduction of Drop height belts using sleeves</b>			
Strongly agree	Ref.		
Agree	0.34	0.10	0.57
Disagree	3.06	0.23	0.23
Strongly disagree	0.23	0.01	0.45
<b>Provision of Channels to drain Quarry run-offs</b>			
Strongly agree	Ref.		
Agree	0.14	0.04	0.23
Disagree	0.11	0.24	0.02
Strongly disagree	0.11	0.34	0.12
<b>Rehabilitation/ relocation of community members</b>			
Strongly agree	Ref.		
Agree	0.10	0.20	0.04
Disagree	0.25	0.36	0.37
Strongly disagree	0.25	0.41	0.18

#### **4.1.8 Association between dust impediment and need for health screening (multiple logistic regression)**

A multiple logistic regression was also conducted to test the association between the outcome variable and other independent variable and to control for confounders. From the results, respondents who disagree that haulage trucks covered with sheets leads to dust impediment (OR 0.21, 95%CI: 0.44-0.95), and those who strongly disagree that haulage trucks covered with sheets leads to dust impediment (OR 1.21, 95%CI: 1.16-1.25) were both significant determinants of dust impediment. However, participants who agreed (OR 0.06, 95%CI: 0.02 – 0.15), those who disagreed (OR 0.11, 95%CI: 0.25 - 0.33), and participants who strongly (OR 0.89, 95%CI: 0.68 – 1.09). Similarly, those who agreed the wearing of nose mask (OR 0.20, 95%CI: 0.09 – 0.31) and participants who

disagreed (OR 0.02, 95%CI: 0.67 – 0.12) were less likely to be associated with dust impediment. Contrary, those who strongly disagreed (OR 1.20, 95%CI: 1.13 – 1.27) were more likely to be associated with dust impediment. In considering exposed surfaces, respondents who strongly disagreed (OR 0.04, 95%CI 0.06 – 0.14), those who agreed that exposed surfaces must be watered (OR 0.13, 95%CI: 0.30 – 0.45), and respondents who disagreed (OR 0.12, 95%CI: 0.01 – 0.23) were all less likely associated with dust impediment. However, those who strongly disagreed that exposed surfaces must be watered to prevent dust impediment were more likely to associated with dust impediment (OR 1.13, 95%CI: 1.05 – 1.23).

#### **Impact of quarry activities on selected buildings**

Plate 1, 2, 3 and 4 summarize some environmental effects of stone quarry activities on selected buildings within the Buoku community as determine by personal observation. As shown, a number of buildings in the surroundings have developed cracks due to the effects of stone quarry activities.



Plate 1



Plate 2



Plate 3

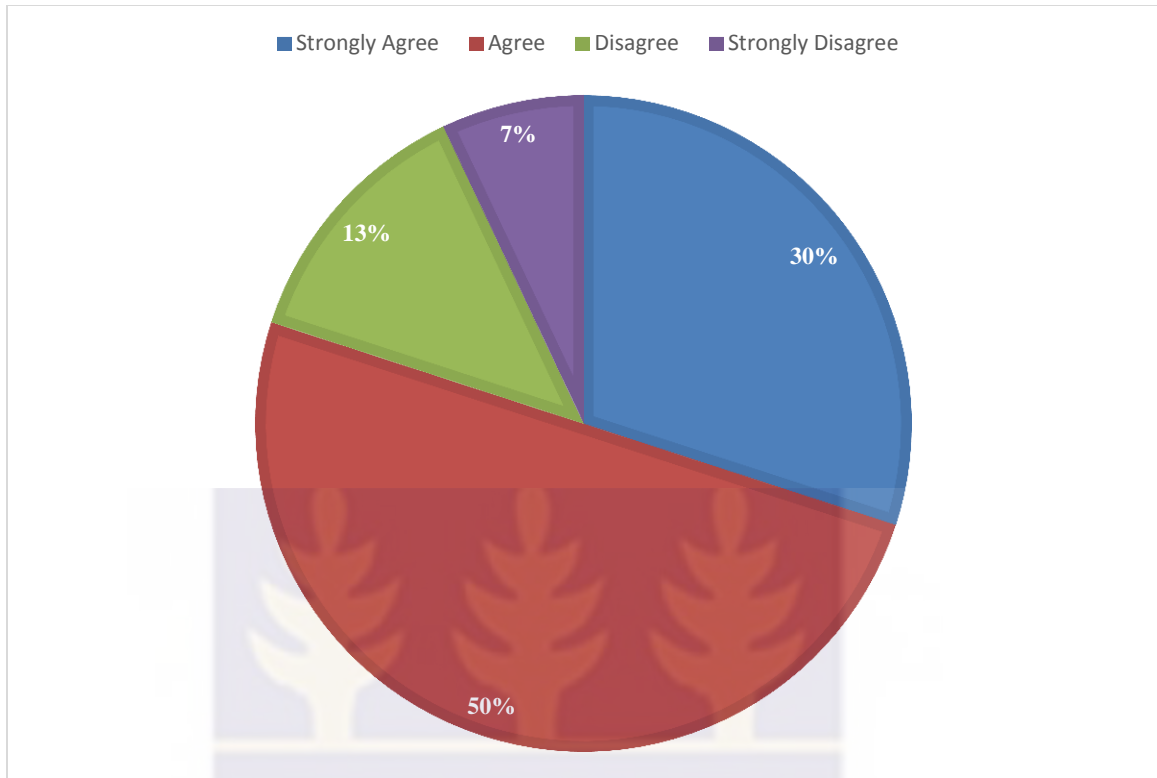


Plate 4

Plate 1, 2 3 and 4: Cracks developed by buildings in the Buoko community as a result of quarrying.

#### **4.1.7 The Need for Rehabilitation or Relocation**

The results from Figure 4.2, below shows that 30% (96) of respondents from the community answered 'Strongly Agree' that there is the need for rehabilitation and relocation of community members. While 50% (162) 'Agree' that there is the need for rehabilitation and relocation of community members. A total of 13% (43) also 'Disagree' that there is no need for rehabilitation and relocation of members of the community. While the remaining 7% (22) also 'Strongly Disagree' that there is no need for rehabilitation and relocation of community members.



**Figure 4. 2: The Need for Rehabilitation or Relocation**



## CHAPTER FIVE

### DISCUSSION OF RESULTS

#### 5.1 Introduction

The study assessed the environmental and health effects of stone quarry activities at Buoku in the Wenchi Municipality of the Brong Ahafo Region of Ghana. Quarry which falls into the extractive industry has been noted over the years to cause serious environmental and health challenges. Quarrying activities involve blasting and cracking of rocks into smaller grades for constructional purposes. The blasting and cracking of rocks lead to the release of copious amounts of sand particles into the atmosphere which upon exposure to the respiratory system and contact with the eye, may lead to respiratory and eye infections. Also, they may lead to cracks and premature collapse of buildings as well as destruction of farms in the surroundings.

Even though a number of studies have been conducted elsewhere (WHO, 2003), very few were in Ghana. Assessment of environmental effects and respiratory symptoms associated with quarrying in the Buoku community would provide baseline data to augment data required to formulate policy decisions to prevent adverse health effects of quarry activities on humans and degradation of the environment around quarry sites. Also, studies on activities and their effects would provide critical data needed to create awareness of the health and environmental consequences of quarrying among people living near quarry sites and the safety precautions that must be taken in order to prevent disease and protect the environment. Finally, studies on quarry activities at Buoku would generate information to augment scientific knowledge currently existing on the subject.

To meet these objectives, therefore, a cross-section of the individuals living in the surrounding community of Buoku quarry site were administered questionnaires to assess information on respiratory symptoms and environmental impact of the quarry activities among the inhabitants of the community. Also, measurement of dust particles in the atmosphere within the quarry site and the surrounding community was conducted using dust sampling machine.

Lastly, buildings and farm lands in the surrounding communities were observed for cracks characterizing the degradation effect of quarrying on the environment.

## **5.2 Demographic characteristic of respondent**

The demographic characteristics of the respondents indicated that a majority of them were educated, 10.22% (33.1/323) had tertiary level of education and 46.72% (152/ 323) had secondary education. At these levels of education, it was expected that health seeking behavior among them would be high. This is because, a majority could read and therefore, should be able to access information about the need to protect themselves against respiratory diseases associated with dust exposure. However, health seeking behaviour among them was low because most of them indicated that they never went for medical check –up or used personal protective equipment. It was therefore, not surprising that a high prevalence of respiratory symptoms associated with dust exposure was observed among the participants.

### **5.3 Assessment of dust particles in the atmosphere of the quarry site and the surrounding community.**

The results showed that the concentration of dust particles within air samples collected from various locations at the quarry site were higher than the Environmental Protection Agency (EPA) standard of  $70 \mu\text{g}/\text{m}^3$  and ranged between 81.2 to  $182.7 \mu\text{g}/\text{m}^3$ . Also, the total concentration of suspended particles within samples of air collected from the various locations within the quarry site were generally, higher than the EPA standard of  $230 \mu\text{g}/\text{m}^3$  and ranged from 239 to  $632.2 \mu\text{g}/\text{m}^3$ . These results confirm the report of earlier studies (Ferris speizer and Spengler, 1979) that quarry activities lead to the release of high concentration of dust particles into the immediate atmosphere surrounding the quarry site.

Even though the concentration of dust particles in the various samples of air within the quarry site were higher than the EPA standard of  $70 \mu\text{g}/\text{m}^3$  for particulate matter (PM) and  $230 \mu\text{g}/\text{m}^3$  for TSP most of these values were lower than the World Health Organization (WHO) standards of 150 and  $500 \mu\text{g}/\text{m}^3$  for  $\text{PM}_{10}$  and TSP respectively. It is however important to note that the EPA are the regulators of environmental pollution at various locations in Ghana and since, they are in charge of licensing for quarry operations in Ghana, we are more answerable to them than to the WHO. It is therefore, for these reasons that, we should be particularly concerned when the amount of pollutions we are generating are becoming higher than the limits that the EPA has set.

In addition, the results indicate that the concentrations of PM in the various air samples from the community were all lower than the EPA standard of  $70 \mu\text{g}/\text{m}^3$  with half of the samples, however, having particulate matter (PM) concentrations which ranged from 67.4

to  $68.8 \mu\text{g}/\text{m}^3$  and therefore give the signal that it is time for measures to be taken to control the emissions from the quarry activities. Also, the TSP concentration from air samples from various locations within the communities were generally lower than the EPA threshold of  $230 \mu\text{g}/\text{m}^3$  though one of them registered  $234.0 \mu\text{g}/\text{m}^3$  of TSP, which was slightly higher than the EPA standard and therefore, gives the signal that pollution by quarry dust particles at various locations within the community could also escalate if measures are not taken to control quarry dust emission into the environment. In spite of the foregoing, the fact that the concentrations of dust particles in the Bouku community were generally lower confirms the report by chaullya, chakrborty and Sing (2001) that concentration of dust particles that are measured in air samples from communities around quarry site are usually lower than those within the quarry itself.

#### **5.4 Respiratory symptoms associated with quarry dust exposure among participants**

The study found that the various respiratory infections that were associated with the quarry activities include; cough, catarrh and shortness of breath. Other related respiratory infections that were found include frequent sneezing and sore throat. It turned out that a chi –square analysis of the relationship between the presence of respiratory symptoms and exposure to dust particles showed that they were significantly associated ( $p < 0.05$ ). Quarry dust is known to contain minerals such as silica and asbestos and respiratory exposure have been linked with respiratory disease as reported by several writers in the field (Nartey et al., 2012). In view of this, the fact that a majority of the participants reported that they had respiratory symptoms which were significantly associated with higher levels of quarry dust in the atmosphere suggests that probably they had developed such respiratory symptoms as a result of exposure to quarry dust which affirms his study

of Urom SE, Antai AB, Osim EE. (2004) chronic exposure to dust generated from crushing of granite rocks impairs lung function and causes some respiratory and non-respiratory symptoms in quarry workers. Based upon these observations, it is therefore important to note that while levels of quarry dust in the community atmosphere are generally lower than the Ghana EPA standards measures must be put in place to prevent them from worsening.

### **5.5 Impact of quarry activities on the environment**

The blasting and crashing of rocks which cause vibration in the earth (Province, 2015). These vibrations create shock waves which travel along the ground causing disruption of the integrity of land for farming and eventually lead to cracks and gullies (Akobzaa, 2000). Eventually these, factors are reported to disturb the foundations of buildings and other structures on the land causing them to crack and collapse with time (Akabzaa, 2000). Vibrations, cracks and galleys that occurs in farm lands are also reported to lead to erosion of the top soil which eventually make the land unable to support agricultural activities (ICMM, 200). In line with the various report stated above, findings of this present study show that a number of buildings in the quarry community have cracks in them while some have collapsed as shown in the photographs (Plate 1-4).

Furthermore, observations from the study show that quarry activities in the Bouku community have adversely affected certain nearby farmlands and probably contributed to the reasons why they cannot support crop cultivation. In addition, the present study shows that quarry dust particles in the atmosphere make the environment cloudy, enter eyes of community members and make visibility poor.

In view of the foregoing, quarry activities at the Buoku Stone Quarry could be said to have deleterious effect on the environment and health of the people living in the surrounding community. There is therefore the need to regulate the activities of such companies.



## **CHAPTER SIX**

### **CONCLUSION AND RECOMMENDATIONS**

#### **6.1 Introduction**

The section presents a summary of the whole work, draws conclusions and makes relevant recommendations.

#### **6.2 Conclusion**

The study noted that the dust concentration level in the community was lower compared to the EPA standards. In the quarry however, the observed levels were noted to be far higher than the EPA standards.

The study found a significant association between exposure to dust particles from the quarry activities and respiratory infections such as cough, shortness of breath and catarrh. Except for frequent sneezing and sore throat which were found to be insignificant, all the other dust related health challenges were significant.

In relation to the effect of blasting and vibrations and other activities of the quarry on buildings and farmlands, the study identified a significant relationship between the variables. There was also a significant relationship between the activities of the quarry and the quality of surrounding farmlands indeed, the observed loss of farmlands in the community due to quarrying has directly affected the livelihood of the people. Before, since farming is the major occupation of the community, destruction of farmlands is dangerous to the survival of the community members.

The activities of the quarry apart from emission of dust levels above the EPA standards, adversely affected the buildings in the community. Dust emissions have a number of

health implications that need to be addressed. The community has lost farmlands due to the activity of the quarry and this directly affects their livelihood.

### **6.3 Recommendations**

From the results and discussion of the study the following recommendations are offered to address some of the challenges identified in the study:

1. The EPA need to visit the site of the quarry and put in place regulations to ensure that the levels of noise and dust concentrations are within the allowed limits. Operating beyond these limits has consequences on the whole environments and especially the health of the workers in the quarry.
2. Regular environmental inspection and monitoring of quarrying activities should be enforced in order to ensure adherence to the standards and limits of the concentrations of the dust generated from the different stages of their operations.
3. The health directorate and other stakeholders in health also need to put in place measures to ensure that the health challenges identified in the community are prevented. In cases where diseases have occurred some form of intervention to assist in addressing these challenges can be carried out.
4. In relation to their buildings, relocation can be done or community members can be assisted by the quarrying companies and other stakeholders to put up buildings with firm foundations that can withstand the vibrations. This can prevent the collapsing of buildings and causing the death of community members.
5. Further research can be conducted into the Corporate Social Responsibility activities of the Quarry in the community and the policies in place to address the

challenges that the operations of the quarry have presented to community members. This will assist in identifying the measures that should be put in place to address some of the challenges that the community members face and their coping strategies in the community.

6. The quarry workers should be adequately informed on adverse health effects of exposure to quarry dust and the importance of using personal protective equipment while at work.



## REFERENCES

- Access, O. (2016). Respiratory symptoms and ventilatory functions among quarry workers in Edo state, Nigeria, 8688, 1–9. <https://doi.org/10.11604/pamj.2016.23.212.7640>
- Adeola, \*Oguntoke Olusegun; Aboaba Adeniyi and Gbadebo T., & Abstract. (2009). Impact of Granite Quarrying on the Health of Workers and Nearby Residents in Abeokuta Ogun State, Nigeria \*Oguntoke Olusegun; Aboaba Adeniyi and Gbadebo T. Adeola. *Ethiopian Journal of Environmental Studies and Management Vol.2*, 2(1), 1–11.
- Adekoya, J. A. (2003). Environmental Effect of Solid Minerals Mining. *J. Phys. Sci. Kenya*. Retrieved January 4, 2018 from <http://www.academicjournals.org/ijbc>.
- Aigbedion, I. N. (2005). Environmental Pollution in the Niger-Delta, Nigeria. *Inter Disciplinary J. Enugu-Nigeria*. Retrieved January 4, 2018 from <http://www.academicjournals.org/ijbc>.
- Akabzaa, M. T. (2000). *Boom and Dislocation - The environmental and social impacts of mining in the Wassa West District of Ghana*. Third World Network. (TWN-Africa).
- Anand PB (2006). Waste management in Madras revisited. *Environ.Urbanization*, 11(20): 161-176.
- Azad S.A and Dr. Ashish Mittal (2006). The Stone quarrying industry around Delhi impact on Worker and the Environment.
- Bada, B. S., Olatunde, K. A., & Akande, O. A. (2013). Air Quality Assessment in the Vicinity of Quarry Site. *Environment and Natural Resources Research*, 3(2), 111–115. <https://doi.org/10.5539/enrr.v3n2p111>
- Banez, J., Ajon, S. M., *et al* (2010). Report on Quarrying and its environmental effects. *U.N. Journal*, Vol 10.
- Co, B. S. (2016). Impact of Occupational Safety and Health on Organizational Performance in East Africa.

- Elizabeth, B. (2006). Small-Scale Stone Quarrying: Its Contribution to People ' s Livelihoods . A Case Study Kasenge Parish , Nama Sub-County , Mukono District By Birabwa Elizabeth M . Phil Thesis in Development Studies ( Specializing in Geography ) Submitted to Department of, 140.
- Eshiwani, F. (2014). Effects of quarrying activities on the environment in Nairobi county: a case study of Embakasi district., (October).
- Fedra, K., Winkelbauer, L., Pantulu, V. R. (2005). *Systems for Environmental Screening. An Application in the Lower Mekong Basin*. Laxenburg, Austria: International Institute for Applied Systems Analysis, p. 169.
- Feldman, J. A. (2006). *From molecule to metaphor: a neural theory of language*. Boston MA: MIT Press.
- Ferris, B. G., Speizer, F. E., & Spengler, J. D. (1999). Effects of Sulphur Oxides and Respirable Particles on Human Health: Methodology and Demography of Populations in Study. *American Review of Respiratory Disease*, 120(4), 767-779.
- Gizaw, Z., Yifred, B., & Tadesse, T. (2016). Chronic respiratory symptoms and associated factors among cement factory workers in Dejen town , Amhara regional state , Ethiopia , 2015. *Multidisciplinary Respiratory Medicine*, 1–9. <https://doi.org/10.1186/s40248-016-0043-6>
- Impacts, S. (2016). Impacts of Stone Quarrying on Environment and Livelihood of Local Community in Addis Ababa Peri-Urban Areas : The Case of Hana Mariam Cobble Stone Quarry Site By: Zelalem Abate For the Fulfillment of MA Degree in Population Resource and Development Submi.
- Lameed, G. A., & Ayodele, A. E. (2010). Effect of quarrying activity on biodiversity : Case study of Ogbere site , Ogun State Nigeria, 4(11), 740–750.
- Makori, E. M., Nandi, O. M. J., Thuo, J. K., & Wanyonyi, K. W. (2012). Influence of occupational health and safety programmers on performance of manufacturing firms in Western Province , Kenya, 4(May), 46–58. <https://doi.org/10.5897/AJHC11.036>
- MWANGI, S. N. (2014). an Assessment of Environmental Impacts of Quarrying Activities
- Nartey, V. K., Nanor, J. N., & Klake, R. K. (2012). Effects of Quarry Activities on Some Selected Communities in the Lower Manya Krobo District of the Eastern Region of Ghana. *Atmospheric and Climate Science*, 2012(July), 362–372.

- Nyakeniga, A. C. (2009). *AN ASSESSMENT OF ENVIRONMENTAL IMPACTS OF STONE QUARRYING ACTIVITIES IN NYAMBERA LOCATION KISII COUNTY A Research Project Report Submitted In Partial Fulfillment for the Requirements of a Bachelors Degree in Environmental Planning and Management at Kenyatt.*
- Oyinloye, M. A., & Ajayi, G. E. (2015). The Journal of Macro Trends in Energy and Sustainability ENVIRONMENTAL IMPACT ASSESSMENT OF QUARRY ACTIVITIES IN OBA-ILE , ONDO STATE , NIGERIA. *The Journal of MacroTrends in Energy and Sustainability*, 3(1), 31–45.
- Province, L. (2015). Dust exposure , respiratory symptoms and Dust exposure , respiratory symptoms and disease among informal quarry workers in Lusaka Province , Zambia, (December).
- Quartey, S. H., & Puplampu, B. B. (2012). Employee Health and Safety Practices : An Exploratory and Comparative Study of the Shipping and Manufacturing Industries in Ghana, 7(23), 81–95. <https://doi.org/10.5539/ijbm.v7n23p81>
- Gale, A, N., & Groat, C. G. (2001). Potential Environmental Impacts of Quarrying stone in Karst, *US Geological Survey*. Retrieved January 4, 2018 from <http://pubs.usgs.gov/of/2001/ofr-01-0484/ofr-01>.
- Gauch, H. G. (2001). *Multivariate Analysis in Community Ecology Cambridge*. University Press.
- Ghana Statistical Service. (2010). Population and Housing Census. *Ghana Statistical Service Report*. GSS.
- Ghotkar, V. B., Maldhure, B. R., & Zodpey, S. P. (2012). Involvement of lung and lung function tests in stone Quarry workers. *Indian Journal Tuberculosis*, 42, 155 - 160.
- Gizaw, Z., Yifred, B., & Tadesse, T. (2016). Chronic respiratory symptoms and associated factors among cement factory workers in Dejen town , Amhara regional state , Ethiopia. *Multidisciplinary Respiratory Medicine*, 1–9.
- Health and Safety Council Annual Report (2008/09). ISBN: 978-1-919853-36- ... *health and safety* at mines through focused research and *guidance* on best practice, effective ... The development of the terms of *reference*.

- Iqbal, M. Z., & Shafiq, M. (2001). *Periodical effect of cement dust pollution on the growth of some plants*. Turk: J. Botany.
- Kombo, D. K., and Tromp, D.L.A., (2006). *Proposal and thesis writing: An introduction*. Nairobi: Pauline Publications Africa.
- Lameed, G. A., & Ayodele, A. E. (2010). Effect of quarrying activity on biodiversity: Case study of Ogbere site, Ogun State Nigeria. *African Journal of Environmental Science and Technology*, 4(11), 740-750.
- Langer, W. H. (2001). Potential Environmental Impacts of Quarrying Stone in Karst. *Open file report*. U.S. Geological Survey.
- Langer, W.H., Drew, L.J. & Sachs, J.S. (2004). *Aggregates and the environment*. American Geological Institute (US Geological Survey) 4220 King Street, Alexandria, VA 112302; ISBN 0-922152-71-3
- Lolcama, J. L., Cohen, H. A., & Tonkin, M. J. (1999). Deep karst conduits, flooding and sinkholes: Lessons for the aggregates industry, in Beck, B.F., Pettit, A.J., and Herring, J.G., Hydrogeology and engineering geology of sinkholes and karst. *Proceedings of the Seventh Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst*, A.A. Balkema, 51–55.
- Mabogunje A L (2008). The Debt to Posterity: Reflection on a National Policy on environmental Management N.P.O. Sada and T. Odemerho (ed). Environmental Issues and Management in Nigerian. *Afr. J. Environ. Sci. Technol. Development*, 750.
- Malm, W. C. (1999). Considerations in the measurement of visibility. *Journal of the Air Pollution Control Association*, 29(10), 1742-1752.
- Mengeshe, Y. A., & Bekele, A. (1998). Relative chronic effects of occupational dust on respiratory indices and health of workers in three Ethiopian factories. *American Journal of Industrial Medicine*, 34, 373-80.
- Montgomery, W. C. (1992). *Environmental Geology* (3rd Edition). Dubuque: Wm C. Brown Publishers.

- Musyoka, P. J. (1997). *Impact of quarry to the environment and land use a case study of stone quarrying in Kangudo division*. E-Repository, University of Nairobi.
- Mwangi, S. N. (2014). an Assessment of Environmental Impacts of Quarrying Activities. *Atmospheric and Climate Sciences*, 2, 362-372.
- Muneku, E., & Naidoo, S. (2015). Dust exposure , respiratory symptoms and Dust exposure , respiratory symptoms and disease among informal quarry workers in Lusaka Province , Zambia, (December). *Integrated Chronic Disease Management*, 21(6), 4-9.
- Nanor, J. N. (2011). Assessment of the Effects of Quarrying Activities on Some Selected Communities in the lower Manya Krobo District. *Msc thesis*, Ghana, Accra.
- Nickling, L., & Boas, A. (1998). Influence of Vegetation Cover on Sand Transport by Wind: Field Studies at Owens Lake. *California Earth Surface Processes and Landforms*, 23(1), 69-82.
- Nwibo, A. N., Ugwuja, E. I., & Nwambeke, N. O. (2012). Pulmonary Problems among Quarry Workers of Stone Crushing Industrial Site at Umuoghara, Ebonyi State, Nigeria. *The International Journal of Occupational and Environmental Medicine*, 3, 178-185.
- Oduro, C. Y., Adamtey, R., & Ocloo, K. (2015). Urban Growth and Livelihood Transformations on the Fringes of African Cities: A Case Study of Changing Livelihoods in Peri-Urban Accra. *Environment and Natural Resources Research*, 5(2), 81–98.
- Okafor, F. C. (2006). Rural Development and the Environmental Degradation versus Protection: In P. O. Sada and T. Odemerho (ed.). *Environmental Issues and Management in Nigerian Development*. Nigeria: Abuja University Press.
- Patton, L. (2009). Signs, toy models, and the a priori: from Helmholtz to Wittgenstein. *Studies in the History and Philosophy of Science*, 40 (3): 281–289.
- Sayara, T. (2016a). Environmental Impact Assessment of Quarries and Stone Cutting Industries in Palestine : Case Study of Jammain. *Journal of Environment Protection and Sustainable Development*, 2(4), 32–38.

- Sayara, T. (2016b). Environmental Impact Assessment of Quarries and Stone Cutting Industries in Palestine : Case Study of Jamma. *Journal of Environment Protection and Sustainable Development Vol.*, 2(4), 32–38.
- Sayara, T., Hamdan, Y., & Basheer-salimia, R. (2016a). Impact of Air Pollution from Quarrying and Stone Cutting Industries on Agriculture and Plant Biodiversity. *Resources and Environment 2016*, 6(6): 122-126 DOI:, 6(6), 122–126. <https://doi.org/10.5923/j.re.20160606.04>
- Sayara, T., Hamdan, Y., & Basheer-salimia, R. (2016b). Impact of Air Pollution from Quarrying and Stone Cutting Industries on Agriculture and Plant Biodiversity, 6(6), 122–126. <https://doi.org/10.5923/j.re.20160606.04>
- Strongman, K. T., & Overton, A. E. (1999). Emotion in late adulthood. *Australian Psychologist*, 34(2), 104–110.
- Strongman, K. T. (1990). Evaluating emotional theory. A review of *The Person and Primary Emotions*. *Cognition and Emotion*, 4, 375–380.
- Strongman, K. T. (1993). Emotion theory and cognitive behaviour therapy. *Behaviour Change*, 10, 141–153.
- Strongman, K. T. (1995). Theories of anxiety. *New Zealand Journal of Psychology*, 24(2), 4–10.
- Strongman, K. T. (1996). *Emotion and memory*. In C. Malatesta-Magai & S. H. McFadden (eds) *Handbook of Emotion, Adult Development and Aging*. New York: Academic Press.
- Sullivan, D. E. (2006). Materials in use in U.S.A. *Crushed Stone: Silicosis*. Interstate Highways. United States Geological Survey Mineral Information. Factsheets.
- Taylor, G. R. (2005). *Integrating quantitative and qualitative methods in research*. Maryland: University Press of America Inc.
- Tanko, A. (2007). Environmental concerns, assessment and protection procedures for Nigeria's oil industry. Centre for Development studies and the school of Geography. *Geol. Environ. Sci.*, Nigeria: BUK.

UNESCO. (1995). *MAB Regional Training Workshop*. Akure, Nigeria, 23–26.

-7.

Urom SE, Antai AB, Osim EE. (2004) Symptoms and lung function values in Nigerian men and women exposed to dust generated from crushing of granite rocks in Calabar, Nigeria. *Niger J Physiol Sci.*;19(1-2):41–47.

Vermeulen, J., & Whitten, T. 1999). *Biodiversity and cultural property in the management of limestone resources*. Washington, D.C.: World Bank, p. 120.

Wang. A. (2007). Principle of Environmental Impact Assessment Best Practice. International Association for Impact Assessment. *Environ. Prot. The role of law*. China.

Ward, D. E., Peterson, J., & Hao, W. M. (1993). An Inventory of Particulate Matter and Air Toxic Emissions from Prescribed Fires in the USA for 1989. *86th Annual Meeting and Exhibition of Air and Waste Management Association*, 13(18), 19, Denver.

WHO (1997) *Guidelines for drinking-water quality*, 2nd ed. Vol. 3. Surveillance and control of community supplies. Geneva, World Health Organization. Available at [http://www.who.int/water\\_sanitation\\_health/dwq/guidelines4/en/](http://www.who.int/water_sanitation_health/dwq/guidelines4/en/).

WHO (2008) Pirimiphos-methyl in drinking-water: Use for vector control in drinking-water sources and containers. Background document for preparation of WHO Guidelines for drinking-quality. Geney, World Health Organization (WHO/HSE/AMR/08.03) *Philosophical Investigations*. Oxford: Blackwell.

World Bank. (2001). *Dynamic Risk Management and the Poor: Developing a Social Protection Strategy for Africa (draft)* World Bank Africa Region. Washington, D.C: World Bank

World Health Organization WHO (2003b) *Report of the WHO workshop: Nutrient minerals in drinking water and the potential health consequences of long-term consumption of demineralized and remineralized and altered mineral content drinking waters*. Rome, 11–13 November 2003 (SDE/WSH/04).

Zheng, Z., Dionisio, K. L., Arku, R. E., Quaye, A., Hughes, A. F., & Vallarino, J. (2011). Household and Community Poverty, Biomass Use and Air Pollution in Accra, Ghana. *Proceedings of the National Academy of Sciences of the United States of America*. Washington DC.



**APPENDIX**  
**RESEARCH QUESTIONNAIRE**  
**UNIVERSITY OF GHANA**  
**GRADUATE SCHOOL**

I am a final year student of the above mention institution pursuing masters in occupational hygiene. I am collecting this data to aid in a research entitled “Assessment of some environmental effects and respiratory symptoms associated with Stone quarry activities at Buoko in the Wenchi.”. You may refuse to answer any of the questions that you do not feel comfortable to answer.

**SECTION A: DEMOGRAPHIC DATA**

Age

- a) 18-30 [ ]
- b) 31-40 [ ]
- c) 41- 50[ ]
- d) 51 and above [ ]

Marital status:

- a) Married [ ]
- b) Single [ ]
- c) Divorced [ ]
- d) Widow

**Religion**

- a) Christian [ ]

- b) Muslim [ ]
- c) Other, specify

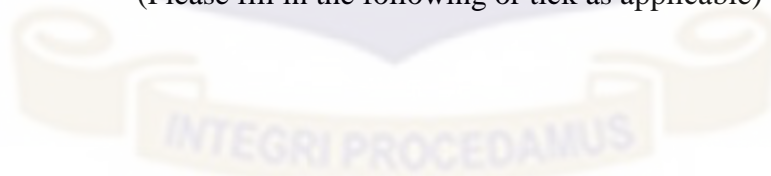
**Educational background:**

- a) Primary [ ]
- b) Vocational [ ]
- c) Secondary [ ]
- d) University [ ]

**Occupation:**

- a) Farming [ ]
- b) Trading [ ] c)
- Quarrying [ ] d)
- Teaching [ ]
- e) Specify other.....

(Please fill in the following or tick as applicable)



**SECTION B: QUARRYING ACTIVITIES (IMPLICATIONS)**

A) STRONGLY AGREE (SA)      B) AGREE(A)    C) DISAGREE( D)    D)  
STRONGLY DISAGREE (SD)

QUESTIONS		RESPONDS			
S/N		SA	A	D	SD
1	The main source of dust in your village is quarrying by the companies involved.				
2	Concentration of dust in the atmosphere is highest during blasting of rocks?				
	Crushing, conveying, sieving, and haulage of gravel produce a lot of dust?				
	Vehicles transporting quarry products on the unsurfaced roads also generate much dust				
	Dry weather promotes dust emission				
	Windy weather facilitates emission of dust.				
	Sunny weather promotes distant movement of dust.				
	Rainy and Cold weather reduce the amount of dust in the air				

	Many living things have lost their homes (habitats) due to rock removal, noise and dust deposition.				
	Dust is a nuisance to you?				
	Dust affects your health?				

Have lands in and around the concession been destroyed? Yes [  ] No [  ]

Are heaps of quarry waste and holes filled with water found around the sites? Yes [  ] No [  ]

Is it true that farmlands near the concession cannot be used to grow crops? Yes [  ] No [  ]

Restoration of degraded land must start immediately. Yes [  ] No [  ]

### **SECTION C: HEALTH IMPLICATIONS**

Has the noise level affected your hearing? Yes [  ] No [  ]

Has any of your buildings developed cracks due to blasting vibrations? Yes [  ] No [  ]

The main cause of cracks in buildings in the village is vibration blasts. Yes [  ] No [  ]

Has any of the cracked buildings collapsed? Yes [  ] No [  ]

Has any member of the community died in a collapsed building? Yes [  ] No [  ]

What is the life span of a well maintained mud house in the village?

Does dust prevent you from seeing things a distance away? Yes [  ] No [  ]

Can these heaps of quarry waste be considered an eyesore? Yes [  ] No [  ]

Which dust related disease do you usually suffer from? (You may tick more than one).

Chronic Cough [  ]

Chronic Sneezing [  ] Catarrh [  ]

Sore throat [  ]

Difficulty breathing sometimes, high reaction to dust) [  ]

Short breath [  ]

(Occasional cough, general nausea, body weakness, fever) [  ]

Heart problem [  ]

Headache [  ]

Eye problems [  ]

Whistling of chest [  ]

Water harvested from roofing spouts is usually unclean (contains dust). Yes [  ] No [  ]

Your frequent ill health may be associated with dust, flooded farmland or rain water from roofs.

Yes [  ] No [  ]

**SECTION D: CONTROL MEASURES**

ASTRONGLY AGREE (SA) B) AGREE (A) C) DISAGREE (D) D) STRONGLY  
DISAGREE (SD)

QUESTIONS		RESPONDS			
S/N		SA	A	D	SD
	Health screening should be organized every 1 or 2 years				
	Haulage trucks must be covered with sheets.				
	Dusty haul roads must be watered regularly using water tankers.				
	Nose masks must be worn especially when rocks are blasted.				
	Exposed surfaces(stockpiles) must be watered regularly				
	Reduce drop heights from conveyor belts using sleeves				
	Channels must be provided to drain quarry run-offs.				
	Communities must either be relocated or buildings rehabilitated.				

**THANK YOU**