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DEPARTMENT OF MATERIALS ENGINEERING

THE IMPACTS OF SAND WINNING: A CASE STUDY OF AFIGYA-KWABRE DISTRICT

By

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DECLARATION

I, Lois Karikari, hereby declare that, this is the result of my own work and that no previous submission for a master's degree has been made here or elsewhere. Works by others, which serve as sources of information, have been duly acknowledged by reference to the authors.

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ABSTRACT

Socio-economic activity like sand winning is very important to the economy and contributes to employment generation to the local people. It also contributes to revenue generation for the District Assembly and the landowners. The extraction of sand does not only provide building materials but also generate employment to the local people directly in winning or extraction of sand as well as indirectly in transportation and sale of the sand. However, these activities have serious adverse effects on the environment and render the land unproductive. The activities are associated with longterm effects on the inhabitants of the affected communities, as well as effects on water bodies and health effects on the people. The study sought to examine the impact of sand winning on the environment. The methodology adopted for the study was a case study whereby a convenience random sampling of 100 people was selected for the study in the Afigya Kwabre District of Ashanti Region in Ghana. Findings revealed that even though sand winning activities have benefits such as employment for the youth in the communities and revenue generation for both the District Assembly and the contractors, the negative effects far outweigh the benefits. The activities lead to polliitiòn of wat sources, degradation and loss of agricultural landS and also health hazards. To address the challenges, measures are recommended including awareness campaigns, collaboration with relevant agencies, legalisation of sand winning activities, effective monitoring and primary health programmes.

DEDICATION

For being sources of inspiration and examples, for encouraging me to follow my dreams, for making me believe that I could reach for the stars if only I stretch my hand, this is dedicated to you, my wonderful family, and one I will find nowhere. I love you all. To God be the glory!

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CHAPTER ONE

INTRODUCTION

1.1 General Introduction

This chapter presents the background to the study, problem statement, purpose of the study, research questions, objectives of the research and significance of the study.

1.2 Background of the Study

Environmental issues are now high on the agenda of all governments worldwide. This is as a result of the realization that development and the environment are inseparable and that utilization of resources to satisfy man's needs should not be done without ecological considerations. The international concern for the environment stems from various scientific, practical and visible evidence of massive environmental degradations in the world. These types of evidence include desertification, the depletion of the ozone layer and greenhouse effect, droughts in certain parts of the world (e.g Ethiopia, Sudan, Zimbabwe, etc.), deforestation of virgin forests, incidence

of floods (e.g. . Bangladesh) and landslides (Mungo, 1990). Environmental damage is brought about by human and economic activities which include mining activities (e.g. sand winning and mineral mining), unsuitable methods of farming, indiscriminate felling of trees for timber logs and fire wood, fumes and pollutants from small, medium and large scale industries. One of such key emerging environmental concerns in recent times is the issue of sand winning.

Sand winning has been valued for many decades by the building industry because of its contributions to the construction of buildings and development in general. It produces materials that are used in road and building construction, landscaping and other general construction uses. The extraction of sand does not only provide building materials but also generates employment to the local people directly in the winning or extraction of sand as well as indirectly in transportation and sale of the sand. Sand also serves so many agricultural purposes. Sandy soils are ideal for crops such as watermelons, peaches and peanuts, and their excellent drainage characteristics make them suitable for intensive dairy farming. Sand makes a low cost aquarium base material which some believe is better than gravel for home use. It is also an absolute necessity for saltwater reef tanks, which emulate environments composed largely of aragonite sand broken down from coral and shellfish. Sand is used for beach nourishment, thus governments move sand to beaches where tides, storms or deliberate changes to shoreline erode the original sand. Another reason for sand mining is for the extraction of minerals such as rutile, ilmenite and zircon, which contain the industrially useful elements titanium and zirconium. These minerals typically occur with ordinary sand-rwhich is d-trg—üÝWe valuable minerals being separated in water by virtue of their different densities, and the remaining ordinary sand re-deposited.

Ashraf et al (2011), defined sand winning as the removal of sand from its natural configuration. This can be done legally or illegally. Although the end results of the use of illegal sand winning may have some social and economic benefits, it can also have environmental problems. Environmental problems occur when the rate of extraction of sand, gravel and other materials exceed the rate at which natural processes regenerate these materials. The negative effects of illegal sand winning far outweigh any social and economic benefit that the practice may have (Walters-Delpeche, 2012). Sand winning creates concerns for environmentally conscious individuals in terms of the impact that it has on land, water, flora, fauna and the air. The aspect of sand wining as a developmental activity and the fact that it is one of the primary activities of human kind from time immemorial has become a major concern now.

This practice has become a global phenomenon and an environmental issue as the demand for sand increases in industry and construction. This practise is often destructive and poorly managed (or in some instances like in Ghana unmanaged). The negative effects of sand winning including permanent loss of sand in areas, as well as major habitat destruction are thus a major concern. In Ghana, the practice is becoming an environmental issue and affected communities and environmentalists are raising public awareness of

illegal sand winning. In some communities, this can lead to conflict among community farmers competing for lands, where post-sand winning restoration is not possible. According to Ghose (1989), unscientific mining has caused degradation of land, accompanied by subsidence and consequential mine fires and disturbance of the watertable leading to topographic disorder, severe ecological imbalance and damage to landuse patterns in and around mining regions. Operations of mining, whether small or large-scale, are inherently disruptive to the environment (Makweba & Ndonde, 1996). Rosenstock (2003) indicates that the significance of environmental factors to the health and well-being of human populations' is increasingly apparent. Although people in general are familiar with the need and importance of sand winning as construction material, the awareness of the negative impact this has on the environment (vegetation, biodiversity and food security) may not be known.

Efforts are being made by the government of Ghana to help address this environmental problem. For instance the 1986 budget highlighted some of the problems that posed threats to the environment and outlined some remedies to combat the environmental threat to the existence of the national economy. In furtherance of this, the Ghana Forest Resource Management Project, supported by the Overseas Development Administration of the United Kingdom and other donor agencies, was set up by the Ministry of Lands and Natural Resources with the responsibility of establishing sound management practices and a hopeful future for generations to come (Botchway, 1986).

At—the- same time, the National Environmental Protection Council was charged with the task of preparing a comprehensive National Environmental Action Plan with the objective to define a set of policy actions, related investments and institutional strengthening activities to make Ghana's development strategy more environmentally sustainable (Ghana Environmental Action Plan, 2009). The policies aimed at a sound management of resources and the environment and to avoid any exploitation of these resources in a manner that might cause an irreparable damage to the environment. Specifically, the policy provides for:

- a sound management of natural resources and the environment, the protection of humans, animals, plants and their habitats;

- guidance for healthy environmental practices in national development efforts; and

- integration of environmental considerations in sectorial, structural and socio-economic planning at all levels, the maintenance of ecosystems and ecological processes essential for the functioning of the biosphere and to seek a common approach to regional and global environmental issues.

In Ghana, most of the socio-economic activities like sand winning, logging, farming, industrial activities are not controlled. These activities have serious adverse effects on the environment which threaten the very existence of the whole country.

Sand-winning is an important activity for the infrastructural development of the Afigya-Kwabre District in the Ashanti Region of Ghana. The high demand for sand by the construction industry at the periphery/peri-urban areas of Kumasi has resulted in the mining of peri-urban settlements in Ghana. Sand can be used for making concrete, filling roads, building projects, brick-making, glass making, sand papers, reclamations, etc.

Agriculture is a low return, sustenance activity practiced year after year by the people of Afigya-Kwabre District on the same piece of land and may not cause much hazard to the environment and topography, while sand winning is a high return industry to lands where large deposits of concentrated sand occur. Sand winning changes the topography of the area and triggers environmental hazards. Recently, activists and local villagers have protested against sand winning, although the activity is providing informal work for people who would otherwise be unemployed. It is also destroying the natural beauty of the area, driving away tourists, business owners and residents, and contributing to erosions in the communities. For instance, while millions of US dollars are used by the government to mitigate the effects of the sea along the coast, which in some cases result in the resettlement of whole or part of communities such as Keta in the Volta Region, some unscrupulous people are actually degrading the beaches through sand winning in the full glare of some state agencies for financial gain. There is therefore the urgent need to address and control these activities to ensure a sustainable and environmentally friendly development.

1.3 Problem Statement

Crop_production underpins the socio-economic fabric of rural households thereby contributing to poverty alleviation in most rural settlements in Ghana. This makes land the focal point for both human survival and economic development especially for the farming communities, as it provides diverse functions in support of ecosystem processes, livelihoods and food security. However, in an attempt to meet the increasing population and the development of the economy, it leads to the degradation of the land and the environment. Environmental degradation due to over-exploitation of natural resources and these utilization in the production of goods and services in various sectors of the economy to meet the growing population is becoming a major problem.

In Ghana, most of the socio-economic activities like sand winning, logging, farming, and industrial activities are becoming uncontrollable. These activities have serious adverse effects on the environment which threaten the very existence of the whole country. One of such environmental problems facing inhabitants of farming communities is sand winning. Sand winning activities has its associated immediate and long term effects. The intensive nature of the activity is destroying the lands rendering it unproductive. The effect leads to the reduction of area of agricultural lands, and hence compelling farmers in farming communities to seek for lands at far ends of the community. People, who are also farming on other peoples land, are made to move out to make way for the contractors to carry on their activity on the land. Any attempt to promote food production and security would be fruitless, unless-activities like-§äñŒÇinning on arable lands are checked. The process also leads to the pollution of some water bodies and denying communities access to quality water. Pipes are also laid in some of the water bodies to divert water ways to enhance easy work on river beds. The activity has become so rampant that every piece of land is now vulnerable and farmers continue to harbour fears, since they do not know exactly when their farms will be destroyed. Gullies are created at sites close to homes becoming

breeding grounds for mosquitoes during rainy seasons, posing threat to human health.

The high demand for sand by the construction industry has resulted in the mining of farmlands at an alarming rate. There is therefore the urgent need to address and control these activities to ensure a sustainable and environmentally friendly development. However, there are no guidelines for these activities and individuals and contractors normally extract sand without the approval of the District Assemblies. With increasing population pressure, it is feared that any form of unguided exploitation of this natural resource (Sand) will lead to an environmental calamity and threaten the community members and hence the whole district.

1.4 Main Aim

The main aim of the study was to determine the effects of sand winning activities on the environment in the Afigya-Kwabre District in Ghana.

1.4.1 Specific Objectives

The specific objectives were:

1. To determine the ex ent to which sand winning activities contribute to environmental degradation and their effect on humans
2. To determine the perceptions of people on the side effects of sand winning activities on the environment
3. To determine the effect of sand winning activities on agricultural lands in particular and
4. To measure the areal extent and quantities exploited.

1.5 Research Questions

The study sought to answer the following research questions:

1. To what extent do sand winning activities contribute to environmental degradation?
2. What are the perceptions on the side effects of sand winning activities on the environment?
3. What are the effects of sand winning activities on humans?

4. What are the effects of sand winning activities on agricultural lands?

1.6 Significance of the Study

This study is very important for a number of reasons. First and foremost, the results of this study would serve as guidance for decision makers such as the Environmental Protection Agency and the District Assemblies who are specifically involved in the review of environmental issues on sand winning and gravel extraction operations to make more informed decisions.

Again, the study would also bring to the attention of chiefs, community leaders, land owners and sand winning contractors of both short-term and long-term effects of sand winning on the environment and to recommend efficient control measures to safeguard the environment. It would also bring awareness to individuals on the effects of sand winning activities on the environment.

The study also serves as a reference point for researchers interested in sand winning activities and related issues. Future researchers who want to work in this area would also know what has been done in Ghana and the areas where there are gaps to fill since there has not been much study on the impact of sanding winning on the environment in Ghana. It would also contribute to the existing knowledge on the impact of sanding winning activities.

1.7 Justification

Several factors necessitated the selection of the research topic using Afigya-Kwabre as the study area. Despite sand winning being an important activity for the infrastructural development of Afigya-Kwabre District in the Ashanti Region, Ghana, the high demand for sand by the construction industry at the periphery/peri-urban areas of Kumasi has resulted in the mining and degradation of peri-urban settlements in Ghana.

Afigya-Kwabre District is a farming community but of late, sand winning activity is very rampant. The intensive nature of the activity is destroying the lands rendering it unproductive. The effect leads to the reduction of size of their agricultural lands.

It is also feared that any form of unguided exploitation of this natural resource would lead to environmental calamity. There is therefore the need to address this issue early to achieve the goal of food security and to minimise other adverse environmental effects.

Finally, the researcher is also amiliar with the study area as a staff at the Ministry of Food and Agriculture at the unit of Crops, Environment and Sustainable Land Management. This would enhance efficiency in data collection during the field survey. The information obtained helps the understanding of the impacts of sand winning activities.

1.8 Scope of the Study

The study was limited to the Afigya-Kwabre District to cover the impact of sand winning activities on the environment. The choice of the area became necessary because, it is one of the areas where sand winning activities is very rampant. However, informal discussion with community members indicated that knowledge on the impact of the activity is very low hence, the decision to study the impact of sand winning on the environment in the district.

Due to constraints in the time frame within which the study had to be completed as well as financial constraints, the study did not cover the whole of the Afigya-Kwabre District but was limited to Boamang Soko, Amoako No. 1, Amoako No.2, Aboabogya and Kwaman communities. The total number of respondents selected from the two communities in the district for the study was hundred (100) and this included both sand winning contractors and affected farmers in the District Assembly. The time frame for the field study was three (3) months. The study examined the geography of the district as a whole and the ollowing issues:

1. Identification of the present contributions of sand winning to the local economy as well as the benefits derived by the community and District Assembly.
2. Assessment of the extent of the present adverse effects of sand winning activities on farmlands.
3. Identification of activities involved and the operational performance of the sand winning industry in terms of acquisition of concessions and equipment used and finally
4. The future environmental impacts of sand winning activities.

1.9 Limitations of the Study

Challenges were encountered in the collection of data for the study. The most frustrating was the unwillingness of the District Assembly and the sand winning contractors to supply information with the suspicion that such information will be used against them.

Indifference on the part of some of the community members especially landowners who are beneficiaries of sand winning activities as respondents were a limitation to the study as some of them felt uncomfortable.

Funding for this research work was also a major challenge which limited the studies to only Boamang Soko, Amoako No. 1, Amoako No.2, Aboabogya and Kwaman. The financial problems encountered included the cost of GPS to assess the stretch of land affected by sand winning activities. Money for communication, travel an transportation to the communities, to and fro, the cost— of data analysis and printing of questionnaires were all major challenges. In view of the above challenges, the study was limited to only a total of hundred (100) respondents in the Boamang Soko, Amoako No. 1, Amoako No.2, Aboabogya and Kwaman communities in the Afigya-Kwabre District of the Ashanti Region.

1.10 Organisation of the Study

Chapter One of the study contains general introduction, the structure of the work, problem statement, objectives of the study, problems encountered and the organization of the study.

Chapter Two consists of a thorough discussion on the existing studies conducted by various researchers on sand winning and its impact on the environment in general.

Chapter Three of the study contains the study area, research material and methods applied for the study. This discussion focuses on issues such as the sample size and selection, data collection, the research instruments and data analysis of the research.

Fourth Chapter consists of results, data analysis for the data collected for the study and their discussion.

The concluding chapter (Chapter Five) consists of summary of findings, conclusions, suggestions for the communities, district assemblies, EPA and interested government groups, as well as recommendations for future studies.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews relevant literature on sand winning across the globe covering sand winning and its usage in general as well as the economic benefits. It addresses the global trend in stone, sand and gravel winning and the various impacts such as physical, deforestation, water pollution, health, economic, environmental effects and environmental policies in Ghana.

2.2 Sand Winning

Construction companies are involved in works ranging from buildings to expansion and renovation of structures in Ghana. Most key materials required for construction purposes are sourced locally. As a result sand, stones and gravel are obtained in significantly larger quantities from quarries. Herein lies the environmental scourge on the face of the communities. It is rapidly becoming an ecological problem as the demand for sand increases in industry and for construction. Most of the quarry sites are located within peri-urban co—nLt1es.

The activities are carried out not only by these construction companies but also by individuals operating on commercial basis. Some of the companies claim to have obtained licenses from the government to carry out these excavations but this claim is often denied by local authorities and community leaders.

The demand for sand winning is growing around the world, particularly in developing countries, such as Ghana, where rapid economic development causes strong growth of the construction industry. Sand winning has a number of adverse environmental impacts (Sonak et al., 2006), which was first reported in the developed world. Concerns about environmental impacts, is increasingly reported in Ghana (Mensah, 2002). Consequently, it has been argued that, because of this globalizing extent and the magnitude of its impacts, sand winning should be considered as an aspect of global environmental change (Sonak et al., 2006). Sand needs to be exploited to satisfy human demands but this requires efficient and effective resource management to ensure economically and environmentally sustainable utilisation (Youba et al., 2002).

2.3 Uses of Sand

Sand winning is the removal of sand from their natural configuration. It is indispensable for many economic development activities such as road construction building houses and concrete production. It also has other familiar uses such as glass-making for window panes, glassware, glazing for pottery, lenses,,-television tubes—mirrors, fibreglass reinforcement, lamps, stained glass art, lasers, insulators, telescopes, bottles and containers for alcohol, soft drinks, and food items such as jams and pickles (USGS, 2011). However, it is also used in several concealed ways such as hydraulic fracturing applications (Anon., 2012), in making of semi-conductors that are used in almost every electronic device today ranging from notebooks to mobile phones and even in cars. Sand is also a source for strategic minerals such as Silica, Garnets, Thorium, and other ores such as Titanium, Uranium, Zirconium, Ilmenite which are in turn used in applications too numerous to list here (Corpwatch, 2007). Nonetheless, two examples can be given to illustrate the breath taking use of sand:

a. Titanium is used in the production of lightweight alloys, aircraft components (jet engines, aircraft frames), automotive components, joints replacement (hips ball and sockets), paints, watches, chemical processing equipment, marine equipment (rigging and other parts exposed to sea water), pulp and paper processing equipment, pipes and jewellery (IIEDD and WBSCD, 2002).

b. Heavy Minerals such as rutile, sillimanite and monazite are also sourced from sand. They also find use in the paint industry, welding electrodes, ceramics, foundry and various applications like plastics, sun screen, food colouring and biomedical applications (Corpwatch, 2007).

2.4 Economic_Benefits of§and-Winning

Sand has become a very important mineral for society due to its many uses. It can be used for making concrete, filling roads, building projects, brickmaking, glass making, sandpaper, reclamation, etc. The role of sand is very vital with regards to the protection of the coastal environment. It acts as a buffer against strong tidal waves and storm surges by reducing their impacts as they reach the shoreline. Sand is also a habitat for crustacean species and other related marine organisms.

The composition of sand is highly variable, depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and non-tropical coastal settings is silica (silicon dioxide, Si02). It is usually in the form of quartz, which because of its chemical inertness and considerable hardness, is the most common mineral resistant to weathering. The bright white sands found in tropical and subtropical coastal settings are eroded limestone and may contain coral and shell fragments in addition to other organic or organically derived fragmental material.

Due to rapid industrialization, urbanization and associated developments, rivers are widely exploited for river bed materials like sand and gravel. Liberalized housing schemes for building constructions mainly from banking sector are some of the causative factors responsible for unabated sand mining from river beds (Padmalal et al., 2008). For thousands of years, sand and gravel have been used in th construction of roads, dams and buildings (Ojos Negros Research Group, 2008). Major constituents of any of these structures, by volume or weight, are the aggregates (sand and stone). Very few structures in their permanent forms are made without the aggregates. Today, demand for sand and gravel continues to increase at a geometric dimension.

Many people get employed and more families have increased income and so on through sand winning. As a matter of fact, NIOSH (2003) asserted that in 2001 alone, a total of 7,131 sand and gravel mining operations reported employment statistics to the Mine Safety and Health Administration (MSHA) of the USA in its area of jurisdiction. There is quite some debate about the contributions of sand winning to sustainable development and sustainable livelihoods. For many people, especially those who are involved in the activity in both rural and peri-urban areas, sand winning is a welcome solution to their problems.

Sand winning also serves as secondary occupation. At the same time, there is the tendency for most operators to change occupation from farming and adopt sand winning as their primary occupation especially the male youth. However, the evaluation of economic performance and progress of sand winning under-estimates the negative contributions of the sand winning industry.

In terms of total volume, aggregates of construction minerals (such as sand and gravel) account for the largest material volumes mined in the world where the global production in 2000, was estimated to exceed 15 billion t/y (IIED and WBCSD, 2002). The irony of this situation is that despite being extracted at such gargantuan rates, sand is classified a 'low value' resource and also a 'minor' mineral resource even in legislation in many countries such as India (MAC, 2007).

Globally, the demand for sand is fuelled by numerous factors. It appears that sand has been long commoditized and is now entrenched in global trade. Table 1.1 shows the high trade value of this commodity. Despite the high value of this trade, or perhaps because of it, the activity is surprisingly depoliticised except when there are public concerns in specific areas.

Table 1.1 Global Trade in Stone, Sand and Gravel

Top Importers	Top Exporter

Countries	Trade Value (US S)	Countries	Trade Value (US S)
China	6,673,837,246	Germany	2,746,361,846
Singapore	2,628,966,030	Turkey	2,466,239,274
Italy	2,579,533,848	India	1,995,113,770
Germany	2,308,306,827	Italy	1,858,309,185
Netherlands	1,920,444,284	Belgium	1,786,925,486
Others	24,207,603,293	Others	20,396,258,376
Total Imports	40,318,691,528	Total Export	31,249,207,937

Compiled from UN Comtrade, United Nations Commodity Trade Statistics Database (2011)

2.5 Impacts of Sand Winning

With globalisation, there is a tendency for infrastructure, especially urban ones to be similar across geographies (Hoering, 2008). Roads, bridges, airport runways are soon becoming ubiquitous. Availability of sand or the lack thereof thus directly or indirectly affects all who partake in this cup of modernity. The immediate effects of the lack though are felt most by the local community. Contrary, to literature that says sand winning is not environmentally damaging, it may be even more so because of its insidious nature and the fact that its effects often take decades to surface. Mining for iron ore or bauxite may cause alteration of the landscape so violently that its ill-effects are impinged on the viewer's consciousness instantly whereas the gradual transformation of sand into bridges, roads, houses, paints, glassware, and other things that are taken for granted in modern urban lives is almost imperceptible. To the non-local spectator, nothing seems to be lost in the process beyond the inconvenient depletion of sand and creation of visible craters in some instances.

With rapid urbanisation across the world, such as a perpetual demand vis-avis a limited supply of an easily available resource such as sand creates a rather complex situation with many winners and losers. Problems associated with sand winning have been reported across many regions of the world (Young and Griffith, 2009). Some examples include Australia (Global Witness, 2010), Ghana (Mensah, 1997), India (Hoering, 2008), Tanzania (Nyandwi, 2001) and Namibia (Hartman, 2010).

However, there is also a literature that explicitly states that sand winning is not as environmentally destructive as other kinds of mining. For example United States Geological Survey (2011) states that 'except for temporally disturbing the immediate area while mining operations are active, sand and gravel mining usually has limited environmental impact.' There is therefore the need to protect the environment due the numerous reported impacts.

2.5.1 Environmental Impacts

Environmental problems in Ghana range from desertification to deforestation in the northern parts of the country. The government has over the years tried to tackle some of these challenges through policy formulations, appropriate legal frameworks but the degree of success of these attempts are a matter for debate. For those who have had the experience of environmental and ecological degradation, especially sand winning, there is a feeling of injustice over alleged crimes to the environment which are mostly manmade.

Sand wining is a direct and obvious cause of erosion, and also impacts local wildlife. Disturbance of underwater and coastal sand causes turbidity in the water, which is harmful for such organisms as corals that need sunlight. It also destroys fisheries, causing problems for people who rely on fishing for their livelihoods. Removal of physical coastal barriers such as dunes leads to flooding of beachside communities and the destruction of pictures of awe beaches causing tourism to dissipate.

The soils are highly susceptible—to-erosion because they are highly porous, permeable and of loose structure. During or after heavy rains cases of land sinking and fractures are not uncommon. The increasing intensity of the various forms of agricultural, commercial, industrial and sand winning activities increasingly impacts negatively on the sustainability of the growth of towns.

Maponga (1995), indicates that mining of minerals is an environmentally unfriendly activity and has thus attracted global attention from the standpoint of its environmental impact. Mining generally, affects all the components of the environment and the impacts are permanent/temporary, beneficial/harmful, repairable/irreparable, and reversible/irreversible. Impacts produced by sand winning activities are felt most by the ecology, land and atmosphere. According to Whitehead (2007), although sand winning is expected to be regulated by law in many places, it is still many a times done illegally. It is rapidly becoming an ecological problem as the demand for sand increases in industry and construction (Wikipedia, 2008). The environmental devaluation that is an aftermath of man's activities such as sand winning on land include disturbance of the landscape, distorted topography, agriculturally unproductive terrain, creation of pools of water for breeding pests, deforestation and general degrading of the ecosystem with air/land/water pollution. Wikipedia (2008) and Alexander & Hansen

(1983) grouped the negative impacts on the environment into three:

a) disturbance to aquatic ecosystem,
b) increase in turbidity which in in turn can affect aquatic species metabolism and interfere with spawning and
c) tertiary impacts to fauna.

Hazards on the environment brought about by sand and gravel winning activities are substantial and damaging. Sand winning can cause changes to channel morphology in rivers through the lowering of the riverbed during extraction (Rinaldi et al, 2005). This is enhanced by the disruption to bed armour caused by excavations and the movement of machinery which makes the bed vulnerable to fluvial erosion (Mossa & McLean, 1997). In Ghana, sand winning is widespread, highly unregulated, uncontrolled and is being carried out at an alarming rate. The gravity of the situation beyond the affected communities and the region at large is enormous and poses threat not only to the environment but also to food security. Chiefs and land owners give out land for monetary gains caring less about the effects of the mining activities on the people and the environment (Imoru, 2010).

2.5.2 Physical Impacts

Generally, the most severe direct physical impact of sand winning aggregate extraction relates to substratum removal, alteration of bottom topography and re-deposition of material (Newell et al., 1998). These in turn affects plants.

Plant roots have three main functions:

l) anchoring the plant in the soil,

2) absorption of water and nutrients and
3) synthesis of organic compounds needed by the plant (Drew and Goss, 1973).

The amount of water and nutrients available to the plant is largely determined by the total volume of soil exploited by its' root system. The volume of soil explored by a plant's root system depends on root genetic properties and soil physical factors. The primary physical factors affecting root growth is soil density and associated strength. Soils with high bulk density and strength will limit root growth by mechanical impedance (Gerard et al., 1982). Roots grow through the soil by penetrating voids or by moving soil particles (when possible) when there are no voids (Taylor, 1974). When a soil is compacted or disturbed, the number and size of pores is reduced. In a study of rooting in mine soils, McSweeney and Jansen (1984) reported that rooting was limited in massive and compacted mine soils, but was prolific in what they termed "fritted" minesoils.

Sand winning pits leave behind open pits which all constitute hazards. At times, these sites are near to peri-urban centres where they are used for dumping solid waste and garbage.

2.5.3 Deforestation

Wherever sand winning is taking place, land has to be cleared which means removal of vegetation which leads to devegetation and soil erosion. The aesthetics of the landscape is destroyed through the production pits on the surface which pose danger because of rock falls and flooding during the rainy season.

The deliberate deforestation of an area for sand winning development may cause the elimination of some plants and exodus of some animal/bird species that feed on such plants or depend on them for cover (Bayley & Baker, 2000; Aigbedon & Iyayi, 2007). Sand winning has to a large extent contributed to land degradation and desertification through the destruction of economically important trees, mostly indigenous in nature. This practice leaves behind bare soil and a large expanse of gullies which can collect water during the

rainy seasons. This can result not only in health-related problems for neighbourhood communities, but can cause negative impacts on the environment as well (Warhurst, 1999).

Mining is one of the major causes of deforestation and forest degradation, as commercially valuable minerals are often found in the ground beneath forests. Large-scale, open-pit mining operations can result in significant deforestation through forest clearing in order to access mineral deposits and to open remote forest areas for miners. Infrastructure built for transient mine workers-roads, tunnels, and dams also has an impact. Large quantities of timber are often used as supports in mine shafts and in tunnels, in the case of underground mines, and as fuel for operating mines.

2.5.4 Water Pollution

Sand winning has an undeniable impact on water resources and the people dependent on them, especially when carried out in an unscientific manner. Rivers all over the world are under immense pressure due to various kinds of anthropogenic activities, among which are indiscriminate extraction of sand and gravel which-is most disastrous, as the activity threatens the very existence of river ecosystems (Kondolf 1994; Lu et al., 2007). Small catchment rivers are also equally important in the making of economic, social, religious and cultural heritage of the area through which they flow. Due to rapid industrialization, urbanization and associated developments, the rivers are widely exploited for river bed materials like sand and gravel.

The extensive winning of these building materials naturally results in fluctuation of groundwater level which in turn, according to Martin (2003) and Bashir & Adebayo (2002), leads to considerable variations in the concentration of geo-chemical and bacteriological pathogens in the water. Very importantly, according to Kondolf et al., (2001), this extensive mining brings about the lowering of alluvial water tables, channel destabilization and loss of aquatic and riparian habitat. Illegal and excessive sand winning in the riverbed leads to the depletion of groundwater levels and environmental degradation on the banks of the rivers.

District assemblies give sand winning rights to some contractors, but due to increased illegal and excessive mining, it leads to environmental degradation and problems for the people through the depletion of groundwater levels in the communities situated on the river banks. These communities are affected by the problem of pollution of this water as it is evident by the colouration of water which in most of the rivers and streams in the mining area look brownish to reddish orange. Low pH (between 2-3), high electrical conductivity, high concentration of ions of sulphate and iron and toxic heavy metals, low dissolved oxyg (DO) and high BOD are some of the physico-chemical parameters which characterize the degradation of water quality.

Sand winning can affect surface runoff and groundwater quality through contamination with dissolved and suspended materials. Perhaps the commonest surface water contaminant is sediment or suspended solids.

Sediment can smother the beds of receiving streams, affecting fish and benthic organisms. Apart from runoff from overburden emplacements and stockpiles, storm water can be contaminated from process plants, workshops and vehicle wash-down pads. Drainage from oxidization of sulphur or sulphidic ores is highly acidic and can contain dissolved heavy metals. These are toxic to aquatic life and impact on the surrounding environment. Mine planners must consider how their facilities will cope with floods. Mines can de-water groundwater aquifers some distance from shafts or open pits, which can make nearby wells or groundwater bores run dry. Mine designers must also guard against the release of chemically or radiologically contaminated water. Viswanathan (2002) reports that the possible ecological impact of indiscriminate sand winning and threats to the livelihoods of local communities include the depletion of groundwater; lesser availability of water for industrial, agricultural and drinking purposes; destruction of agricultural lands; loss of employment to farm workers and damage to farm roads and bridges.

Sand winning transforms the riverbeds into large and deep pits; as a result, the groundwater table drops leaving drinking water wells on the embankments of hese rivers dry. ____n-stream I sand winning activities will have an impact upon the river's water quality. Impacts include increased shortterm turbidity at the mining site due to re-suspension of sediment, sedimentation due to stockpiling and dumping of excess mining materials and organic particulate matter, and oil spills or leakage from excavation machinery and transportation vehicles. Suspended solids may adversely affect water users and aquatic ecosystems resulting in high chance of poisoning of aquatic life. The impact on human life is particularly significant if water users downstream of the site are abstracting water for domestic use.

Degraded stream habitats result in loss of fisheries productivity, biodiversity and recreational potential. Gravel extraction can cause changes to channel morphology in rivers through the lowering of the riverbed during extraction (Rinaldi et al., 2005). Erosion destroys river banks, diverts rivers from their normal courses and increases siltation (caused by direct panning in the river systems). Rivers are diverted and water accumulates as pools in open pits, becoming good breeding grounds for mosquitoes and other disease causing organisms.

Unsustainable sand winning can cause disturbance of coastal marine ecosystems and upset the ability of natural marine processes to replenish the sand. Erosion problems may worsen especially during severe storms and may also result in the alteration of shorelines. Mining from streams or rivers upstream can reduce water quality for downstream users and poison aquatic life. Seawater quality can be contaminated due to subsoil of the waterbed being surfaced and this may also reduce light penetration necessary for marine organisms to feed.

Uncontrolled sand winning from riverbeds leads to the destruction of the entire river system. If sand and gravel is extracted in quantities higher than the capacity of the river to replenish them, it leads to changes in its channel form, physical habitats and food webs of the river's ecosystem. The removal of sand from the river bed increases the velocity of the flowing water and the distorted flow-regime eventually erodes the river banks. Beside these on-site effects the off-site effects are also quite lethal. Sand acts like a sponge, which helps in recharging the watertable; its progressive depletion in the river is accompanied by sinking watertables in the nearby areas, adversely impacting people's daily lives, even their livelihoods.

2.5.5 Health Effects

Ghose and Majee (2000), indicate that the main air quality issue with mining is dust particles. Large amounts in concentrations of dust can be a health hazard, exacerbating respiratory disorders such as asthma and irritating the lungs and bronchial passages. However, people invariably feel a loss of environmental amenity, due to dust deposits or dust concentration, before their health is affected. Dust deposition is measured with deposition gauges and reported in units of g/m^2 per month of dust fallout. Pre-mining background levels and total amounts of deposited dust are the usual measures against which limits are set. Dust concentrations are monitored with mechanical high volume air samples and limits are placed on average and peak hourly values.

Dust generated by sand, laterite and gravel digging affects the individual sand winners who do not usually use nose dust shield to cover their noses. Thus, such sand winners inhale the dust and stand the risk of developing diseases such as silicosis and tuberculosis. However, because of their clandestine mode of operation, this phenomenon has not been easy to monitor in the mining areas.

2.5.6 Economic Effects

According to Griffith (2009), sand winning has been known to cause loss of livelihoods in several instances. Other macroeconomic impacts have also been observed such as changes in land use patterns (Myers, 1999) and increased public health costs (Mensah, 1997). Sand winning activities also have economic effects on the communities where the activities are rife. When sand is removed to certain depths, it results in long-term loss of riparian vegetation. Loss of vegetation also occurs when sand/gravel removal results in a significant shift of the river channel that subsequently causes annual or frequent flooding into the disturbed site (NMFS, 1998).

Given the rapid rate of urbanisation and the current rate of extraction of sand and the silent devastation left behind in its wake, the modern process of assigning value, economic or otherwise to resources seems sadly inchoate and needs to be re-evaluated. In matter of food, clothing and other activities, people are influenced in many ways by the physical settings in which they live — coastal, desert, mountainous or forest regions. People are also proficient at changing the environment with unprecedented speed and effect (U.S.A National Academy of Sciences, 1969).

Many species of trees and shrubs in dry riverbeds are supported by groundwater retained by the river sand in these alluvial aquifers at varying depths, e.g Acacia erioloba, Salvadora persicam, Faidhelbia albida and Combretum imberbe. Therefore, the extraction of sand from the riverbed may affect their survival and recuperation ability (Nair, 2005). Dust caused by trucks can impede the photosynthesis of plants by blocking the leaves' stomata (Muller, 2005). Sand winning may have an adverse effect on the biodiversity as loss of habitat caused by sand mining will affect burrowing animals and insects, as well as plants, and to a lesser extent larger mammals and reptiles because they can easily migrate to uninterrupted places. As sand winning destabilises soil structure, river banks and often leaves isolated islands of trees, subsequent flow will erode these banks and islands further. Sand winning activities alongside rivers and in floodplains involves removal of top soil, and vegetation cover. This also contributes to future soil erosion.

2.6 Environmental Policy in Ghana

The environmental costs can be so adverse that there may be no alternative use of the land if the sand winning activity grinds to a halt. The costs of restoring the land by filling the quarry can be economically too large. Such is the state of some sand winning pits in various parts of the world. The environmentavcosts of—am-TTñtúing abandoned open mines can be astronomical. To avoid this, there is the need of having a policy concerning the management of mining industries worldwide.

Of great importance to the sand winning activity is the difficulty in monitoring and enforcing environmental violations due to lack of resources and the widely scattered and inaccessible nature of the terrains. Because of the remoteness of the mining locations, and the wide dispersion of the sand winners, they are very difficult to control and police.

Ghana is not a unique case in matters relating to the environment, as it is a well-known fact that most sand winning adversely affects the environment. Several countries have adopted different strategies for tackling pressing environmental problems in the industry. The following describes how Ghana has been working to address some of the aforementioned environmental impacts. Over the past years the government of Ghana has taken initiatives to address the challenges of land issues and Awudi (2002) indicates that land degradation and the environmental burden from the extraction of natural resources and related activities has been significant. According to Ebenezer (1991), Ghana adopted a National Environmental Policy in 1991 to ensure a sound management of resources and the environment, and to avoid any exploitation of these resources in a manner that might cause irreparable damage to the environment.

The Environmental Protection Agency (EPA) formalised in 2004 as the primary government agency responsible for the formulation and enforcement of policies related to a -aspects of the environment (Environmental

Protection Agency Act, 1994). Prior to the 2004 formalisation of EPA, the Minerals Commission and EPA in 1994, adopted guidelines mandating environmental impact assessment for mining activities in the country (Minerals Commission and Environmental Protection Council, 1994). The policy indicates that, environmental impact assessments must ensure that companies that deal with sand and mining demonstrate that the project has been planned in an environmentally sensitive manner and that appropriate pre-emptive or mitigating measures and safeguards have been integrated into the project's design (Minerals Commission and Environmental Protection Council, 1994).

In addition to the policies adopted by the government agencies, district assemblies also collaborate with other governmental and non-governmental organisations such as the Forestry Commission, Environmental Protection, Friends of Rivers and Water Bodies, to develop by-laws at the community level to control the menace. These collaborations also involve opinion leaders such as chiefs, assemblymen/women, etc.

Sand winning operation, undoubtedly has brought wealth and employment opportunity, but simultaneously has led to extensive environmental degradation and disruption of traditional values in the society. Environmental problems associated with sand winning are felt severely because of the fragile ecosystems and rich biological and cultural diversity. Large scale denudation of forest cover, scarcity of water, pollution of air, water and soil and degradation of agricultural lands are some of the conspicuous environmental »pbcations i of e.g. coal mining (Swer and Singh, 2004).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Introduction

This chapter focuses on the study area, the research design and discusses the methods utilised to test the research questions and particular attention is given to the structured interview guide used to collect the data for the study and data analysis.

3.2 Background of the Study

3.2.1 Area, Location and Size

Afigya-Kwabre District is located in the central part of the Ashanti Region of Ghana and spans a total of 342.3 km^2 forming about 1.44% of the total land area of the Ashanti Region. The location of the district in the central part of Ghana and also, along the highway which runs from the south to the north makes it easily accessible. Its closeness to the second largest city in Ghana, Kumasi, makes it a dormitory district and is responsible for its high population growth rate as well as its fast growth of settlements. The district has a total cultivable area of about 53,250 ha excluding pastures and forest reserves.

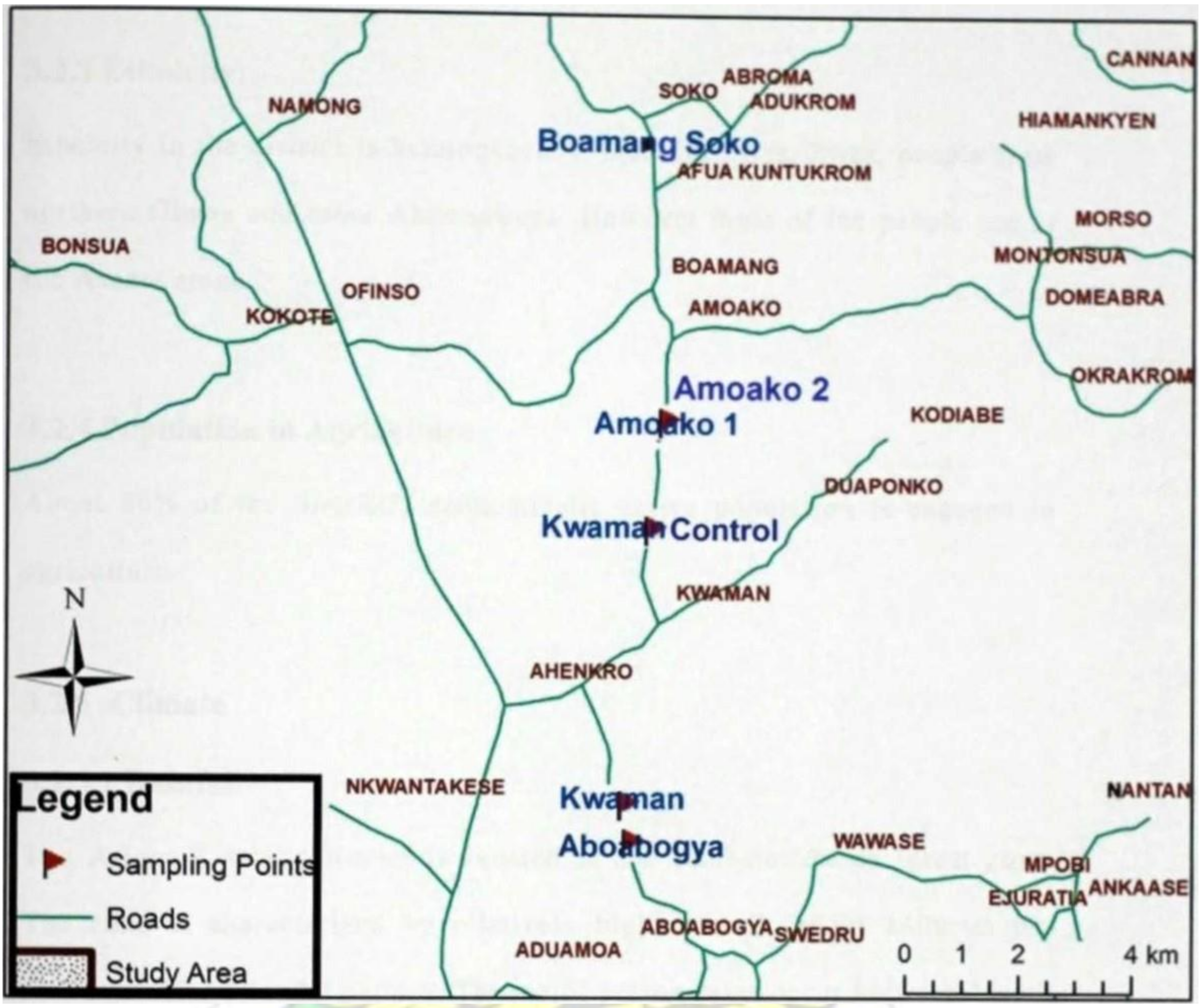


Figure 3.1 Map of the study area (Source: Field Study 2012)

3.2.2 Population

The 2010 population and housing census put the entire population of the District at 136,140 with a growth rate of 4.6% per annum. The population is projected to be 155,805 currently. This population is found in 90 communities and hamlets.

3.2.3 Ethnicity

Ethnicity in the district is heterogeneous, including Gas, Ewes, people from northern Ghana and other Akan groups. However most of the people are of the Asante stock.

3.2.4 Population in Agriculture

About 80% of the district's economically active population is engaged in agriculture.

3.2.5 Climate

3.2.5.1 Rainfall

The Afigya-Kwabre District is located in the semi-deciduous forest zone. The zone is characterized by relatively high rainfall (about 1400mm per annum) with a bimodal pattern. The major season rains occur between March and mid-July with a peak in May /June. There is a dry spell from mid-July to mid-August. The minor rainy season starts from mid-August to the end of October with a peak in September. A long dry period is experienced from November to February with possibilities of occasional rains.

3.ïS.2 Temperature

Temperatures are normally high throughout the year with very little variations. The mean monThly temperature ranges between 250C in

3.2.3
July/August and 28 ^{0}C in March/April.

Humidity

The District experiences relative humidities ranging from 90—98% during the night and early mornings of the rainy season. Day-time humidity falls below 75% during the dry season. The climatic conditions favour the cultivation of diverse cash and food crops which are of tropical nature. Again, the relatively high temperatures and sunshine favours the drying of most crops such as cocoa and maize.

3.2.6 Vegetation

The original vegetation is forest and this has largely been degraded by lumbering, expansion of settlements and farming. The closed forest consisting of a continuous canopy of tall and medium—height trees with little or no undergrowth no longer exist. The area now largely consists of farm patches with isolated stands of individual trees or small areas of tree-clusters which can be described as transitional forest. Crops cultivated in the district include, cocoa, oil palm, citrus, avocado pear, coffee, plantain, maize, cassava, cocoyam, cowpea, vegetables, etc.

The District—hås three rest reserves namely; A fram Head Waters Forest Reserve, Gianima Forest Reserve and Asufu Shelterbelt Forest Reserve. Species of tropical trees of high economic value such as wawa, sapele, odum, and mahogany abound in the forest.

3.2.3 Relief and Drainage

The landscape is a dissected plateau with heights reaching 800-1200m above sea level. The plateau forms part of the Mampong-Gambaga scarp. The landscape is predominantly undulating resulting in erosion along the slopes. However, the northern part reaches up to 365.76m above sea level. Isolated hills in the south around Buoho also have altitude of up to 365.76m.

The undulating nature of the relief of the district makes drainage easy. Besides the river valleys, there are very few waterlogged areas. The water logged areas supports the growth of hydrophytes such as cocoyam and rice.

The high points serve as observations for people who enjoy sceneries. The District is drained by three main rivers and their tributaries. The rivers are Offin, Oyon and Abankro. Continuous human activities along these rivers and streams have adversely affected their flows. Almost all the rivers experience seasonal flows.

3.2.8 Soils and Geological Formation

The District has two geological formations, namely Voltaian and Dahomeyan.— The Voltaian-fõññäîÍG{consists of shale, sandstone, mudstone and limestone. The Dahomeyan formation consists of metamorphic rocks such as gneiss and schist. The mass presence of granite rock in the district supports the quarry industry. The soils of Afigya-Kwabre District are developed over granite, lower Birimian Phylite and coarse-grained Voltaian

3.2.3 Sandstone.

3.3 Research Paradigms

The design of a study begins with the selection of the topic and a paradigm (Robson, 1993). A paradigm provides the research with an idea of assumptions about the social world and how the study should be conducted. Most notably, a paradigm suggests legitimate problems, solutions, and criteria of "proof'. Therefore, paradigms encompass both theories and methods. A study can follow a qualitative and/or a quantitative paradigm (Creswell, 1994). This study was conducted within a mainly qualitative paradigm. The research uses qualitative research approaches on the community members in the study area and provides descriptive information based on their opinions of sand winning activities.

With the objective of assessing the impacts of sand winning activities on the environment, hundred (100) community members were selected for interviews. These shareholders included individual landowners, groups of farmers whose farms were located close to gravel and sand winning sites, and selected individuals from nearby communities. Representatives from relevant state departments and agencies in respect of sand winning and other land use management systemsÃëWalso included. The aim of the selection was primarily to give broad views on the subject. For individual farmers and community members, qualitative interviews were used since this approach allows a more in-depth investigation into the unique experience of each interviewee (Huntington, 2000). Most of the questions raised during the interview were to elaborate and/or clarify the respondents understanding of a point. The questionnaire basically focused on gathering respondents' views from the study areas on the impacts of sand winning and how various regulations are operated to guide the activities.

3.4 Purpose of the Study

A descriptive study is undertaken in order to ascertain and to describe the characteristics of the variables of interest in a situation. Descriptive studies are also undertaken to understand the characteristics of organizations that follow certain common practices for example the service strategies implemented by a specific organization (Radder, 2001). The purpose of this study was to assess the impact of sand winning on the environment.

3.5 Sampling Procedure

The sampling procedure section includes the population and sampling technique used for the study.

3.6 Population and Sampling

The population consisted of a total of hundred (100) respondents from the Boamang and Kwaman communities in the Afigya Kwabre District. A sample of forty (40) respondents as selected from each of the two (2) communities and_twenty (20) respondents from government agencies and community opinion leaders such as chiefs and assemblymen/women. The individual respondents included individual landowners, groups of farmers whose farms are located close to gravel and sand winning sites and selected individuals from nearby communities. The government institutions included the District Assembly and the Environmental Protection Agency.

3.6.1 Sampling Technique

In this research, non-probability sampling design was used with emphasis on convenience and purposive sampling. The purposive sampling was used to extract the various behaviours of the sand winning activities that affect community members. This technique was used because the needed information can only be provided by these targeted population. After the non-probability sampling, a detailed interview guide was used to gather information.

3.7 Data Collection

Data was collected from two main sources. Primary data was obtained from the use of interview guide which was used to collect empirical data for this study in order to assess the impacts of sand winning activities. It also used key informant interviews, focus group discussions and participant observation. Questions were in both open and closed-ended types. This was to make sure that, respondents were very objective in their responses. The interview guide gathered information on farmers, landowners, the District Assembly, EPA, sand winning contractors and drivers on their perceptions of the impact of-sand winning-ÉtÑŒan the environment.

For estimating the size of sand winning sites in the five (5) selected communities which are Boamang Soko, Amoako No. 1, Amoako No.2, Aboabogya and Kwaman, in the Afigya Kwabre District the approach used was modern technology. The areas and location of the sand winning were obtained using the GPS co-ordinate system to locate the extent of the impact of the activities around the study area. Additionally, photographs were taken from the affected sites on the level of sand winning impact on the environment in the affected areas, depth of scooping of sand and the dry bulk density of the soil were determined.

3.8 Laboratory Procedures for the Soil Analysis

3.8.1 Soil Organic Carbon

Organic carbon was determined by a modified Walkley and Black procedure as described by Nelson and Sommers (1982). This procedure involved a wet combustion of the organic matter with a mixture of potassium dichromate and sulphuric acid. After reaction, the excess dichromate was titrated against ferrous sulphate. One gramme of the sample was weighed into an Erlenmeyer flask. A reference sample and a blank were included. Ten millilitres of 1.0 N potassium dichromate solution was added to the soil and the blank flask. To this, 20 ml of concentrated sulphuric acid was carefully added from a measuring cylinder, swirled and allowed to stand for 30 minutes in a fume chamber. 100ml of distilled water and 10ml of orthophosphoric acid were added and allowed to cool. One millilitre of diphenylamine indicator was added and titrated with 1.0NúFðÚÇsolution.

SOTÕganic carbon content is given by:

0/0 Organic C= M x 0.39 x mcf(V, - V:)

Where,

M = normality of ferrous sulphate

V = Volume of ferrous sulphate required for the blank

V_2 = Volume of ferrous sulphate required for the sample s

— Weight of air-dried sample in grammes m cf — moisture correction factor (100 + % moisture)/ 100)

0.39 = 3 x 0.001 x 100% x 1.3 (3=equivalent weight of carbon)

1.3 — a compensation factor for the incomplete combustion of the organic matter.

3.8.2 Nitrogen

Total nitrogen was determined using the Kjeldahl digestion and distillation methods as described in the US Soil Salinity Laboratory Staff (1984). A 0.5g air dry soil sample was put in a Kjeldahl digestion flask and 5.0ml distilled water added to it. After 30min, 5.0ml conc. H2S04 and selenium mixture were added and mixed carefully. The sample was placed in a Kjeldahl digestion apparatus for 3 hours until a clear digest was obtained. The digestate was diluted with 50.0ml distilled water and mixed thoroughly until no more sediment dissolved and allowed to cool. The volume of the solution was made to 100.0ml with water and mixed well. A 25ml aliquot of the solution was transferred to the reaction chamber and 10.0ml of 40% NaOH solution was added followed by distillation. The distillate was collected in 2% boric acid—The distillate—was—titrated with 0.02N HCI solution with bromocresol green as indicator. A blank distillation and titration was also carried out to take care of traces of nitrogen in the reagent as well as the water used.

Calculation:

The percentage nitrogen in the sample was expressed as:

$$0/0N \quad \frac{N\ (a - b)x1.4\ x\ mcf}{s}$$

Where,

N = Concentration of HCI used in titration a

= ml I-ICI used in sample titration b — ml I-

ICI used in blank titration s = Weight of air-

dried sample in grammes

mcf = Moisture correcting factor = (100 — %moisture)

1.4 = 14 x 0.001 x 100% (14 = atomic weight of nitrogen)

3.8.3 Bray No. 1 Phosphorus (Available P)

The readily acid-soluble forms of phosphorus were extracted with HCl:NH4F mixture called the Bray No. 1 method as described by Bray and Kurtz (1945) and Olsen and Sommers (1982). Phosphorus in the extract was determined on a spectrophotometer by the blue ammonium molybdate method with ascorbic acid as reducing agent.

A 2.0g air dry soil sample was weighed into shaking bottle and 20ml of extracting solution of Bray- I (0.03M NH4F and 0.025M HCI) was added. The sample was shaken for 10 min by hand and then immediately filtered through a fineTilter (Whatman No. 42). Iml of the standard series, blank and extract, 2ml boric acid and 3mI of the colouring reagent (ammonium molybdate and antimony tartrate solution) were pipetted into a test tube and homogenised. The solution was allowed to stand for 15min for the blue colour to develop into its maximum. The absorbance was measured on a spectronic 2 ID spectrophotometer at 660nm wavelength. A standard series of 0, 1.2, 2.4,

3.6, 4.8, and 6 pg /lmP was prepared from a 12mg/l stock solution by diluting 0, 10, 20, 30, 40 and 50ml of 12 pg /ml into 100ml volumetric flask and made to volume with distilled water. Aliquots of 0, 1, 2, 4, 5 and 6ml of the 100 pg /ml of the standard solutions were put into 100ml volumetric flask and made to the 100ml mark with distilled water. After 10 minutes, the blue colour of the solution was read on the spectrophotometer at a wavelength of 660 nm.

Absorbance reading was plotted against "pg P" and the points were connected as shown in Fig 3.2:

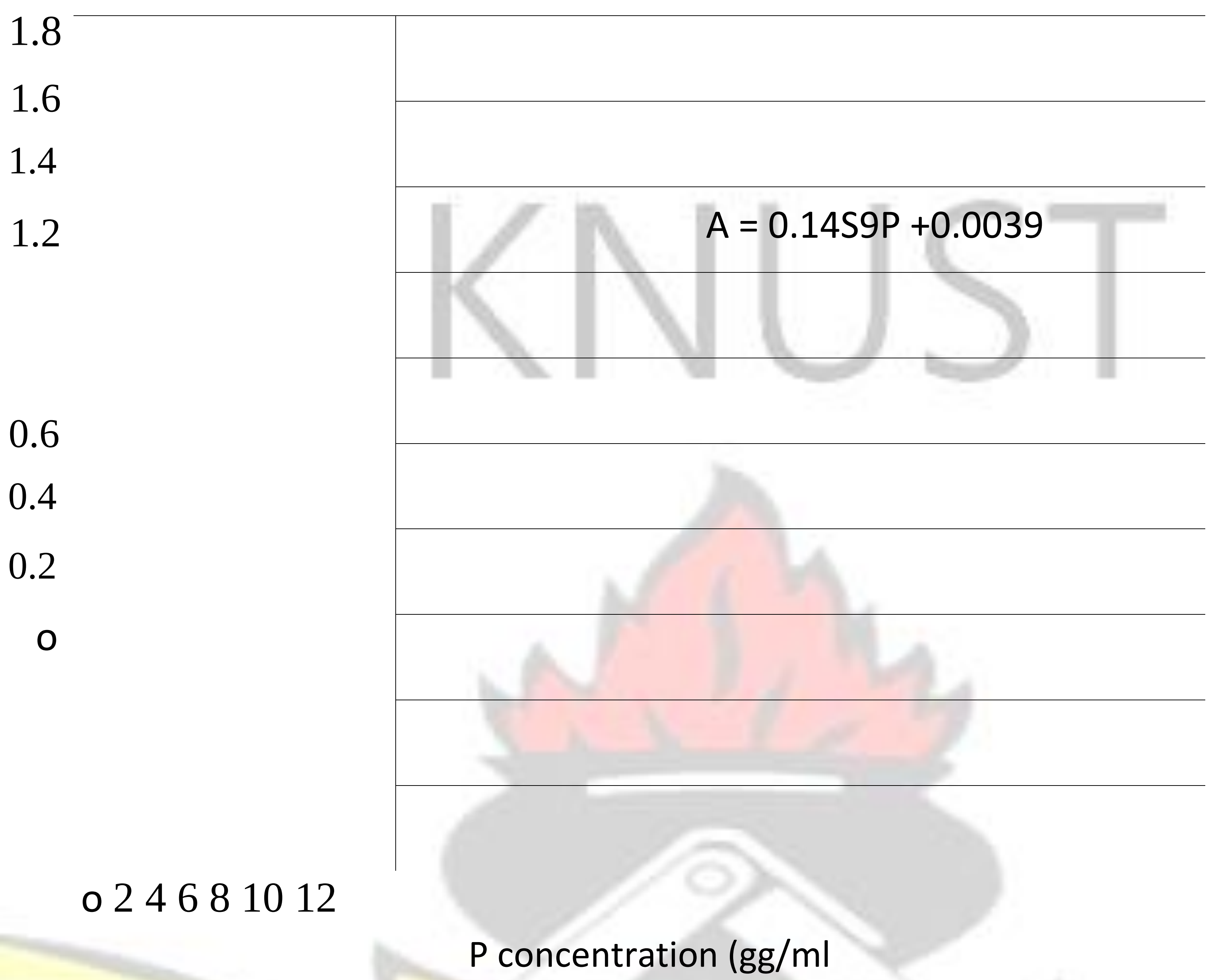


Fig 3.2 Absorbance vrs P Concentration

Calculation:

$$P\ (\mu g/ml) = \frac{(A - 0.0039) \times 10}{0.14559}$$

Where,—-

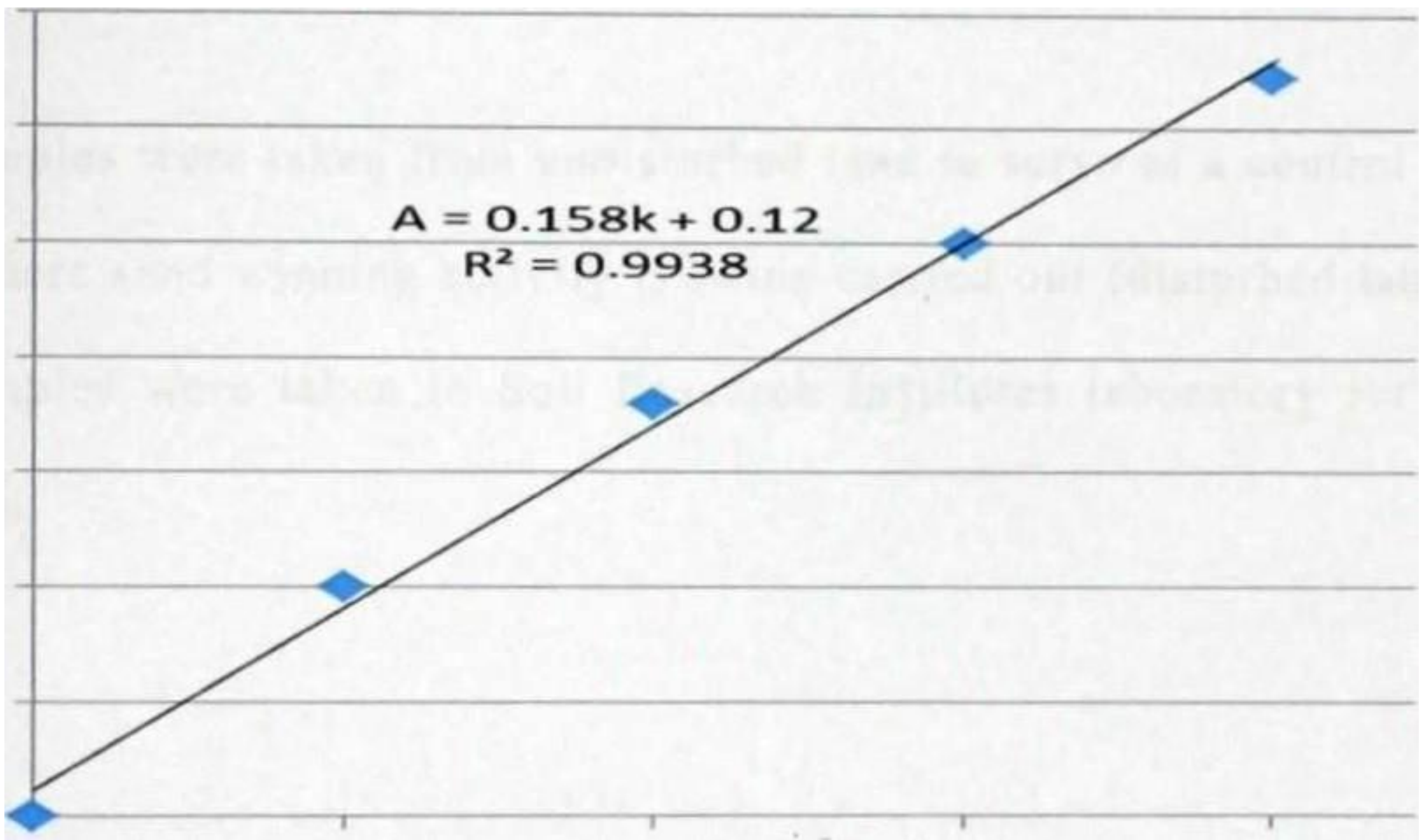
P = concentration of phosphorus in pg/ml

A = absorbance of the blue colour

10 = ratio of the volume of the extractant to the weight of the sample.

3.8.4 Available Potassium

The remaining extract which also contained potassium was read on the flame photometer giving the emission of the solution (Toth and Prince, 1949). A standard series of 0, 5, 10, 15 and 20gg/ml was also prepared from a 40 pg/mlk stock solution and read on the flame photometer. The emission reading was plotted against ggk (Fig 3.3).



3.5
3-0
2.5
2.0
1.5
1.0
0.5
0.0

0.0 5.0 10.0 15.0 20.0

K concentration (pg/ml)

Fig. 3.3 Absorbance vrs K Concentration

Calculation

$$KOtg\ /ml) = \frac{(A - 0.12) \times 10}{0.158}$$

Where,

K = concentration of potassium in pg/ml

A = emission

10 = ratio of the volume of the extractant to the weight of the sample.

3.9 Data Analysis

Data analysis was qualitative in nature and involved using SPSS descriptive statistics in terms of percentages and frequency distributions. In addition, data was analysed to assess the impacts of sand winning activities on the environment. The responses to questions were coded and the results were analyzed qualitatively. Thematic method was used as a tool for the data analysis. The findings were then presented in the form of tables and charts.

Soil samples were taken from undisturbed land to serve as a control and also from where sand winning activity is being carried out (disturbed land). Both soil samples were taken to Soil Research Institutes laboratory for nutrient analysis.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter deals with the results collected for the study, data analysis and discussions. Parts and the part one covers the economic benefits and the impacts of sand winning activities using frequencies and percentages for presenting data on personal characteristics of the respondents. Part two presents soil physico-chemical analyses conducted on soil samples collected from sand winning and non-sand winning sites to compare the levels of degradation that had occurred at the selected sites. The areas degraded were determined using GPS to take coordinates to determine the stretch of land that has been degraded, Core samplers were used to determine soil bulk density, quadrat to check for biological organisms and soil augur to take soil samples to determine chemical parameters to ascertain the amount of nutrients at the top layer of the soil.

4.2 Demographic Background

4.2.1 Gender of Respondents

Table 4.1 Gender of the Res ondents

Variable	Frequency	Percent
Male Female	92 8	92.0 8.0
Total	100	100.0

(Source: Field Study, 2012)

From gender perspective, as indicated in Table 4.1, 92% of the respondents' were men while 8% were females. Although women are also engaged in sand winning activities, is mainly a 'man's-business', due to its tedious nature, requiring more physical strength than what a woman could probably handle. The men are usually involved in the digging and loading of the sand into the tipper trucks.

4.3 Age of Respondents

Table 4.2 Res ondents A e

Variable	Frequency	Percentage (0/0)

21 -30	32	32.0
31 -40	42	42.0
41 -50	18	18.0
> 50	8	8.0
Total	100	100.0

(Source: Field Study, 2013)

Table 4.2 indicates the respondents' age groups and from the analysis, 32% are within the age group of __________ 21-30 years and 42% are within the age group of 31-40 years which constituted the highest age group. 41-50 years and above 50 years constitute 18% and 8% of the respondents respectively. From the analysis, majority of the respondents who were actively involved in the sand winning activities were between the ages 31-40 with a total of 74%. This confirms that the youth involved have the physical energy required for the activity.

4.4 Level of Education

Table 4.3 Education Level

Variable	Frequency	Percentage (0/0)
Illiterate	12	12.0
	49	49.0
Sec/O'/A' Level	27	27.0
Diploma	8	8.0
Degree	4	4.0
otal	100	100.0

(Source: Field Study, 2013)

Table 4.3 indicates that majority of the sampled respondents, 49% have Junior High school education. This was followed by 27% of the respondents who have completed senior high/O'/A' level and 12% of the respondents were illiterate and have never attended school before. Only 8% have diploma as their highest level of education and that only 4% of the respondents have a university degree. It is worth mentioning that those with the highest level of education are those in the various institutions selected for the study. Gordon and Craig (2001) holds the opinion that education increases the skill levels required for some rural non-farm activities and besides, it contributes to increased productivity or may be an employment—rationing device. This justifies the influx of these less educated people in the business, which requires little or no formal education to embark upon.

4.5 Assessment of Sand Winning activities

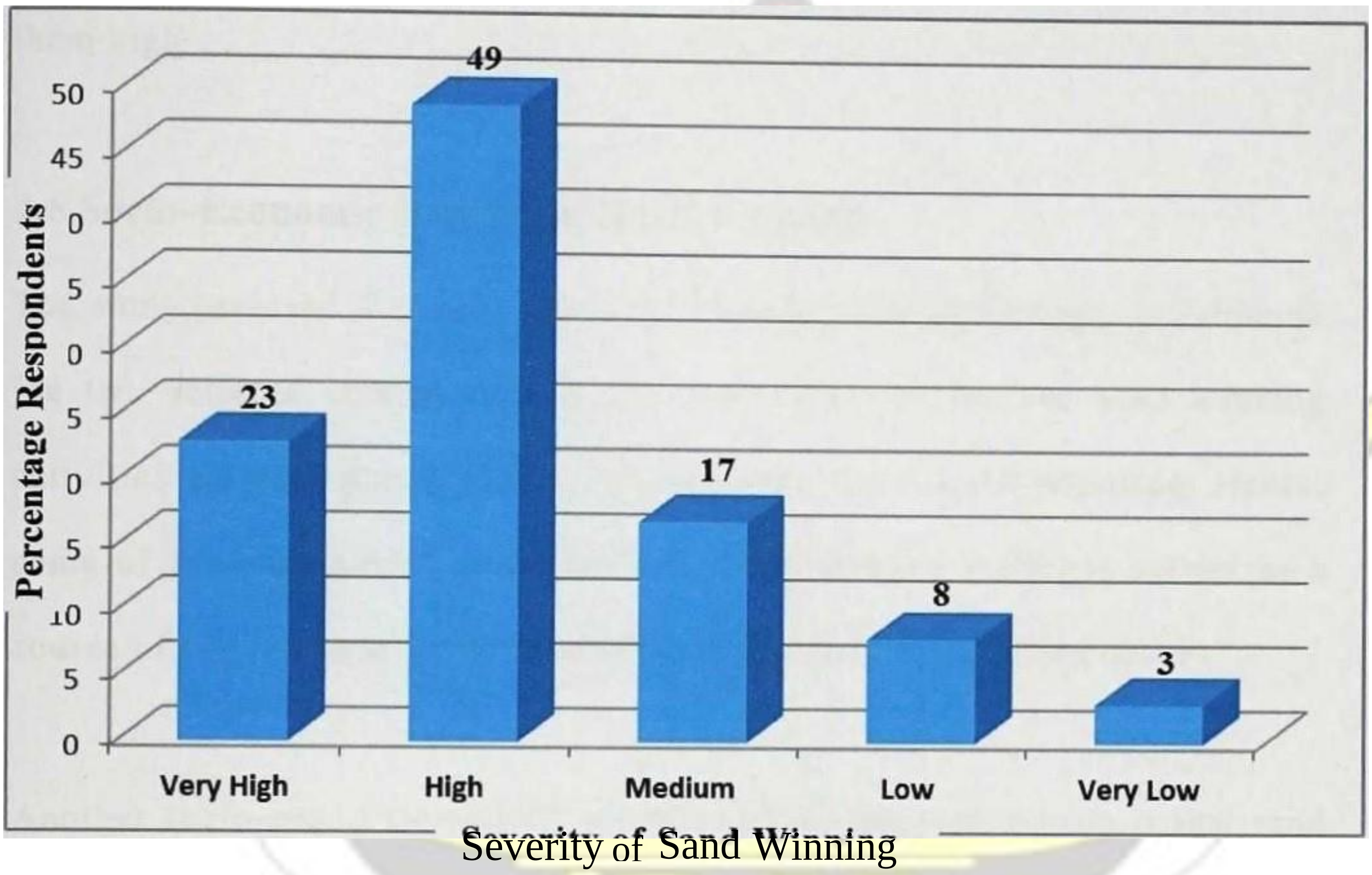


Figure 4.1 Assessment of Severity of Sand Winning (Source: Field Study, 2013)

Sand winning as livelihood activities that affected land in the study area were ranked based on their severity. Sand winning was ranked by the majority of the respondents to be high by 49% of the respondents and 23% were of the opinion that sand winning activities were also very high in the communities._L7%—of the respondents assessed the activities as medium while 8% ranked it low with only 3% rating it very low. This is probably because sand wining activities has direct impact on the agricultural land where the activities were intense in the study area. According to Byrnes et al (2004), extraction of sediment from offshore sites may result in modifications to physical processes of the land in such sites. Therefore, the observation of the respondents based on the modification of the physical soil structures at sand and gravel winning sites could be their reason for ranking them high.

4.6 Socio—Economic Benefits of Sand Winning

The study assessed the socio-economic benefits of sand winning activities in the two selected communities and it was observed that the sand winning activities are high due to lack of job opportunities for the populace. Hence, some of the respondents indicated that sand winning activities served as a source of employment for the youth and the people in the communities.

Another socio-economic benefit as indicated by the respondents is that sand winning also generates revenue for the District Assembly and the individual contractors as well as the landowners. According the respondents, the District Assembly collects money from the contractors as toll to execute development projects to improve the living standards of the populace in the district. Landowners also collect money from the contractors on daily basis as a source of their living. Contractors who rent the land or buy the sand also derive incomes and hence economic benefits accrue from the activities.

Sand winning activities are important sources of revenue for the communities because of the absence of alternative employment except farming which is also at the subsistence level. Thus, sand winning is crucial for economic development because the communities would have been financially handicapped, if the activity is not sustained to ensure regular flow of revenue. It serves as an alternative livelihood aside the agricultural work to the people in the communities.

4.7 Impacts of Sand Winning on Water

Sand winning has impact on water bodies in the affected areas according to the respondents and pollution of water sources was identified as one of the potentially negative impacts. They revealed that frequent movement of heavily loaded vehicles across the river banks did not only impose land stability problems but also pollutes the river water through oil spillage. Machinery used for sand wining usually has spillages in respect of oils and other dangerous lubricants. When these spillages find their way into the water, they pollute it, and people downstream, who may use the water for drinking and other domestic purposes, are affected. The water turns to dirty because of sediments resulting from sand winning making it unsightly and not worth drinking.

The activities can also retard free flow of the water course. As indicated by Sandecki (1989), such direct in-stream sand winning can alter the channel geometry and bed ed elevation and may involve extensive clearing, diversion of flow, stockpiling of sediment, and excavation of deep pits.

Apart from threatening bridges, sand winning transforms the riverbeds into large and deep pits; as a result, the groundwater table drops leaving the drinking water wells on the embankments of these rivers dry during the dry season and this is seen pictorially in Fig. 4.4. It leads to flooding and sometimes because of the activities it diverts the water from the main cause making it stagnant at some places.

Figure 4.2 Aboabo River bed affected by Sand Winning Activities
(Source: Field Study, 2013)

4.8 Sand Winning Contributes to Environmental Degradation

The effect of Cðntinuous faTïííííî@-as ranked 'very severe', probably due to the low yield experienced on their farms. Continuous farming without fertility replenishment causes deterioration of soil nutrient status. Sanchez and Jama (2002) reported that cultivated soils with no major chemical limitations would become deficient in nitrogen which is a major soil nutrient, under continuous cropping systems without nutrient inputs to supplement for the deficiency. The richer topsoil is also physically removed and not replaced.

During the process of sand winning from the affected areas, they deforest the location to create space for mining activities leading to the loss of forest trees and diminishing of covered vegetation as seen in Fig 4.3.

The clearing and digging of the soil surface further encourages erosion. This agrees with findings by Charlier and De Meyer (2000) who reported that erosion has increased in many locations as a consequence of human activity which encouraged increased frequency of flooding and deterioration of ecosystems.

Figure 4.3 Degraded Environment at Aboabogya (Source: Field Study, 2013)

The respondents also revealed that farm lands were now far away from the village centres since the nearby agricultural lands have been degraded and can no longer adequately support agricultural production. The farms have thus been shifted to fallow grounds for better production. This poses difficulty in the movement of farm produce to the village or market centre, thereby increasing the price of farm produce in the market, because of the extra transportation cost incurred. Again, the discharge of dust settles not only on land, plants and trees but also in the surface waters used for drinking and other domestic chores by the community which is their main source of water. Dusts on plants do affect their ability to photosynthesize and also looks unsightly.

4.9 Effects of Sand Winning on Humans

On the effects of sand winning activities on humans, the respondents said that, they do not accept that sand winning is a source of livelihood for many people because the impact of the act makes many more people including the state worse off while only a handful benefit from such illegal acts.

During the dry-season, it leads—to-dust in the atmosphere with a lot of health hazards. The dust also leads to coughing during their activities and the smell of dust causes sickness to human life. It leads to air pollution and the possible dangers of long-term exposure. An example of such a dusty road is indicated Fig. 4.4.

Figure 4.4 Dusty Road at Kwaman (Source: Field Study, 2013)

Again the activities create manholes on the roads which during the rainy season collect stagnant water which serves as breeding grounds for mosquitoes to cause malaria. The respondents again said that the sand winning activities has also been known to cause loss of livelihoods in several instances which creates poverty due to the destruction of farm crops.

4.10 Effects of Sand Winning Activities on Agricultural Land

Table 4.4 Effect of Sand Winning on Agricultural Land

No.	Description	Percentage
1	Loss of forest trees	
2	Diminished vegetation cover	90%
3	Exposure of soil surface	
4	Gullies on farmland	45%
5	Soil nutrient depletion	100%

6	Destruction of organic matter	
7	Destruction of soil structure	34%
8	Soil erosion occurrence on the farm	100%
9	Low farm yield	
10	Reduction of agricultural land	100%

(Source: Field Study, 2013)

Several reasons were given by the respondents concerning the effects of sand winning activities on agricultural land. Among them is the loss of forest trees and that was observed by 98% of the respondents. This implies that during the process of excav¥g_sanðand gravel from the mining sites, they deforest the location to create space for mining activities. 90% of the respondents indicated diminishing of vegetation cover, while 56% observed exposure of the soil surface to erosion. This is seen Table 4.4 and pictorially in Fig 4.5

Figure 4.5 Degraded Farm Land at Amoako No. 1

(Source: Field Study 2013)

Furthermore 45% of the respondents indicated that these were too many gullies on their farmlands mainly due to sand winning activities going on in the area. It exposes the root of crops and cause trees crops to fall. All the respondents were in agreement that the activities cause soil nutrient depletïon. 30% also observed that there is also the effect of destruction of organic matter whereas 34% indicated that the physical structure of the soil is destroyed due to sand mining activities.

Soil erosion occurrence is one of the changes observed due to sand winning activities as observed by 100% of the respondents. Since the soil surface is cleared and dug, it further encourages erosion. This is in agreement with Charlier and De Meyer (2000) who reported that erosion has increased in many locations as a consequence of human activity which encouraged increased frequency of flooding and deterioration of ecosystems. 95% of the respondents observed that there is low yield from sites where sand winning activities are being practised, while all the respondents' indicated reduction in the size of land available for agricultural purposes.

4.11 The Rate of impacts on Agricultural Land

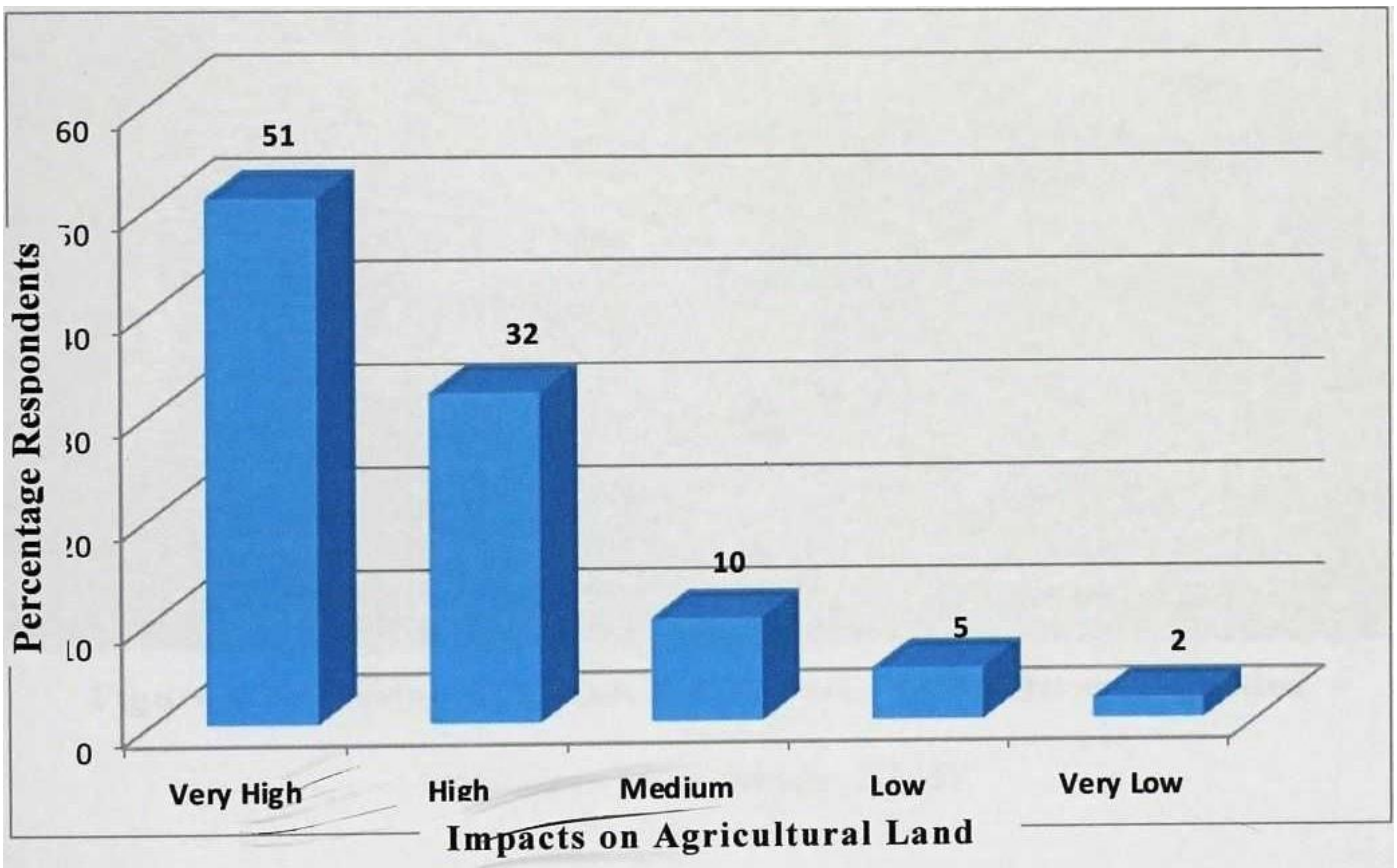


Figure4.6 Assessment of Sand Winning (Source: Field Study 2013)

The level of impact of sand winning activities on agricultural land was assessed as indicated in Fig. 4.6 and majority of the respondents, 51% of the total respondents indicated that the level of impact of the activities are very high, 32% indicated that the level of impact is high while 10% rated the impact as medium. Low and very low were rated by 5% and 2% respectively.

From the analysis, most of the respondents agreed that the impact of sand winning activities on agricultural lands in the study areas is very high as seen in Fig 4.7.

Figure 4.7: Section of Cassava Farm near Offin River Degraded

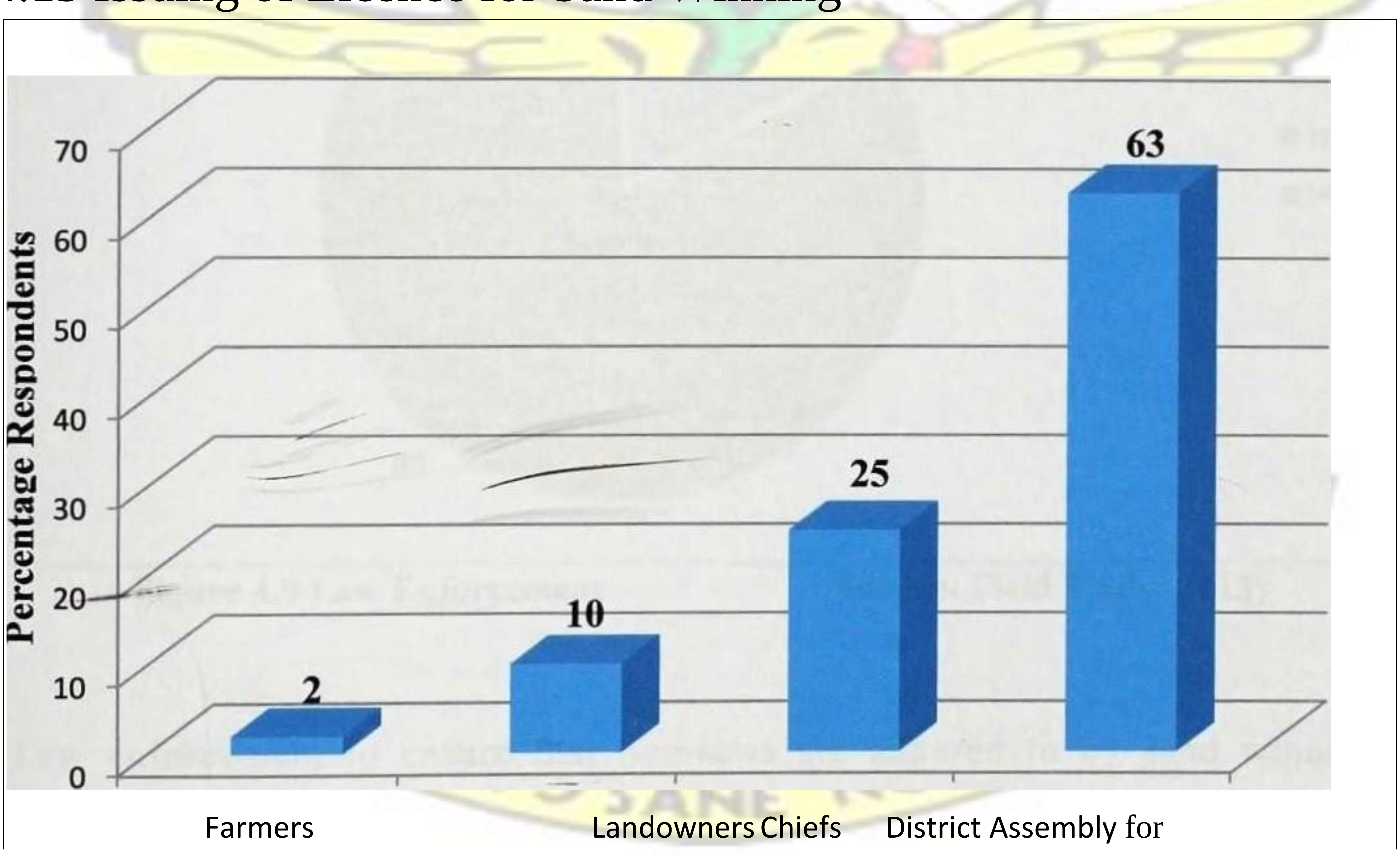
(Source: Field Study, 2013)

4.12Terception of Sand Winning effects on the Environment

The cumulative effect of sand winning activities does not only affect the agricultural activities on the land, but also has severe impacts on constructed roads as seen in Fig 4.13. As Hedge (2011) indicated, large tracts of revenue land is rapidly getting cleaned up, besides innumerable trees are facing the axe and the land which was used for sand winning is becoming futile now which was once used for cultivation. The respondents said that the sand winning activities has negative effects on the environment because it destroys agricultural land and creates erosion.

Again the activities reduce the size of land available for agriculture and the sales value of such lands at the mining sites decline drastically. Owners decide to either use such land for farming activities, or dispose of it in order to acquire other fertile lands. There is also the case of low productivity in terms of farming and crops produced. It was also indicated that one of the major effects is the destruction of atmospheric balance as a result of the destruction of the tree cover.

4.13 Issuing of Licence for Sand Winning



Licence Sand Winning

Figure 4.8 Licence for Sand Winning Source: (Field Study, 2013)

Those who issue permit/licence to sand winners play critical roles in sand winning activities. From Fig 4.8, majority of the respondents which constituted

63% indicated that the District Assembly issues the permit/licence to sand winners. 25% indicated that the chiefs issue the permit to sand winners. 10% indicated that landowners issue the permit/licences to sand winners and only 2% indicated that farmers issue permits/licences. This shows that, there is lack of knowledge above the issuance of permits/licences leading to indiscipline in the sector.

4.14 Law Enforcement

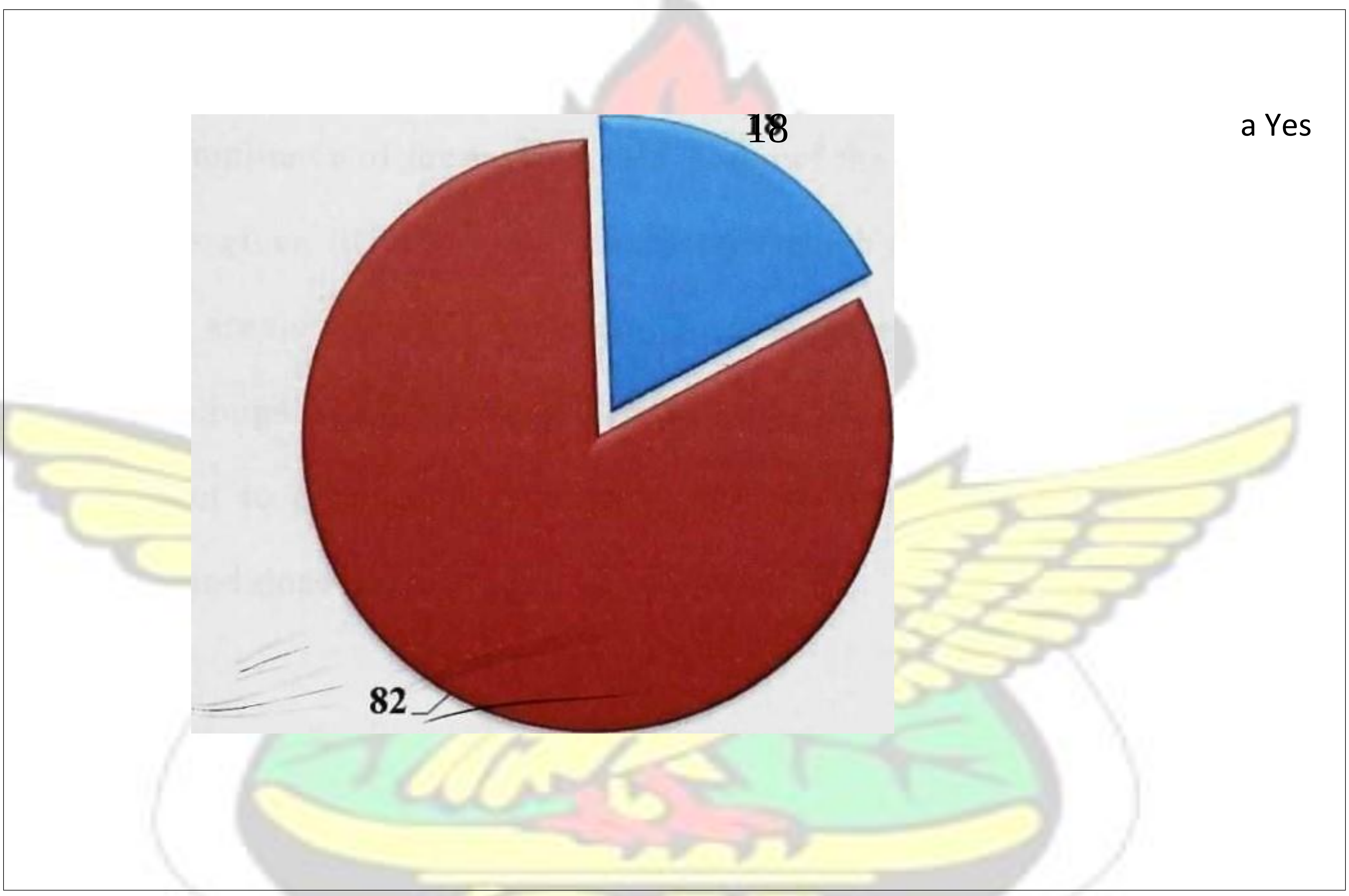


Figure 4.9 Law Enforcement (Source: Field Study, 2013)

Law enforcement to ensure that bye-laws are adhered to by sand winning contractors is very crucial to bring sanity into their activities. The study sought to find out if bye-laws regarding sand winning activities are enforced by the authorities in charge of ensuring compliance. From Fig. 4.9, majority of the respondents which constituted 82% indicated that the authorities in charge of ensuring compliance do not do it whereas 18% indicated that the authorities in charge ensure compliance. From the analysis, it is clear that law enforcement regarding sand winning activities is very weak and most of the respondents who indicated that the laws are being enforced are the institutions in charge of ensuring compliance.

The respondents indicated that some of the officers collect monies privately (bribes) from the sand winning contractors hence their inability to enforce the laws. Others also said that the District Assembly collects fees from the contractors and as a result of the levy they collect they find it difficult to enforce compliance of the laws. Again, some of the respondents said that the district has given licence to the contractors which makes it legal to operate hence they are not able to enforce any laws. Some were also of the view that, the land belongs to individual farmers and the chiefs and therefore when land is given out to contractors, the law enforcement agencies have no control since the land does not belong to the government.

4.15 Monitoring System

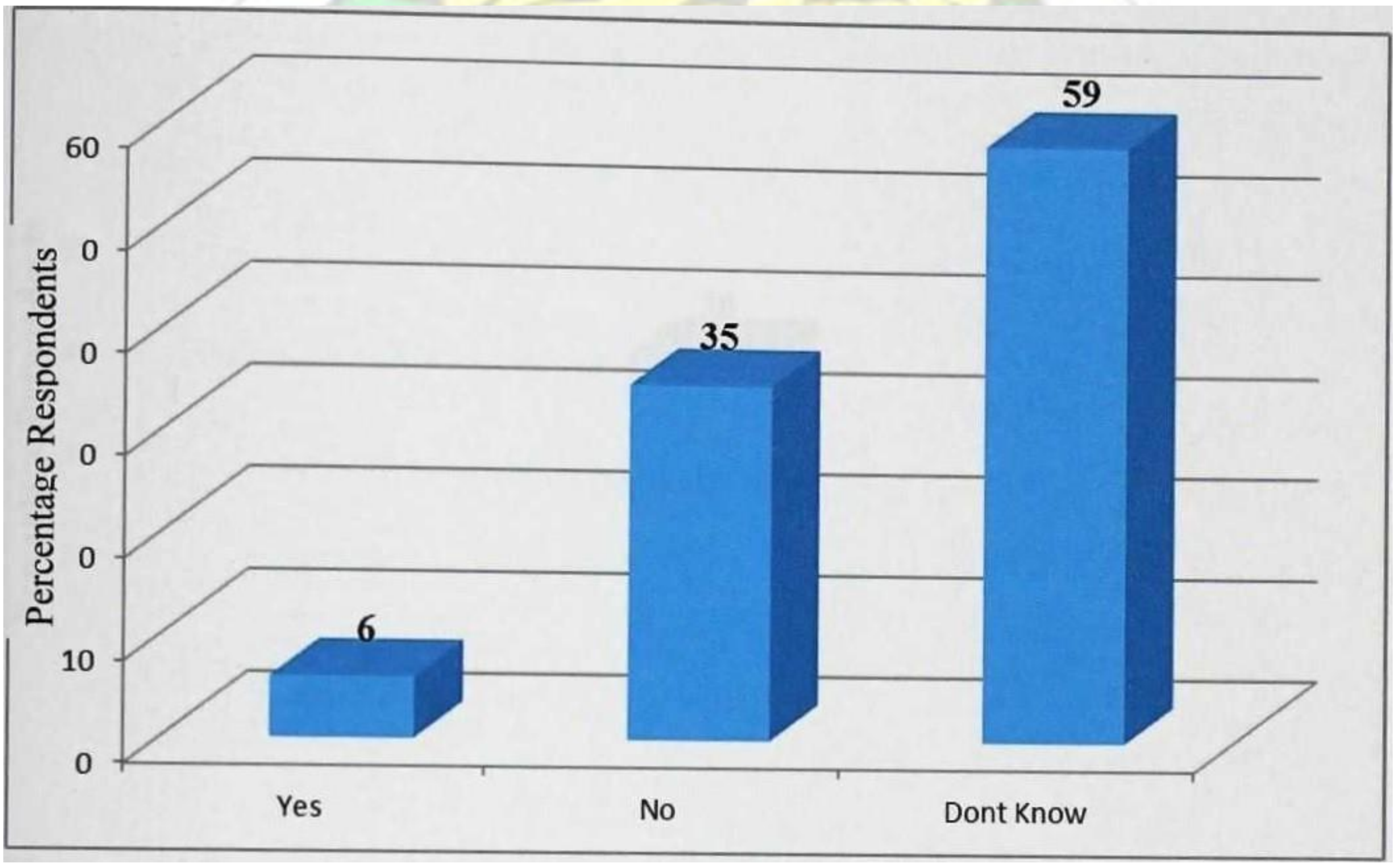


Figure 4.10 Effectiveness of the Monitoring Systems

(Source: Field Study, 2013)

One of the effective ways of ensuring law compliance is the monitoring of the activities being undertaken. From the studies as indicated in Fig. 4.10, majority (59%) of the respondents indicated that they do not know if there are monitorinysystems in place to ensure compliance. 35% indicated that

there are no monitoring systems in place to ensure compliance and only 6% said—that there are monitoring systems. From the analysis, most of the respondents are not aware of the existence of any monitoring system to ensure the compliance of the laws regarding sand winning activities.

4.16 Effectiveness of the Monitoring System

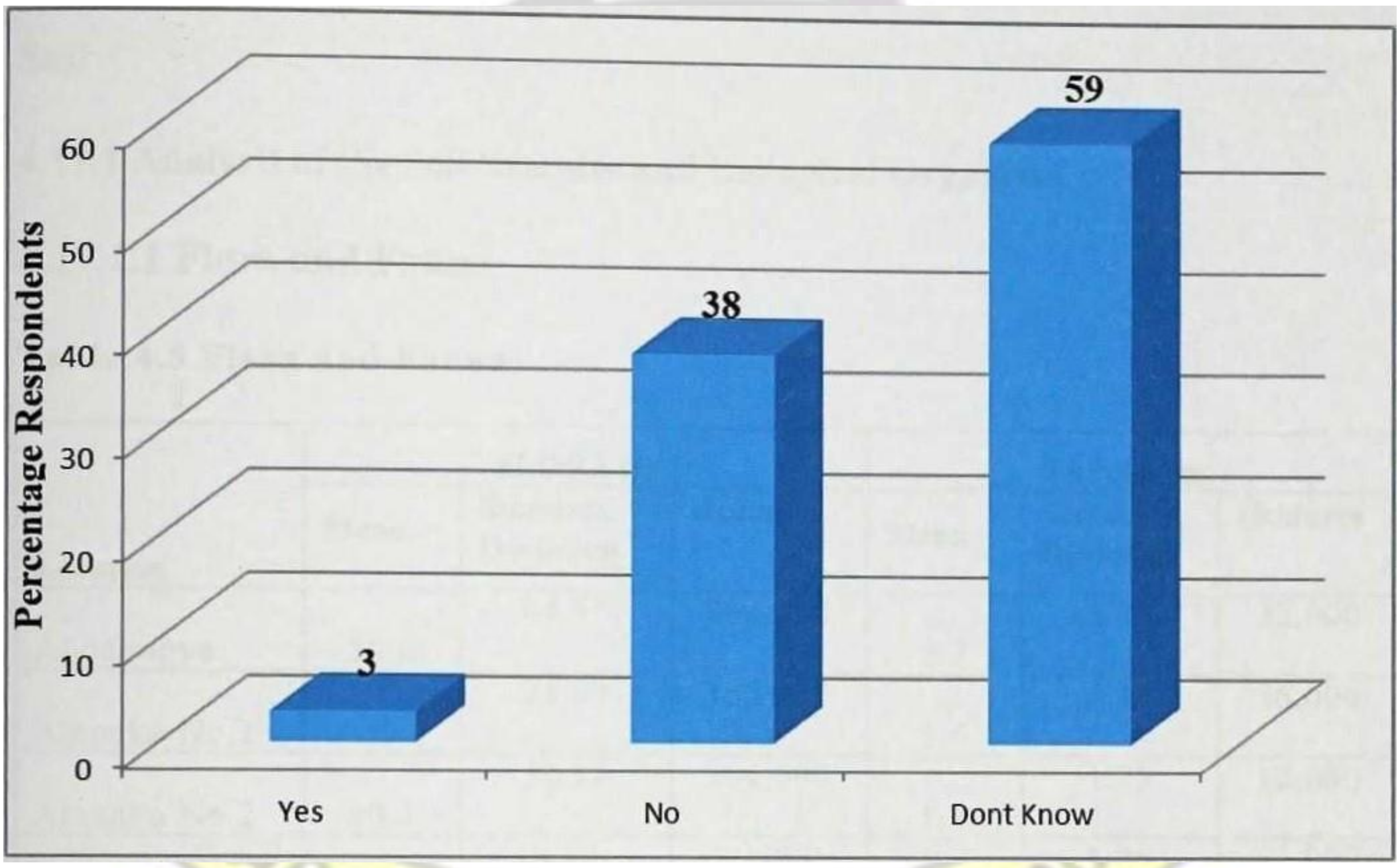


Figure 4.11 Systems for Monitoring (Source: Field study 2013)

The effectiveness of the monitoring system to ensure compliance was again indicated by the same respondents who said they don't know whether there are monitoring systems or not. Again they indicated that they don't know whether the monitoring systems are effective to ensure compliance and this constituted

59% of the respondents. On the other hand those who indicated no were 38% whereas only 3% indicated that the systems for monitoring are effective.

4.17 Results of Laboratory Analysis of Sand Winning Impact on the Soil

4.17.1 Analysis of the Soil Samples and Biological Organism

4.17.1.1 Flora and Fauna Table

4.5 Flora and Fauna

Location	FLORA m			FAUNA m		
	Mean	Standard Deviation	Hectares	Mean	Standard Deviation	Hectares
Aboabo a	30.6	44.55	306,000	3.2	5.74	32,000
Amoako No. 1	15	24.09	150,000	3.6	7.14	36,000
Amoako No.2	20.4	32.14	204,000	1.2	1.29	12,000
Boaman soko	8	9.22	80,000	6.6	5.25	66,000
Kwaman	3.6	5.06	36,000	7.2	1.15	72,000
Kwaman Control	51.2	34.54	512,000	16.6	9.56	166,000

(Source: Field Study, 2013)

Soil micro-organisms are essential to the soil and healthy growth of plant life. Cover crops directly influence the soil community by their root growth and plant cover. The majority of organisms found in soils are associated with the plant roots that provide them __________ with carbon and other nutrients. Long periods of bare/fallow may disrupt the community structure and reduce the numbers and activity of soil organisms, particularly mycorrhizal fungi. The physical cover on the soil surface also moderates soil temperature and moisture changes, creating generally more hospitable habitat for soil organisms. As a general rule, soil with vegetation supports higher microbial populations than fallow soil. Plant roots exude compounds such as amino acids, simple sugars and organic acids, and they slough off cells containing polysaccharides. These compounds provide a continuous energy supply to micro-organisms living in the root zone (the rhizosphere). Studies have shown that the size of the microbial biomass fluctuates seasonally in response to the growth of crops such as wheat due to the rhizosphere effect (Lynch and Panting, 1980).

Earthworms, when present, stimulate the decomposition of cover crop residues. Their feeding and burrowing activities incorporate residues and other amendments into the soil, enhancing organic matter decomposition, humus formation, nutrient cycling, and the development of soil structure (Werner, 1993; 1994). Earthworm burrows can persist even after the worms responsible for building them are gone, providing pathways for rapid root growth, water infiltration, and gas exchange. Deep-burrowing species can burrow through compacted soil and penetrate plough pans.

Table 4.5 shows the result of the analysis of the flora and fauna of the communities where the studies were undertaken. It is worth mentioning that part of Kwaman was used as a control against other parts of Kwaman together with the rest ofÿg_communities including Aboabogya, Amoako 1 and 2 and Boamang Soko. The results show the standard deviation and the mean for both flora and fauna in all the communities. The results showed that Kwaman control had the highest mean score of 51.2m ^{2} for flora with standard deviation of 34.543 m ^{2} . This was followed by Aboabogya with a mean score 30.6m2 and standard deviation of 44.5m^{2} . Boamang Soko had the lowest mean score for flora with 8m ^{2} and standard deviation of 9.215m2 .This means that the mean score and the standard deviation for the disturbed land is lower as compared to the controlled communities.

In terms of fauna, Amoako No. 2 had the lowest mean score of 1.2m^2 with standard deviation of 1.290m^2, followed by Aboabogya with a mean score of 3.2m^2 and standard deviation of 5.744m^2 . However, Kwaman control was the community with the highest fauna of 7.2m^2 and with standard deviation of 1.154. Amoako No. 1 had a total depleted land area of 1.3 hectares, Aboabogya had a total depleted land area of 1.2 hectares, Amoako No.2 had a total depleted land area of 0.9 hectares, Kwaman had a total depleted land area of 0.8 hectares and Boamang Soko had a total depleted land area of 0.5 hectare. From the analysis, the control land had the lowest mean score for flora and the highest for fauna.

4.17.2 Phosphorus and Potassium

Table 4.6 Phosphorus and Potassium

Location	P (ppm) Mean	Standard Deviation	K (ppm) Mean	Standard Deviation
Aboabogya	3.874	0.872	22.204	4.311
Amoako 1	6.082	1.0569	30.464	1.521
Amoako 2	5.95	2.038	19.092	4.850
Boamang Soko	3.902	1.041	19.920	2.345
Kwaman	4.468	2.168	34.428	5.463
Kwaman Control	10.18	0.785	60.450	18.937

(Source: Field Study, 2013)

Phosphorus (P) is one of the key essential elements in modern agriculture. Fertilization of crops comprises the largest proportion of P used in agriculture. Phosphorous use has become increasingly prevalent during recent decades due to its depletion in soils used for crop and hay production. The importance of P to crop production systems is illustrated by the amount of fertilizer-P in seed production which promotes increased root growth and promotes early plant maturity.

Table 4.6 indicates the results of the analysis of phosphorous and potassium in the soil. The community with the lowest mean score for phosphorus was Boamang Soko with 3.902ppm mean score and 1.040ppm standard deviation. The control community which is Kwaman control had the highest mean score of 10.18 and standard deviation of 0.785 ppm. From the analysis, the mean score for phosphorous for the control community had the highest mean and the lowest standard deviation. According to the Soil Research Institute (SRI, 1994), the average normal phosphorous supposed to be in the soil should range between 10-20 ppm. This is in support of the result of this study because the data collected revealed that only the agricultural land i.e. Kwaman controLfell within the range of 10.18 ppm with decreasing values in the disturbed lands.

Again, the standard average level of potassium according to SRI (1994) ranges between 50—100 ppm. Data collected revealed that the agricultural land i.e. Kwaman control is the only land that had an average value that fell within the required standard (60.45 ppm) with decreasing average values in the disturbed lands. The community with the highest mean score for potassium, Kwaman control, had a score of 60.45 and standard deviation of

18.936. The community with the lowest mean score for potassium was Amoako No. 2 with a score of 19.092 and standard deviation of 4.850. The analysis indicates that the control land (Kwaman control) has the highest mean score for potassium, but the disturbed land had been depleted of its nutrients.

4.17.3 Organic Carbon, Total Nitrogen and Organic Matter

Table 4.7 Organic Carbon, Total Nitrogen and Organic Matter

Location	% Organic Carbon, C	Standard Deviation	0/0Tota1 Nitrogen, N	Standard Deviation	%Organic Matter, M	Standard Deviation

Aboabogya	0.22	0.0084	0.02	0.00	0.356	0.0167
Amoako 1	0.324	0.0378	0.02	0.00	0.558	0.0657
Amoako 2	0.202	0.0179	0.014	0.0055	0.346	0.0329
Boamang Soko	0.298	0.01 10	0.012	0.0045	0.514	0.0195
Kwaman	0.394	0.0555	0.016	0.0055	0.68	0.0946
Kwaman Control	1.702	0.0449	0.098	0.0045	2.93	0.0781

(Source: Field Study, 2013)

Table 4.7 shows percentages of orga of organic carbon, nitrogen and organic matter of the various communities. Soil organic carbon is important for the formation of soil organic matter, promotes soil structure and serves as a food source for soil fauna and flora. The organic carbon for the controlled land was 1.702% which is in conformity with the SRI (1994) standard of 0.928% to 1.740%. Nitrogen in the soil is the most important element for plant development. It is required in large amounts and must be added to the soil to avoid a deficiency. Nitrogen is a major part of chlorophyll and the green colour of plants. The total nitrogen for the control land was 0.098% which also fell within the SRI (1994) standard of 0.1 to 0.2%. Lastly Soil organic matter (SOM) is an essential reservoir of carbon, nutrients and energy in the cycle of life. Without SOM, the earth's surface would be a sterile mixture of weathering minerals. The organic matter for the Kwaman control was also 2.93% which conform to the SRI (1994) standard of 1.6 to 3%. The analysis indicated that, the disturbed lands had the lowest percentages of organic carbon, total nitrogen and organic matter.

In terms of standard deviation, the results showed that Aboabogya had the lowest standard deviation of 0.008 as compared to Kwaman control which had the highest standard deviation of 0.044. The disturbed lands which had the lowest standard deviation for total nitrogen were Aboabogya and Amoako No. 2 which had zero each. The organic matter was also measured and the results showed that Amoako No. 2 had the lowest percentage standard deviation of 0.0328 and the undisturbed land (Kwaman control) had the highest standard deviation of 0.0781. From the analysis, Kwaman control had the highest standard deviation for organic carbon, total nitrogen and organic matter, as cogÐpared to the disturbed lands which had low standard deviations.

4.18 Total Volume of Sand Taken From Each Site

Table 4.8 Volume of Sand Extracted

Name of Communit	Area Du m	De th M	Volume of Soil m
Am oakol	12,678.0	1.8	22,820.40
Amoak02	8,824.3	1.8	15,883.74
Aboabogya	11,790.0	1.6	18,864.00
Boamang Soko	5,028.5	0.85	4,274.23
Kw aman	7,577.0	1.55	11,744.35
Kwaman Control	0	0	0

(Source: Field Study, 2013)

Volume excavated could be computed as:

Volume = Area Covered x Average Depth of Area Dug

Table 4.8 shows the total volumes of sand taken from each community as compared with the control community. The results indicates that in terms of the volume dug, Amoako No. 1 had the largest volume dug of 12,678 m^3 followed by Aboabogya with 11,790m^3 and the control area which is Kwaman control had none. In terms of depth, Amoako No. 1 and No. 2 have the same depth of 1.8m followed by Aboabogya with depth of 1.6 and the control area has zero depth. The volume of soil as indicated in Table 4.8 shows that Amoako No. 1 had the highest volume of 22,820.40 m^3 followed

by Aboabogya 18,864m^3 with the control community having none. From the aiúsis, it can be concluded that Amoako No. 1 and Aboabogya are the most affected communities in terms of volumes dug, the depth dug and the volume the soil removed. The control community which is Kwaman is not affected by any of the mentioned effects. Fig. 4.12 depict the extent and depth of area dug.

Fig. 4.12 Dug Area for Sand at Amoako No.2 (Source: Field Study, 2013)

4.19 Soil Moisture Content

Table 4.9 Soil Moisture Content

Name of community	Mass of Dry Soil	Mass of Wet Soil	Moisture Content %
Amoakol	2.96	97.04	3.05
Amoak02	5.64	94.36	5.98
Aboabogya	3.24	96.76	3.35
Boamang Soko	8.12	75.08	10.82
Kwam@n	8.12	96.16	3.99
Kwaman control	8.92	91.08	9.79

(Source: Field Study, 2013)

Moisture content = Moisture x 100 %

Dry mass

The moisture contents of the soils in the communities were also measured during the study and the results are indicated in Table 4.9 showing that

Amoako No. 1 had the lowest moisture content of 3.05%, followed by Aboabogya with 3.35% moisture content. However, Boamang Soko had the highest moisture content of 10.82%, because it is closes to a water body with a high water table, making the soil always moist. The control community (Kwaman control) had 9.79%. It is clear from the analysis that the two most affected communities had lowest moisture content. The land with the highest moisture content was as a result of its closeness to a waterbed else the control land would have been the land with the highest moisture, because of the undisturbed crop cover. The soils in the mined areas were very dry because of their exposure to the elements.

4.20 Soil Bulk Density

Table 4.10 Soil Dry Bulk Density

NAME OF COMMUNITY	soil Bulk DENSITY		Volume of Soil Mined	Mass of Soil Mined(kg)	Rate of Soil Removed (kg/t)
	(g/cm	(kg/m			
AMOAKOI		1482.4	22,820.40	33,828.9	8,457.2
AMOAK02	1.8165	1816.5	15883.74	28,852.8	7,213.2
ABOABOGY	1.6510	1651.0	18,864.00	31,144.5	7,786.1
BOAMANG SOKO	1.7831	1783.1	4,274.23	7,621.4	1,905.4
KWAMAN	1.4996	1499.6	11,744.35	17,611.8	4,402.9
KWAMAN CONTROL	1.4320	1432.0			

(Source: Field Study, 2013)

Soil bulk density is computed as:

$$\text{Bulk Density} = \frac{\text{Dry Mass}}{\text{Bulk Volume}}$$

Table 4.10 shows the dry soil bulk densities and from the analysis, Amoako 2 had the highest bulk density of 1.82g/cm ^{3}. The Kwaman control had the least bulk density of 1.43g/cm ^{3}. The control community was in conformity with the SRI (1994) standard of 1.37g/cm ^{3} for bulk density. It shows that mined soils leave compacted subsoils which cannot easily support agriculture.

4.21 Extent of Sand Deposits

Sand winning activity begun about four years ago in the Afigya Kwabre District. The main occupation of the people of Kwabre is farming but their alternative source of income is trading and sand winning which has become a major activity but is destroying most of their agricultural lands.

From the data collected, it was realised that their agricultural land is being depleted as a result of sand winning activities. Amoako No. 1 had a total depleted land area of 1.3 hectares, Aboaþogyahad a Ltggl_depleteðland area of I .2 hectares, Amoako No.2 had a total depleted land area of 0.9 hectares, Kwaman had a total depleted land area of 0.8 hectares and Boamang Soko had a total depleted land area of 0.5 hectares. The implication is that, the agricultural lands are being destroyed at the rates of 0.33ha/y, 0.3ha/y, 0.23ha/y, 0.2ha/y and 0.13ha/y for Amoako No.l, Aboabogya, Amoako No.2, Kwaman and Boamang Soko respectively.

Again, in terms of mass, the agricultural lands are being destroyed at a rate of 8,457.2kg/y, 7,2132kg/y, 7,786.1kg/y, 1,905.4kg/y and 4,402.9kg/y for Amoako No.l, Amoako No.2, Aboabogya, Boamang Soko and Kwaman respectively. At this rate, very soon agricultural lands will be obliterated and crop farming will be a thing of the past. What alternative employment will be available then becomes an issue for future consideration.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter provides a summary of the findings, the conclusion and recommendations of the study relating to the objectives.

5.2 Summary of Findings

The study revealed that most of the people involved in sand winning activities are men probably because it requires physical strength and the majority are between the ages of 21 and 40 years. A large number of the people involve are JHS and SHS graduates.

Sand winning was rated high in the selected communities by the majority of the respondents. In terms of benefits, it was indicated that sand winning activities serve as a source of employment for the youth and the people in the communities. It also generates revenue for the District Assembly and the individual contractors as well as the landowners. Again, it serves as an alternative - livelihood "Ag—agzicultural work to the people in the communities.

The study revealed that sand winning has impacted on the water bodies through the pollution of water sources and the groundwater table drops leaving drinking water wells on the embankments of these rivers dry during the dry season. It also leads to flooding and sometimes it diverts the water from the main source and making it stagnant at some places.

Even though sand winning activities have a lot of benefits to the communities, there are numerous detrimental effects on the operational communities and among them are the impacts on the water bodies including pollution of water sources and drying of rivers during the dry season. It leads to the degradation of agricultural land and deforestation. It also has a lot of health hazards such as air pollution and the possible dangers of long-term exposure. Another major effect is the destruction of atmospheric layer as a result of the destruction of tree covers.

The findings also revealed that permits/licence are issued by the District Assembly, however, law enforcement regarding sand winning activities to ensure compliance is very weak.

The findings show that the mean score and the standard deviation for flora for the disturbed land is lower as compared to the controlled community. Also in terms of fauna the control community has the highest mean score and standard deyiation. The control land has the highest mean score for flora and fauna. Sand winning destroys the flora and fauna and in general the biodiversity of the area.

Again, the findings show that the mean score for phosphorous for the control community has the highest mean and the lowest standard deviation and phosphorous of the controlled land conforms to the Soil Research Institute (SRI, 1994), approved standards. The control land (Kwaman control) has the highest mean score for potassium and also the control community conforms to the standard average level of potassium according to SRI (1994).

The finding revealed that organic carbon, nitrogen and organic matter of the controlled community are in conformity with the SRI (1994) standards. However, the disturbed lands have the lowest percentages of organic carbon, total nitrogen and organic matter. Kwaman control has the highest standard deviation for organic carbon, total nitrogen and organic matter, as compared to the disturbed lands which have low standard deviations.

The finding again revealed that Amoako No. 1 and Aboabogya are the most affected communities in terms of the area dug, the depth and the volume of the soil dug. The control community which is Kwaman is not affected by any of the mentioned effects.

Again, the two most affected communities had the lowest moisture contents during the study. The land with the highest moisture content was as a result of its closeness toa waterbed, else the control land would have been the land with the highest moisture content because it had plant cover. Also, the Kwaman control had the least bulk density which is in conformity with the SRI (1994) standards.

5.3 Conclusions

Sand wining activities have contributed greatly to the economic development in Ghana and it is an important activity for the infrastructural development because of its high demand by the construction industry. It is also used for making concrete, filling roads, building houses, brick-making, glass making, sand papers, reclamations, etc.

Although sand winning activities have many benefits, indiscriminate sand and gravel mining over the years has imposed irreparable damages to the river ecosystems, human health and impacts negatively on the environment. Yet these activities have remained uncontrolled because the government lacks the ability to check them and their scattered areas of operation makes the task more difficult. The non-recognition of these sand winners by government has forced them to continue to operate illegally and clandestinely.

It is clear that sand winners have been operating informally and illegally but their activities should not be ignored because of the impacts on the socioeconomy and-environment-rytïïõïs the need for the government to embark on educational campaigns on the impacts of sand winning activities and also legalise the activities of sand winners. There should be effective collaboration by the government with other relevant agencies. Also effective monitoring of sand winning activities will help to bring sanity into their activities and there is the need to conduct health education and monitoring

to minimise the health impacts. Annually, land area lost to sand winning is

4.7ha, transporting volumes of sand in the region of 1,236,277.37m^3

5.4 Recommendations

The suggested recommendations can help address the problems found from the study in order to help improve sand winning. They are:

5.4.1 Awareness Campaign

Awareness campaigns should be conducted by Environmental Protection Agency, District Assemblies and other governmental agencies about the various impacts of sand winning activities such as on river bodies, human health, environment, use of alternatives to sand in construction and immediate need for control measures.

5.4.2 Collaboration with Relevant Agencies

For effective revenue collection and control of the sand winning activities, there is the need for the government through the District Assembly to collaborate with relevant departments/ministries and non-governmental organisations to regulate-säïTÇffiÑing and maximise revenues.

5.4.3 Legalisation of Sand Winning Activities

Since sand winning activities are critical to the socio-economic development of Ghana, there is the need for the government to put in place measures to encourage these sand winners to be registered and to operate legally. This will bring them to the formal status of the sector and allow them to function well and perform their duties efficiently and effectively. The advantages of this are that their activities can be monitored and they can contribute meaningfully to positive environmental and socio-economic development. They can be made to pay a refundable deposit which will be returned if they heap the top soil layer and spread it back after mining.

5.4. 4 Effective Monitoring

The activities of the sand winners need to be effectively monitored and controlled by the relevant government agencies in order to minimize indiscriminate sand winning activities. The most important step that government should take is to legalize their activities so that the government can have good and effective control over their operations.

5.4.5 Primary Health care Programmes

There is the need to implement comprehensive primary health programmes incorporating effective and efficient epidemiological units in the district to undertake periodic survey, monitoring and handling of epidemiological problems in sand wining communities.

SS-Recommendations for Future Research

It is recommended that further research is conducted into the long term health impacts of Sand Winning Activities in the District.

A look can also be taken at using disused mined sites for composting of municipal wastes to solve waste disposal problems whilst regenerating mined sites.

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APPENDIX 1

QUESTIONNAIRE

The aim of this questionnaire is purely for academic purposes as a requirement for a Master's Degree programme in Environmental Resource Management and information given will be strictly confidential. This questionnaire is designed based on the topic: "Assessing the Impacts of Sand Winning on the environment" in the Afigya Kwabre District. Please, tick the box where applicable

Thank you.

1. Gender

   Male

   Female [1

2. What is your age range?

20-30 Years [ ]

31 -40 Years [ ]

41-50 Years [ ]

51 -60 Years [ ]

Above 60 Years [ ]

3. What is your highest education level?

Illiterate [ ]

JHS [ ]

SHS/O'/A'1eve1 [ ]

Diploma [ ]

Degree [ ]

Others (State) ....

4. What is your assessment of sand winning activities in the community?

Very High High [ ]

Medium Low [ ]

Very Low [ ]

[ ]

5. In your opinion what are the socio-economic benefits of sand winning activities?

....

....

....

....

6. What are the impacts of sand winning activities on water?

....

....

....

....

7. To what extent do sand winning activities contribute to environmental degradation

....

....

....

....

8. What are the effects of sand winning activities on humans?

....
....
....
....

9. What are the effects of sand winning activities on agricultural land? Please tick as many as are applicable.

No	Description	Tick
I	Loss of forest trees	
2	Diminished vegetation cover	
3	Exposure of soil surface	
4	Gully on farmland	
5	Soil nutrient depletion	
6	Destruction of organic matter	
7	Destruction of soil structure	
8	Soil erosion occurrence on the farm	
9	Low yield	
10	Reduction of agricultural land	
Il	Others (State)	

10. How would you rate the impacts of sand winning activities indicated in Question?

Very High

High

Medium [ ]

Low [ ]

Very Low [ ]

11. What is your perception on the side effects of sand winning activities on the environment?

....
....
....
....
....

12. In your opinion who issues the permit / licence to sand winners?

Farmers [ ]

Landowners [ ]

Chiefs [ ]

District Assembly [ ]

13. Do you think that rules regarding sand winning activities are enforced by the authorities in charge of ensuring compliance?

Yes

No

14. If no, why?

....
....
....
....

15. Are there monitoring systems to ensure compliance?

Yes [ ]

No [ ]

Don't Know [ ]

16. Is the monitoring system effective to ensure compliance?

Yes

No

Don't Know

17. What measures can be put in place to mitigate the negative impact of sand winning activities on the environment?

....
....
....
....
....

APPENDIX 2

MAPS OF AGRICULTURAL LANDS

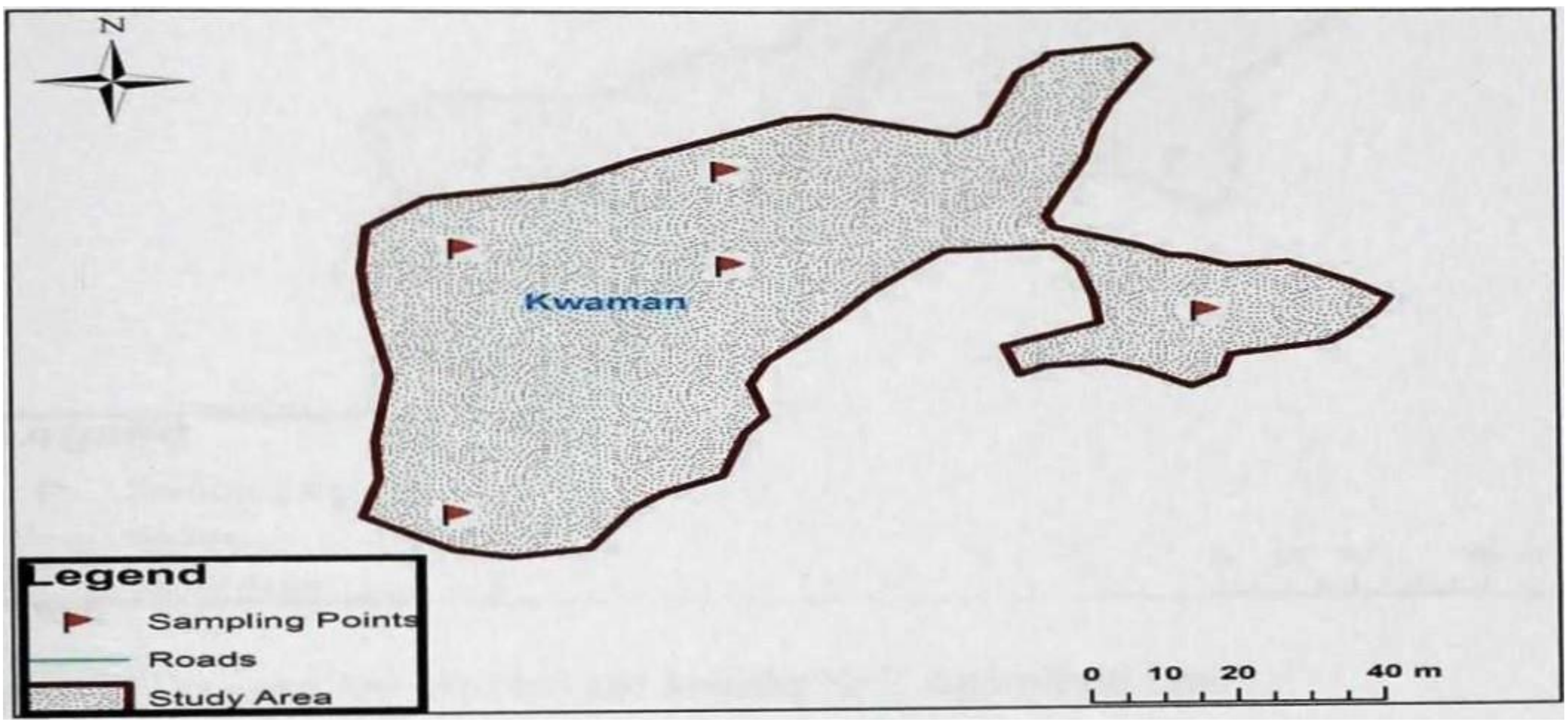

Figure 2A Degraded Kwaman Agricultural Land

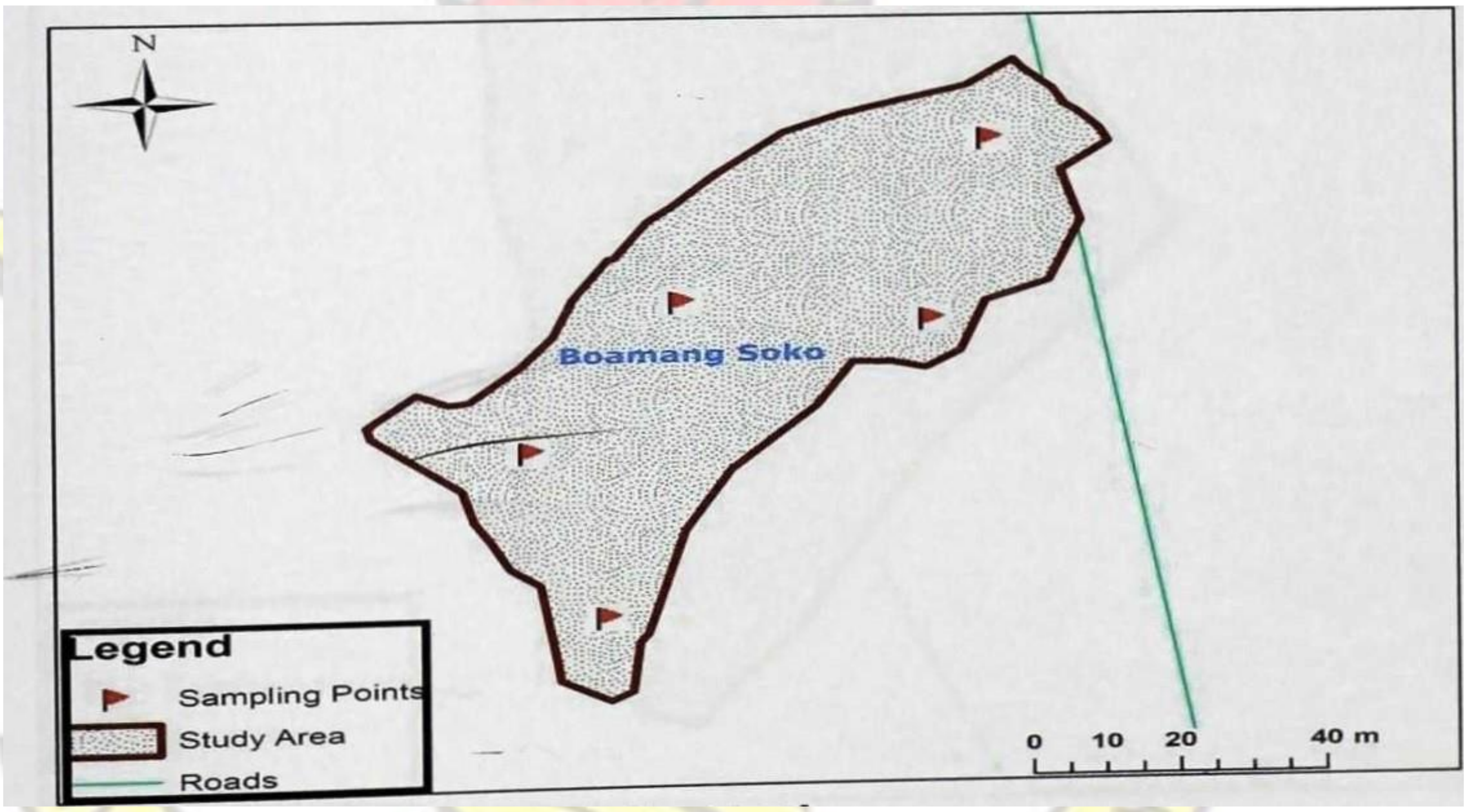

Figure 2B Degraded Boamang Agricultural Land

egend

Sampling Point

Roads

Stud Area 0 15 30 60 m

Figure 2C Degraded Amoako No. 1 and Amoako No.2 Agricultural Land

Aboabogya

egend

Sampling Point

Study Area o 12.5 25 SO m

Roads

Figure 2D Degraded Aboabogya Agricultural Land

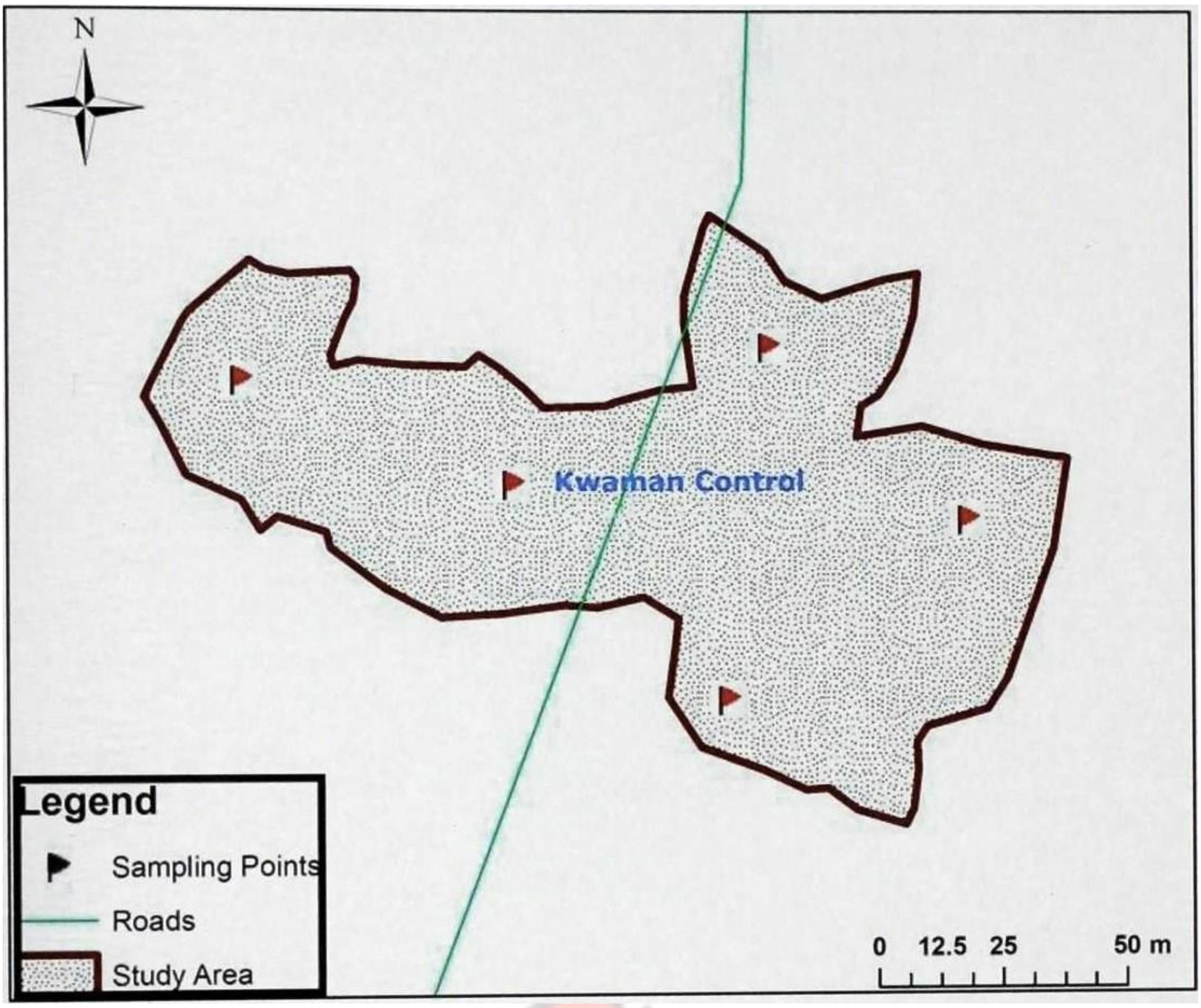

Figure 2E Kwaman Agricultural Land