EXAMINING THE SOCIAL AND ENVIRONMENTAL IMPACT OF TAILINGS DAM PROJECTS IN GHANA: A CASE STUDY OF PERSEUS MINING TSF PROJECT

By

Prince Kwaku Denyo

(BSc. Geological Engineering)

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DECLARATION

I hereby declare that this submission is my own work and that , to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which is a substantial extent has been accepted for the award of any other degree or diploma at Kwame Nkrumah University of Science and Technology, Kumasi or any other educational institution, except where due acknowledgment is made in the thesis

Prince Kwaku Denyo	…….	……
(PG 5044118)	Signature	Date

Certified by:

Dr. Kofi Agyekum	…….	……
Supervisor	Signature	Date

Certified by:

Prof. Bernard K. Baiden	…….	……
Head of Department	Signature	Date

ABSTRACT

There is demonstrated information to underscore the way mining activities improves the socio-economic wellbeing of a country in areas such as employment, business, direct commitment to the Ghana's gross domestic product (GDP), external income earnings and support for other industries. Along with mining operations and activities is an associated structure called the Tailings Storage Facility (TSF) which serves as an impounding facility for waste disposal in the mining industry. The construction of a TSF has varied impacts ranging from displacement of inhabitants, destruction of farmlands, resettlements among others. Many of these facilities have been constructed without a carefully conceived contemplations about their impact; living the host community displaced and disadvantaged. Many mining firms tend to overlook the social and environmental risk presented by Tailings Storage Facilities fundamentally on the grounds that there is no immediate income from the expense made in planning, designing, construction and operation of the such facilities. Hence the study was conducted to examine the impact of the Perseus Mining Ghana Ltd (PMGL) TSF project on the host community and recommend improvements to the identified social and environmental impacts. Seventy respondents in total were administered with questionnaires to collate relevant information. The sets of data obtained was analysed by utilising the statistical software (SPSS) – Statistical Package for Social Sciences, excel sheets programmed with Relative Index formula (RII) and descriptive statistics was adopted in analysing the demographic information.

The overall summary of the respondents surveyed indicated that the construction of the TSF poses a positive impact on the economy and development of host communities, thereby making the community a much better place. However, the respondents also indicated the TSF poses some negative impacts such as poor air quality and degradation of lands and forest. Notwithstanding the respondents pointed out some improvements to the existing positive impacts identified such as the resettlement of project affected persons (PAPs) and compensation to affected communities.

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ABBREVIATIONS

TSF	Tailings Storage Facility
PAP	Project affected person
GDP	Gross domestic product
PMGL	Perseus Mining Ghana Ltd
SPSS	Statistical Package for Social Sciences
RII	Relative Importance Index
EIA	Environmental Impact Assessment
SIA	Social Impact Assessment
ICMM	International Council on Mining and Metals
ANCOLD	Australian National Committee on Large Dams
ICOLD	International Commission On Large Dams
WCD	World Commission On Dams
LI	Legislative Instruments
WHO	World Health Organisation

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DEDICATION

This work is dedicated to God almighty, my family and friends for the immerse support through this study.

God bless you all.

CHAPTER ONE

INTRODUCTION

1.1. BACKGROUND

In recent decades Ghana's economy has benefited tremendously from mining and its related activities (Lawson and Bentil, 2014). Being one of the oldest industries to have seen sustainable development; the sector has over the years formed an undoubted essential segment of the economy and has since played a significant part in the country's socio-economic development as the largest sources of revenue to the country (Mensah *et al.,* 2015).

Ghana has been recognised and ranks first after South Africa as the leading producer of gold in Africa (Mensah *et al.,* 2015) with 158 tonnes of gold in export in 2018 (BBC News, 2019).

The mining sector has recorded GH¢15.8 billion and GH¢17.1 billion in 2016 and 2017 respectively in contribution to the economy of the country. These contributions came in the form of mineral royalties and corporate taxes of mining in revenue collected from the mining sector (Odonkor and Amoah-Darkwah, 2019).

The Mining sector also provides enormous job opportunities to several millions of Ghanaians which indirectly generates for the economy huge returns in the accrued employee income taxes (Amponsah-Tawiah and Dartey-Baah, 2011)

An integral facility of mining activities is a Tailings Storage Facility (TSF). The TSF's characterise the most critical environmental burden and/or liability associated with mining projects, both during the active and closure phases of a project (Martin

and Davies, 2000) yet a fundamental requirement for the operation of any Mining operations in the country (Minerals And Mining (LI 2182, 2012).

Tailings Storage Facility (TSF) as defined by (Mining Association of British Columbia, 2009) and (Tayebi-Khorami *et al.*, 2019) is a structure that is mostly made from earthworks and built mainly for the purposes of storing and/or impounding uneconomical ore.

The construction of Tailings Storage Facilities is unavoidably go with by considerable displacement and resettlements thus in effect possess intricate social impacts on the host communities (Huang *et al.*, 2018). Large acres of farmland are affected in the process of construction of a TSF.

Social impacts incorporate every one of the issues related with a project that affects or concern individuals, regardless of whether direct or by implication.

This study therefore seeks to examine the social impact that is associated with the undertaking of the TSF projects in the host community; Ayanfuri where Perseus Mining Ghana limited (PMGL) carries its mining operations.

1.2. STATEMENT OF THE PROBLEM

There is proven data to underscore the fact that mining activities improves the socio-economic wellbeing of a nation in areas such as employment, direct contribution to the national gross domestic product, foreign exchange earnings and support for other industries (Tsuma, 2010) and (Cobbinah and Amoako, 2018). In line with mining operations comes several structures which either negatively or positively impacts its operations and the communities hosting the mine. One of such facilities is the Tailings storage facility.

The construction of a TSF has varied effects ranging from displacement of inhabitants, destruction of farmlands, resettlements (Obour *et al.*, 2016). For a tailings dam to be socially acceptable, it must, by definition, have a "social license" by demonstrating that the benefits of the project outweigh the negative impacts of the project (Harvey and Plewes, 2003).

Many are these facilities that have been constructed without a well thought through considerations about their impact; with the host community left displaced and disadvantaged (Owen and Kemp, 2015).

There is the perception that TSF projects affect the livelihood and environment of the host communities. (Heming *et al.*, 2001) in their research asserted that the construction of TSF's results in the loss of viable farmlands and crops which otherwise support and provides a means of livelihood for individuals and/or families of the host communities, for example, cocoa farms were a fundamental source of income for displaced project affected persons whose lands have to be cleared to pave way for the construction of TSF's and the farmers are left to suffer economic loss through the destruction of their cocoa farms. Furthermore, (Schmidt, 2003) stated that higher concentrations of cyanide and other heavy metals from processed gold cause enhanced take-up by crops furthermore, influence plant development adversely, sometimes leading to plant mortality

The focus of the study seeks to examine the impact of the Perseus Mining Ghana Ltd. (PMGL) TSF project on the host community and recommend improvements to the identified social and environmental impacts.

1.3. AIM AND OBJECTIVES

1.3.1. AIM OF THE STUDY

The aim of this study is to examine the social and environmental impact posed by the TSF construction project on the host community.

1.3.2. OBJECTIVES OF THE STUDY

The objectives of this study is limited to the following:

1. To assess the current perception of community members on the TSF projects.
2. To determine the social and environmental impacts of the TSF project on the livelihood of community members.
3. To suggest measures to improve the positive social and environmental impacts of TSF projects on the community and its inhabitants

1.4. RESEARCH QUESTIONS

The study is aimed at addressing these research questions:

1. What are the impressions of people in the community towards TSF projects?
2. What is the effect of TSF projects on the livelihood of people in the community?
3. Has the TSF projects added value to the host community?

1.5. RESEARCH METHODOLOGY

To ensure that the set objectives are achieved, this study will employ quantitative method of approach to get the required information which will permit an appropriate and exact data organisation, examinations and interpretation.

The process of the data collection involves the administration of a well-structured questionnaires to the relevant stakeholders of the community in which the mine operates and the key professionals related to the Mine and the TSF project.

The study will adopt a quantitative research methods approach consisting of online distribution of questionnaires to key stakeholders such as contractors, members of the community and Mine works.

1.6. SIGNIFICANCE OF THE STUDY

The conclusions reached as a result of this research will go a long way to inform all stakeholders especially policy makers on factors that have implications of TSF construction projects on the various mining communities. It will offer policy makers objective advantage to make informed decisions on how to formulate, design and implement policies at improving execution of TSF projects in Ghana.

The research findings will furthermore provide critical feedback to policy makers and mining firms the expectations of all stakeholders from communities in which these TSF projects are sited and serve as baseline to measure and establish a benchmark from which to compare results over time to make informed decision on TSF projects.

Additionally, the findings of this research will contribute to literature and increase knowledge in recognizing and understanding the importance of considering social impact implications of such projects.

1.7. STRUCTURE OF THE STUDY

This study is organized into five parts. The chapter one contains the background or basis of the research, the objectives, the relevant research questions and the significance of the research. Chapter two gives a broad writing survey on the social

impacts of TSF construction Projects. The chapter three describes in point by point the study area, population and sampling technique, data collection strategy, research instrument and data analysis.

Chapter four provides descriptive analysis of the survey information gathered and furthermore discusses the findings from the analysis. Chapter five provides a summary of the research findings, conclusion, some policy recommendations to enhance effective implementation of TSF projects and suggestions for future research.

1.8. SCOPE AND LIMITATIONS OF THE STUDY

There are several identified effects of mining operations on host communities however, this study is limited to the social and environmental impacts of the TSF construction project on the host community within which PMGL directly operates.

The study is limited to this scope because of the time involved in undertaking researches on impact assessments coupled with the time frame for the submission of the research work.

CHAPTER TWO

LITERATURE REVIEW

2.1. INTRODUCTION

Mining being one of the important economic activities in Ghana has drawn the attention of many to the sector. Since the inception of mining activities in Ghana, there have been several researches directed on mining related operations and its effects as well as the contributions to economic development of the country (Lawson and Bentil, 2014).

The impacts of dams have been extensively studied (Fung *et al.*, 2019). Some researchers have looked at benefits of mining to economic development, others highlight the negative impacts of mining on the overall development of the economy. The chapter two of this research focuses on review of existing literature on social and environmental impacts of mining in broad-spectrum and the impacts of tailings dam construction that seeks to answer what the social impacts of such facilities have on the host communities in which they are sited. The conduct of social impact assessments are cost effective in improving the knowledge that is required for upright policy resolutions and to advance the decision making processes (Lockie, 2012).

Many mining firms or enterprises tend to ignore the social and environmental risks posed by Tailings Storage Facilities mainly because there is no immediate money related return from the expense on planning, design, construction, operation and management. TSF construction projects have the potential to cause adverse social and environmental impact across several communities and therefore should be managed by ensuring there is continuous social and environmental impact assessments.

2.2. TAILINGS STORAGE FACILITY (TSF)

There are two kinds of products generated from mineral processing plants. These are categorised as either economic or noneconomic ore. The economic product being the sort after mineral, such as gold, copper, bauxite etcetera. The non-economic product, typically known as tailings, comprises of waste, trivial quantities of valuable minerals or metals, chemicals, and process water (Li and Coop, 2018). Tailings storage facility or dam is a structure that is mostly made from earthworks and built particularly for the purposes of storing and/or impounding undesirable or uneconomical ore known as the 'Tailings' (Rico et al., 2008).

Tailings storage facilities have been used for over a hundred years and are the most common disposal system for mining waste. TSF's are the most common methods of waste disposal in the mining industry in view of their capacity to hold huge enormous volumes of waste material.

2.2.1. CONCEPT OF TAILINGS STORAGE FACILITY

Tailings storage facilities are unique (United Nations Economic Commission for Europe, 2014). They vary in size and shape and some can have more than 500 m crest length with height greater than 30 meters (Bowles et al., 2007). The construction of a TSF is therefore one of the main design choices for mining firms in the development of a mine.

There are countless factors which needs to be considered in selecting an ideal site and construction method. Site conditions such as topography, rainfall, seismic activity, mineral characteristics and proximity to nearness to individuals and/or communities dictate appropriate TSF locations. The aim is to safely contain the tailings under any and all circumstances to shield the environment and individuals from risks associated

with mine tailings (Adiansyah *et al.*, 2015). Depending on the environmental conditions, ground conditions, and the chemical characteristics of the tailings the facility may be lined using a variety of lining systems which are designed to check impacts of the tails to surface and groundwater systems (Minerals And Mining Health, 2012).

The primary importance of a TSF is the protection of the community. This can be attained by avoiding situations where seepages from a tailings storage structure could undesirably impact on the host community. Research has demonstrated that siting Tailings Storages Facilities within inhabited areas is not a good practice (ANCOLD, 2012) and (Fung *et al.*, 2019).

2.2.2. TAILINGS STORAGES FACILITIES AND THE ENVIRONMENT

The decision to construct a Tailings Storages Facilities requires consideration of the potential impacts of the structure on the surrounding environment in order to limit the operational and future risk from the storage of chemicals associated with it. The following guidelines of environmental values for consideration were proposed by (ANCOLD, 2012):

1. Waters bodies: This includes immediate receiving sources of water, aquifers and groundwater sources and domestic potable water supply sources such as wells.
2. Air: Dispersion of dust contaminants and fugitive gases transported through wind erosion.
3. Land: Constitutes fauna and flora support ecosystems within the terrain of operations.

4. The community: Takes into account safety, individuals and their supporting infrastructure and industry.

2.3. PERCEPTION AND IMPACT OF DAMS

2.3.1. GENERAL PERCEPTIONS

Perceptions depend on a wide range of elements or factors, which much of the time cannot be influenced by the environmental impact assessment. In any case, an earlier and more straightforward inclusion of local population in the plan and execution of dam projects, and in the preparation of their environmental impact assessments, can impact to a huge degree the perceptions of impacts. An open, transparent correspondence process and the immediate inclusion of affected communities in the structure of activities such as design and evaluations of the projects, of their impact studies and of their relief or remuneration measures can diminish the likelihood of misperceptions about impacts and the intensity of their social repercussions (Égré and Senécal, 2003).

2.3.2. IMPACT OF DAM PROJECTS

The immediate effects of large-scale dams on host communities incorporate the loss of viable farmlands, houses, forest reserves and other resources (Wang, 2012). To offset or counter the losses, relocated individuals are in some cases given new accommodations and freshly cleared farmland, while in some different cases, their material wealth losses are tended to through money related remuneration programs. In the event that solitary material riches loss is considered, resettled individuals as a rule are fairly redressed and compensated, or sometimes even over compensated (Tilt *et al.*, 2009).

There have been several debates over the pros and cons of Tailings Storage Facilities over the years (Tilt, 2008). Social, Environmental, Physical and ecological impacts are some examples of impacts associated with TSF projects. One of the key difficulties of evaluating the social influences of dam projects is establishing a standard set of variables by which impacts can measured (Vanclay, 2002). These variables will vary from one community to the other. The variables that are significant essentially be defined and characterized locally, and there may be local considerations that a conventional inventory that does not satisfactorily denote all cases.''

In a study conducted by (Mancini and Sala, 2018), the study concluded that employment and increased income levels are the main positive impacts associated with mining and its related activities. Environmental Impact Assessment (EIA) and Social Impact Assessment (SIA) are tools and techniques that are used to recognise and classify the social, environmental, and economic impacts of a project (Dutta and Bandyopadhyay, 2010).

2.4. SOCIAL IMPACTS

What is social impact? In the broad sense of the word, social impact is defined as how society, enterprises or people's activities influence the surrounding community. It might be the consequence or result of an activity, project program or policy and the effect can be deliberate or accidental, just as both positive or negative (Hilson, 2002). Tailings dam projects in most cases have had adverse environmental and social impacts. The effects can be felt by individuals directly or associated with the organization or have an increasingly extensive effect on people in different communities (Yankson *et al.*, 2018). Much of the time, the implementation of dam

projects has led to food insecurity, medical issues and property loss among individuals living in the host communities (Gwazani *et al.*, 2012).

An important issue that is noteworthy in relations to prospects of job opportunities is that mining set-ups tend to bring changes to the host communities due to migration of people from neighbouring communities and towns. A major consequence of such migrations is that there is population increase which comes with boost in economy, spread of diseases among the residents and the migrants (Lindahl et al., 2014).

Another huge effect is the loss of the means of a living that oozes from the change-over in the land use function when the vast majority of native farmers of the host communities who in the past relied on the land are denied their lands when it is rather used rather for mining operations. The normal average cost for basic items in mining communities now and then increases and results in economic disparity among the different societal groupings (Kitula, 2006).

(Ahmadvand and Karami, 2009) shown that there have been actions made by some social researchers to advance orders of social impact classifications, nevertheless few have established catalogue of explicit social effects, and a few others have given operational meanings of their factors. The following are some classifications:

1. **Culture:** The individual's way of living, their shared convictions, traditions, qualities and language or tongue, work, play, and associate with each other on an everyday premise.
2. **Community:** The attachment which exist among the general population, the stability, their character, services, just as their amenities.

3. **Political systems:** The degree to which individuals of a particular community can share in choices that influence their lives, the degree of democratization and the resources available that drives them.
4. **Ecological setting:** The nature of the available water and air sources for an individual's utilization; the accessibility and nature of the nourishment from what they eat; the degree of risk or danger and clamour in which they are presented to; the sufficiency of hygiene and their somatic wellbeing.
5. **Health and well-being:** 'Wellbeing' is comprehended in a way as defined by World Health Organization (WHO) as a position of complete somatic, rational, and social thriving, not simply the nonattendance of diseases and infirmity or sickness.
6. **Private and property rights:** pertaining to whether individuals are financially influenced, or experience individual impediment, that incorporates an encroachment of regular common opportunities or civil freedoms.
7. **Fears and aspirations:** The perception of their wellbeing, apprehensions on the eventual fate of their community, their yearnings for the future and the fate of their progenies.

2.4.1. SOCIAL IMPACT ASSESSMENT (SIA)

(Vanclay, 2002) defined social effect evaluation as the way toward surveying or assessing, ahead of time, the social effects that are probably going to accompany new project establishments or expansions, especially with regards to suitable national ecological policy regulation. Social effects incorporate all social and cultural cost to human populace of any general or private activities that change the habits by which

individuals live, labour, compose, identify with one another, seek out to tackle their problems, and by large adjust as individuals from society.

Most often than not, social impacts do swing here and there, from one project undertaking to the other, and the weighting allocated to respective social effect will contrast from one cultural network to the other and between various gatherings inside a given cultural network (Verma, 2012). Several SIA researches have significantly thought little of the social impacts that have been experienced by influenced communities as a result of these projects. A comprehensive list of impacts on the other hand may escalate the consciousness of the full scope of social effects, and may prompt improved evaluations as thereof.

2.4.2. CONCEPTUALISING SOCIAL IMPACTS

Numerous social changes are not necessarily in themselves referred to as impacts. On the off chance that a social effect insinuates the impacts truly esteemed by people at any level in the physical or perceptual sense, at that point by then many impact factors usually estimated in social impact assessment for instance increase in population, nearness of labour in the community, and other migrant's etcetera are not necessarily impacts but instead alteration forms which results in the impacts (Ansari *et al.*, 2012).

The upsurge of populace or the influx of foreigners do not constitute the experienced impacts (Vanclay, 2002). Rather, the effects which will probably outcome from these change methods are changed observations about the possibility of the network (Ahmadvand and Karami, 2009). The manners by which the social alteration progressions are seen or valued hinge upon the social setting wherein different social groups act.

2.4.3. SOCIAL CHANGE PROCESSES

Mostly it is unusual or nearly not possible to perceive altogether social change forms that could happen while commencing a new project or whilst undertaking an existing venture and to especially distinguish all the foundation social change forms that are occurring in the society (Vanclay, 2002). While there are various social change forms, some part of the issue of distinguishing proof is nonattendance of lucidity of what unquestionably sets up a social change process, and the degree of detail at which these procedures ought to be determined. The following represent a couple of instances of the social change forms that are significant in SIA (Nance *et al.*, 2012).

2.4.3.1 DEMOGRAPHIC PROCESSES

These are changes that identify with the movement as well as synthesis of individuals in the areas influenced by the development projects such as mining. Some demographic processes comprise the following:

1. **In-migration:** This outcome in populace development and places tension on the host community in connection to a wide scope of economic, social and environmental concerns. In-migration may not necessarily be an impact in itself, yet conceivably prompts impacts, for instance, deficiency of administration of services (Steinicke *et al.*, 2012).
2. **Out-migration:** Developments can likewise cause a decrease in population size where individuals change locations because of the effects of the mining operations turns out to be less alluring, or an alternate project elsewhere draws individuals looking for work. Decrease in populace particularly if related to altering statistic structure is likely to pose significant impacts to feasibility as well as essentialness of a location (Dyson, 2011).

3. **Influx of strangers:** Impacts are frequently unique when the recruits are construction workers who are inhabitant in the project area on a momentary basis (Amponsah-Tawiah and Dartey-Baah, 2011). Likewise, with immigrants, their essence may pose an impacts on physical structural needs, for example, accommodation structures and wellbeing facilities, streets and markets; in any case, on account of the momentary state of their stay as mostly the case, numerous construction workforces do not build up a connection to place or association with indigenes of such communities, and construction camps may require a variety of services, for example, drinking spots, prostitution and now and then drugs that becomes a reason of worries for native residents (Steinicke *et al.*, 2012).

4. **Resettlement:** This alludes to designated or constrained procedures by which the native individuals give up property for development projects, for example a tailings dam and are re-established somewhere else as a component of a reimbursement offer. Resettlement concerns are to a great extent considered the most serious type of social impact created by the development of tailings dams (Égré and Senécal, 2003).

5. **Movement and deprivation:** This refers to procedures by which advancement tasks/activities and strategies give grounds for people to lose plots of lands and various resources, or lose access to assets, that they are not satisfactorily reimbursed. The assets lost might be in the form of households, farmlands, or different areas that they are reliant to make a living. Displacements may bring about physical disengagements, forfeiture of revenue, and other allied procedures and effects, for example, poverty, social break down etcetera (Liévanos, 2015).

2.4.3.2 ECONOMIC PROCESSES

Economic processes exist in a form that influence the economic movement in a particular location as well as the manner in which individuals make a living, just as macroeconomic components that influence the society in general. The economic processes comprise the following (Kinkel, 2012):

1. **Change and expansion of economic activities:** This constitute arranged intercessions, for example, jobs and guidelines that invigorate a course of variation in the type of economic action from one kind of invention to different sorts of production.
2. **Inflation:** This is a procedure of increasing expenses. It can occur at the higher level because of macroeconomic elements, or at community levels brought about as a result of the expenditure intensity of expanding number of significant high income people, that may emerge out of development of the travel industry, nearness of outsiders, etcetera.

2.4.3.3 TOPOGRAPHICAL PROCESSES

The topographical processes refer to those that impact land use forms of a community. These includes the following (Ayoubi *et al.*, 2012):

1. **Physical splintering:** Infrastructure projects such as tailings storage facilities, roads, railways, water system trenches, etcetera can prompt the fragmenting of local networks that in turn prompt social impact, for example, forfeiture of informal grids, assets, likewise, in the most critical situations, to relocation and resettlements.

2. **Urban sprawl:** This refers to development of city territories into already provincial or urban zones with related property use modifications and weight on city framework.
3. **Improved transport and rural availability:** Enhancements in transportations services brings about expanded availability, in effect upshots in various population structure alterations.

2.4.3.4 SOCIO-CULTURAL PROCESSES

Socio-cultural processes are those which influence the way of life of a society, it includes every facets of the manner in which individuals dwell respectively, comprising (Jabareen, 2013):

1. **Seclusion:** Alludes to the process of making social differentiation inside a community.
2. **Social breakdown:** This alludes to the forfeiture of communal capital, self-destructing of family relationship systems, renunciation and absence of significance of socio-cultural practices.
3. **Cultural diversity:** This alludes to the expansion in distinctions, or professed contrasts between different clusters within the community dependent on social ethics, customs, linguistic, customary rites, and so on. This process brings division within a community (Mazur, 2010).

2.4.4. SOCIAL IMPACT FRAMEWORK

(Kirchherr and Charles, 2016) developed a framework that conceptualizes the social effect of tailings dams from a dimension and component viewpoint point of view. The suggested ‘Dimensions’ include space, time and value and the ‘Components’ they

classified as infrastructure, livelihood and community. Figure 2.4-1 represents a picture of the framework.

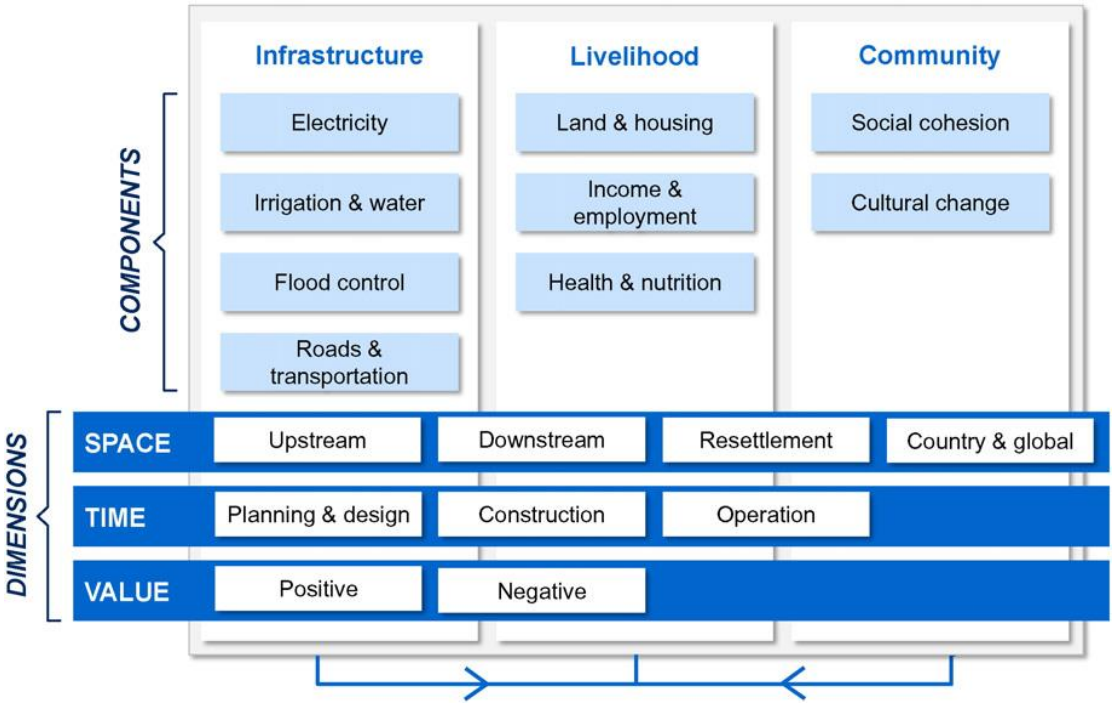

Figure 2.4-1: Suggested matrix framework on dams' social impacts
(Source: Vanclay, 2002)

The dimension of space takes into consideration the social effects that may emerge as consequence of the choice of TSF construction types available, resettlement just as nation and worldwide point of view. The key time dimensions to be considered include Planning and design, construction and operation of the facility. The third dimension considers the estimation of the value impacts which might be certain or negative (Vanclay, 2002).

There are nine unique segments of social impact laid out from the structure. These are bunched in infrastructure, occupation and community impacts. Inside infrastructure, power, water system, flood control just as roads and transportation are portrayed.

The framework provides the perspective and defines what components and dimensions of social impact to examine and what impact to dismiss from the assessment. For TSF construction projects, a sensitive and belligerent project, a comprehensive framework can aid hypothesise the integrally complex and several social and environmental issues involved with the TSF construction in a manner that enables more apparent evaluation decision making processes of projects.

2.4.5. CONSTRUCTION PHASE SOCIAL IMPACT

2.4.5.1 EMPLOYMENT OPPORTUNITIES

The development of TSF's in itself offer very limited employment opportunities because of the fact that its construction require a profoundly skilled work force (Obiri *et al.*, 2016), however, there are several other employment opportunities. TSF project offer several employment opportunities (Istvan, 2011) and (Tuokuu *et al.*, 2019) and are projects general are perceived many unemployed indigenes from the host mining communities.

2.4.5.2 HIGH COST OF LIVING

(Antwi, 2010) pointed out in his research that the average cost of living and cost for basic items in mining communities in Ghana is generally high when contrasted with communities without mining. Wages or livelihoods of mine workers are utilized as a decider for products and services in those communities disregarding the conditions and plight of the non-mine workers.

2.5. ENVIRONMENT IMPACTS OF TAILINGS STORAGE FACILITY

Any change or effects to the natural environment (Li and Wang, 2018), regardless of whether antagonistic or gainful, completely or mostly brought about by an

improvement, industrial, or infrastructural venture through the release of a substance(s) into the natural state of the environment is defined as an environmental impact . Mining operations irrespective of size of operations can have significant impacts on the environment. This impacts could be from dust, noise, effects of blasting etcetera.

The environmental impacts of TSF's are many and varied from one location to the other and incorporates direct effects to the biological, chemical and physical characteristics of natural bodies. The effects of tailings dam disasters on biodiversity can be both prompt and long term Figure 2.5-1.

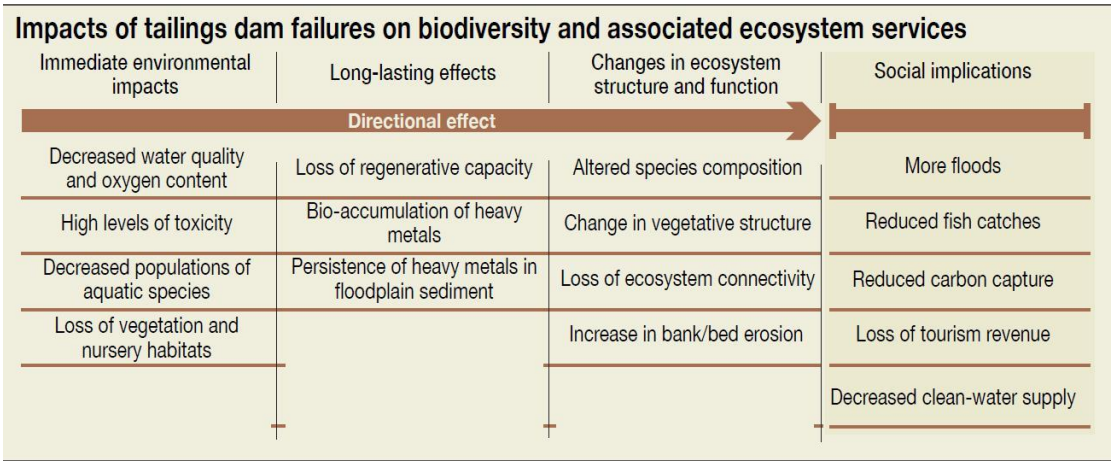

Figure 2.5-1: Impacts of tailings dam failures

(Source: UNEP-WCMC)

2.5.1. ENVIRONMENTAL IMPACTS CLASSIFICATION

Environmental impacts are classified in the following subsections: Direct impacts, indirect impacts, Secondary impacts and Cumulative (de Vries and de Boer, 2010).

2.5.1.1 DIRECT IMPACT:

Direct effects are related to the real establishment of a structure, chemical discharge, or emanation of a gas. They are intense effects, brief, abrupt, and critical, shown in Figure 2.5-2.

2.5.1.2 SECONDARY IMPACT:

Secondary effects arise as a result of direct impacts. They form consequences of the direct impact, such as the reduction of a species of rare animals or plant, as a consequence of high unexpected mortality, on the biota (Verlicchi *et al.*, 2012).

2.5.1.3 INDIRECT IMPACT

Indirect impacts are the effects on environmental value and popular sentiment emerging from related activities and might be related with development external to the physical degree of the field development (Verlicchi *et al.*, 2012).

2.5.1.4 CUMULATIVE IMPACTS:

These are the resultant effects from various sources inside a specific development or the effects emerging from more than one development in a particular area. These are prolonged impacts, which result from a consistent release or outflow, build-up over a period of time, and bringing about dynamic destruction on natural quality of the environment (Coll *et al.*, 2012).

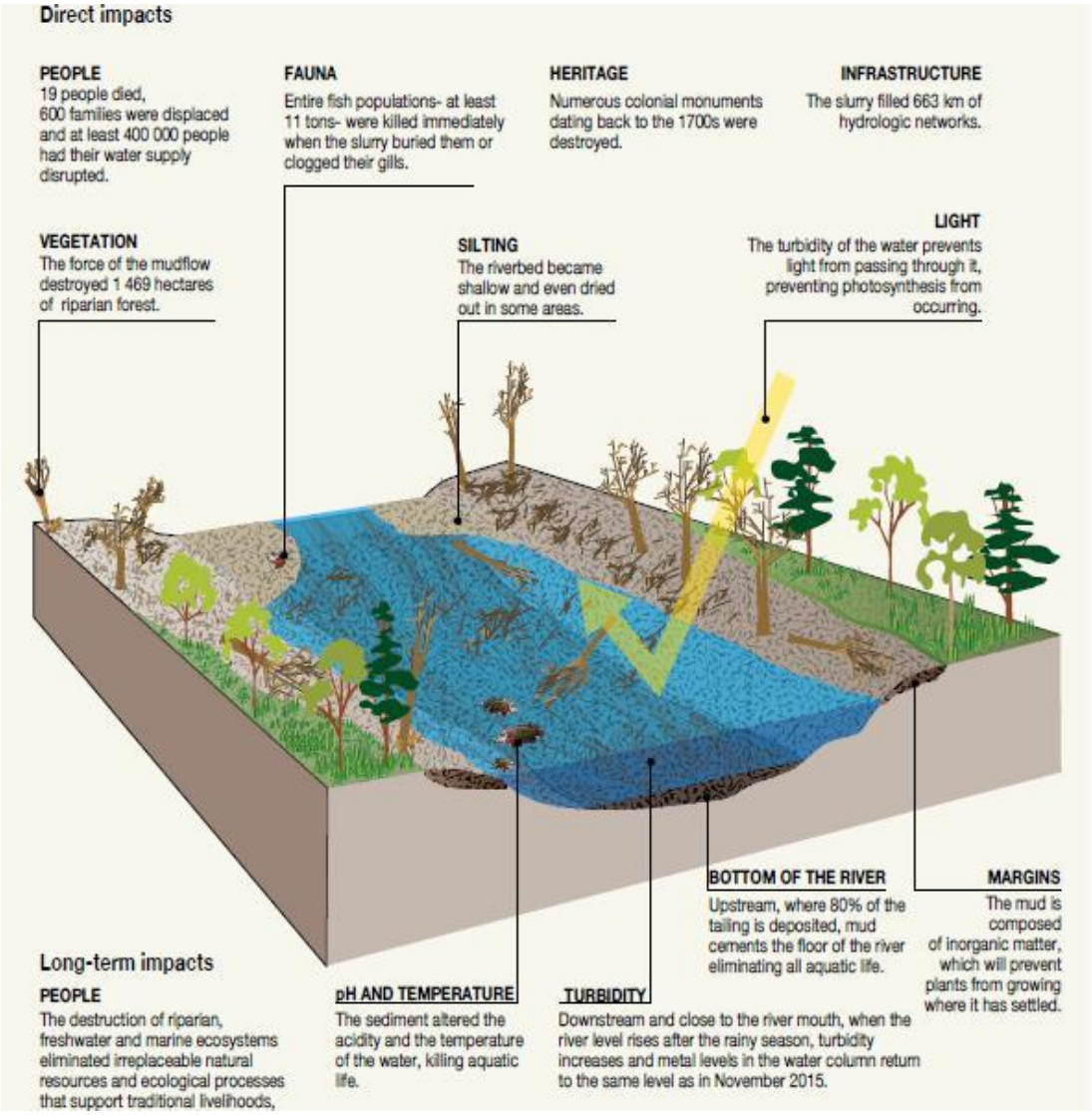

Figure 2.5-2: Direct Impact of Mining Operations

(Source: UNEP-WCMC)

2.5.2. ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

(WebFinance, 2019) defined EIA as conceivable unfavourable impacts brought about by an improvement or development, industrial, or infrastructural project or by the advent release of a substance in the ground or environment. Gold mining has raised several environmental issue that has been overlooked greatly in Ghana because relevant research has been largely neglected nationwide (Hilson, 2002).

An environmental impact assessment (EIA) ought to be well-thought-out as a prerequisite for TSF constructions and more so any development project. The EIA ought to address the potential physical effect of the TSF on the environment and ought to be open for the general population and intrigued or project affected to remark and give contribution on the appraisal, and to object to it if there are any legitimate grounds to do as such (Dutta and Bandyopadhyay, 2010).

According to the (United Nations Economic Commission for Europe, 2014) the EIA should address the following when it comes the TSF construction projects:

2.5.2.1 Location criteria

This considers atmospheric conditions, general geography, provincial topography, associated seismic risk, environmental sensitivity, the hydrology including groundwater and surface waters systems and nearby geomorphology.

2.5.2.2 Tailings criteria

This includes chemical compositions of the tailings, the physical properties and geotechnical design considerations of the TSF.

2.5.2.3 Site criteria

This constitute nature and available infrastructure present at the downstream of the proposed site, cadastral boundaries, probable underlying resource, site structure and hydrogeology.

2.5.2.4 Management

Takes into account the tailings discharge and deposition strategy, site water balance and bathymetry, method for managing events of storm and general monitoring.

2.5.2.5 Closure

The criteria for completion, expected post-operational land use and long term physical, geotechnical and environmental sustainability, just as biological system reclamation.

2.5.3. CONSTRUCTION PHASE ENVIRONMENTAL IMPACT

Some common environmental impacts identified during the construction phase of TSF's includes land contamination, noise pollution, solid waste generation etcetera. Mainly resulting from site preparation and development work. About 90% of terrestrial and wetland habitat losses and 100% of aquatic habitat losses occur during the construction phases of TSF projects (Stornoway Diamond corporation, 2011).

2.5.3.1 LAND AND SOIL CONTAMINATION

Mining operations often compete for land that are equally used for agricultural purposes. Land degradation is a common practice with TSF construction projects. There is often disturbance to the soil structure (Lin *et al.*, 2005) due to vegetation and bush clearance, stripping, cut and fill, etc. Soil contamination is considered a serious problem related to TSF construction activities (Dudka and Adriano, 1997).

2.5.3.2 CONSTRUCTION NOISE POLLUTION

During construction noise pollution is inevitable. Sources of expected noise will be from the use and maintenance of machinery and generator sets, haul road traffic. Other sources include the use of motorized chain saws for vegetation clearing. This results in various nuisances that will make a certain number of animals move/relocate themselves from the construction site, while bothering local indigenes, the project workers and the affected settlements.

2.5.3.3 CONSTRUCTION TRAFFIC

During the process of construction, some dust and exhaust fumes will be generated from the heavy duty trucks and vehicles as they move through the primarily dry and roosted landscape in the construction site (Foley *et al.*, 2005). The use of excavators and rock breakers in certain areas leads to dust generation and exhaust fumes.

2.5.3.4 SOLID WASTE GENERATION

During the construction time frame, strong waste will be produced from the actual construction activities such as packaging materials, among other waste and from the workforce undertaking the project in the form of waste from food, wrappers, bottles, containers, and other expendable items (Jumaat *et al.*, 2010).

2.5.3.5 HAZARDOUS SUBSTANCES

During construction phase the use of construction equipment on site has the potential to lead to spillage of gasoline and other petroleum products (Snashall, 2005). Some contaminants resulting from construction activities could infiltrate the soil or be transported in runoff and groundwater.

2.5.3.6 AIR QUALITY

Air quality impacts could happen through the release of toxins or pollutants, such as carbon monoxide, nitrogen oxides, unpredictable natural mixes and dangerous air contaminants present in emanations from operation of construction equipment. The particulate matter emanations additionally occur from dust release during grading, excavation, and different other earth-moving exercises (Ledec and Quintero, 2003).

2.5.4. OPERATIONS PHASE IMPACTS

There are other environmental impacts that are associated with some TSF's during the operational phases. These include:

2.5.4.1 SEEPAGE:

The passage of water from the basin of an embankment through the abutments and foundation is considered as seepage. This incorporates permeable media stream, flow through fractured zones, and concentrated flow through structural defects, for example, splits, loose lifts, etcetera (Akkuzu, 2012). Seepage from conventional tailings storage facilities is unavoidable (Waterhouse and Friday, 2000). The transport of leachate through abutments of the TSF during the operation phase of the facility has the potential to pollute groundwater bodies and thereby result in harm to dependents of such water sources. The seepage of precipitation through the solid waste of tailings at the abutment may result in the transport of contaminants to the water table.

2.5.4.2 AIR POLLUTION

Air contamination is one of the key impacts related with mining operations. Dust is generated from emissions from dry tailings. Dust usually becomes an issue of concern. During the dry seasons dust from tailings dams are transported through wind erosion and causes a major environmental concern (Kaonga and Kgabi, 2009). This is mainly because growing vegetation that serve as wind barriers are cleared away. Consequently there is transport of enormous volumes of particulate matter, that may contain substantial quantity of heavy metals and different contaminants that have potential unfavourable impact on the quality of air downstream of the tailings storage

facility (Abdus *et al.*, 2016). Dust contamination can be a disturbance and a health risk to residents and animals that double in juxtaposition to the TSF.

2.5.4.3 WATER POLLUTION

Mining is one of the most main sources of heavy metals in the environment. Tailings Storage Facilities can and do potentially impact negatively on both superficial and groundwater bodies in proximity to the mining operations. Seepage of leachate and/or surface water run-off from the facility can adversely affect the groundwater quality (Razo *et al.*, 2004). Dangerous substances can filter from these TSF's, permeate through the ground, and pollute groundwater, particularly if the base of the TSF's are not appropriately lined to reduce the permeability (Bedi, 2013).

The contamination of such waterways, groundwater sources and the associated hazard or risk to human health, facilities and ecological resources can negatively affect relations between host communities and the mining enterprises.

2.6. LAND ACQUISITION AND RESETTLEMENT FOR TSF'S

Tailings Storage Facilities have been identified to be a key component of mining operations and large acres of land are required for the construction of such facilities. Mining enterprises are often seen to compete for land owned by indigenes in areas of identified economically viable natural resources. Land that are otherwise meant for farming in most places are therefore destroyed for the implementation of such economic projects. An imperative part of social effects brought about by TSF construction activities is spontaneous displacement and resettlement of persons that reside in the sited areas (Huang *et al.*, 2018).

As per the World Commission on Dams report , dams have displaced some 40-80 million individuals from their lands in the previous six decades (World Commisions on Dams, 2000) and indigenous, tribal, and peasant communities tend to be the victims of such displacements. A huge quantity and quality of lands acquired for TSF constructions have brought adverse impacts to land owners after the displacements (Garada, 2018). Most victims in incredible majority of instances end up financially, socially and mentally crushed. Many more have lost assets, resources and homes to the waterways and water system projects, road projects, power line installation projects and other industrial developments projects that go with dams (Tilt and Gerkey, 2016). A significantly number have lost access to fresh water, sustainable food sources and other natural resources in the areas of dam constructions. Millions more have experienced the ailments that comes with some of these facilities. The most significant issue in resettlement procedure is to find out the appropriate technique for the specific nature and approach to carry out such relocations and resettlement projects. Since ill-advised resettlement activities cause social disparities between the community and the mining firms (Vanclay, 2002; Owen and Kemp, 2015).

According to Vo and Brereton the displacement and resettlement of people is more likely to have negative impacts on the mining operations if not properly managed (IFC, 2014) however a well-managed and well implemented resettlement program can become a development opportunity.

The current laws overseeing land leasing and acquisition for the purposes mining in the country are the Mineral and Mining Act, 2006 (Act 703) and the 1992 Constitution.

2.6.1. INVOLUNTARY RESETTLEMENTS

While impacts are a significant issue around the construction of new dams, the social and wellbeing impacts especially resettlement questions around dams are the immediate effects that affected individuals are faced with even prior to dam completion (Cobbinah and Amoako, 2018).

In a study conducted by (Obour *et al.*, 2016), the study outlined that while there have been critical advances in issues regarding the resettlement and compensation payments as related to the previous dam projects in Ghana, there are still some deficits. Motivations and payment of compensations contributes to the real reasons for issue involving resettlement (Jackson and Sleigh, 2000) and (Scudder, 2011). The development of Tailings Storage Facilities breeds untold social discontent and misery when engineers acquit themselves from the obligation of consideration to see that displaced individuals are not worse off.

The (IFC, 2014) in a report by Fitriani et al recommended that, Companies should endeavour to avoid or at least limit spontaneous relocation any place doable by considering alternative site locations in project designs. In cases where the option of resettlement is unavoidable; companies are expected to provide opportunities for the resettled individuals and the host communities in order to derive some development benefits from the project.

(Raschid-Sally *et al.*, 2008) in a study proposed some processes as a measure to tackle the issue of resettlements when it comes to dams construction and resettlements. These are:

1. Timing of resettlement process: ensuring statistics/census of the projects affected persons happens from the get-go all the while, and that the sites are identified well ahead of time.
2. Participation of project affected persons (PAPs): Involving the affected person's in different viewpoints concerning their lives including decision of resettlement destinations or sites.
3. Adequate compensation utilizing both money related and non-fiscal parameters/benefits and considering local conditions and social prerequisites: an example is taking into account family sizes when settling or deciding on size of houses ascribed.
4. Clear rules on remuneration that are made known to the recipients.
5. Giving clear residency security by means of title deeds and documentation of exchanges.
6. Unequivocally supporting contact among project affected persons and host communities, preceding resettlement for trade of data, awareness creation and sensitization.
7. Special provisions be made for training of literate persons from the groups as facilitators to clarify residency and other issues.

2.6.2. COMPENSATIONS

The core value on which the general policy for resettlement of the government of Ghana is based is that that no one ought to be exacerbated by the implementation of new projects, however, compensation payments in real cash and provision of new houses are generally viewed as deficient or unfulfilled (Aiken and Leigh, 2015). Compensation for land taking is to be reasonable and fair, adequate and prompt and

delivered within a reasonable time (Mineral and Mining Act, 2006 (703)). The main objectives of compensation thus are to:

1. Restore and upgrade the livelihood of project affected persons through land allotment for sustainable agribusiness and open opportunities for other types of economic activities.
2. Ensure primary services such as schools and medical care facilities are available and accessible to project affected person.
3. Ensure least disruption in their social organisation and help them to develop viable social relations.
4. Guarantee project affected person share satisfactorily in benefits from project activities.
5. Supplant asset losses.

2.7. SOCIAL AND ENVIRONMENTAL IMPACT MANAGEMENT PLAN AND MITIGATION

2.7.1. IMPACT MANAGEMENT PLAN

Environmental and social management plan for most Tailings Storage Facilities are based on ISO14001 standard. This management framework allows checking and control of environmental effects of the project and thereby reconcile imperatives of mine operations with the applicable regulatory framework and industry best practices. The management plan also permits monitoring and validation of environmental and social impacts assessed within the context of the impact assessment, to ensure the application of mitigation measures, regulatory requirements and best practices within a context of continuous improvement.

Specific management plans are mostly expected to be developed to prevent and minimize residual impacts identified in the impact assessment during the construction, operation, closure and post-closure phases of the TSF project. These includes:

1. Requirements of the environmental policy and guidelines, including a synopsis of required approvals during the different project stages, components applicable to working pronouncements and objectives outlined in project specifications.
2. General impact prevention and the management measures, including general environmental controls permitting to avoid and oversee natural effects and general mitigation measures distinguished in the impact assessment.
3. Functions and obligations of the supervisory group, workers and subcontractors in the execution and upkeep of the plan;
4. The quality audit and quality control protocols and follow-up of reports.
5. Development, execution, and assessment processes of remedial actions.

Specific plans are developed for the following management activities:

1. Social concern management.
2. Air emission management.
3. Noise and vibration management.
4. Water, sediment and sludge management.
5. Solid waste and hazardous material management.
6. Pollution prevention.

These programs ensure compliance with the laws, regulations and other environmental considerations developed in the plans and specifications.

2.7.2. IMPACT MITIGATION

Mitigation measures decreases the undesirable impacts of a tailings dam by alteration of its operations, or through changes to the management of the catchment within which the dam is located (Tilt *et al.,* 2009). Mitigation measures require a lot of understanding of complex processes and their interactions (McCartney, 2009).

2.7.2.1 SOCIAL IMPACT MITIGATION

Certain socioeconomic factors, for example, income or cost of housing, are simpler to identify and quantify than others as a result, mitigation approaches often suffer from the lack of emphasis on socio-social effects just as the affinity to think little of the economic and social value of earlier livelihood strategies in host communities (Tilt *et al.*, 2009). Programs planned for re-establishing expectations for the comfort of project affected persons will in general leave the majority worse off, because emphasis shifts from development to remuneration and mitigation. Fiscal compensation is generally guaranteed to project affected persons before the beginning of the project, be that as it may, funds are not appropriated until quite a while after project commencement in some cases never paid at all. Alternative livelihood development plans are implemented because of shortages in replacement lands, which included training and support for setting up businesses and cash crop cultivation (Beck *et al.*, 2012).

Some typical social impact mitigation measures include:

1. Involuntary displacement of project affected persons is frequently the principle hostile social effect of TSF projects. The fundamental mitigation measure for any physical relocation is the resettlement of displaced persons or families, which includes the construction of new housing units, making available new arable

lands, and other material assistance, as required (Ledec and Quintero, 2003). For individuals that are not actually evacuated but rather suffer financial loss through jobs, means of making a living, farmlands, agricultural or grazing lands, other assets, mitigation measures ought to include the setting up of new career training or additional revenue rebuilding help as required.

2. Job opportunities: Livelihoods are affected by relocation, it is imperative to provide and employment or business income for project affect persons.

2.7.2.2 ENVIRONMENTAL IMPACT MITIGATION

In developing TSF projects significant efforts are put into minimizing the negative environmental and social. These measures include (Stornoway Diamond corporation, 2011):

1. Control of mine releases/discharges such as water and mine waste. The release points of confinement are mostly defined and are a part of regulatory requirements.
2. Monitoring/surveillance: Monitoring of the primary environmental pointers could be completed by regulatory authorities so as to keep developing a database of baseline conditions. This monitoring will likewise fill in as an instrument for assessing changes and the effect of the impacts.
3. Meetings and engagement commitment from stakeholders of host communities in the change management processes is critical to overseeing development related expectations.
4. Common land planning and zoning: effective land use planning and zoning are fundamental to overseeing cumulative impacts and reducing land use clashes

Some other specific mitigation and management measures include:

1. Involuntary displacement of project affected persons can likewise have significant ecological ramifications, for example, with the transformation of common natural surroundings to accommodate resettled rural populaces. A approach to prevent natural habitat destruction involves selective relocation of endangered species (Ledec and Quintero, 2003).
2. Construction traffic: The location fresh access streets ought to come in an environmentally and socially minimum harming passageways. Construction site access road designs ought to ensure drainage to ensure protection of river-bodies and minimize erosion and disintegration.
3. Land degradation: The negative impacts of land degradation are largely compensated for by the final rehabilitation and revegetation of the site, which in addition to improving the visual aspect of the site, will allow vegetation and wildlife to gradually recolonize the environment at the closure stage of the facility.

2.8. SUMMARY OF LITERATURE REVIEW

The history Ghana's social and economic strength is undistinguishably linked exploration and mining of natural resources. Mining has assumed a predominant part in the social, fiscal and political existence of the country for over the past 2000 years (Obiri *et al.*, 2016).

Strife between an extractive enterprises and the host community is often triggered by the environmental impacts of company operations (Tayebi-Khorami *et al.*, 2019). The ultimate goal or definitive objective in tackling the social dimensions of gold mining ought to be on recognizing and identifying the ways to expand the positive impacts of

mining on the lives of individuals and the host communities at large as much as limiting the adverse impacts (Obiri *et al.,* 2016). These impacts ought to mirror the effects of mining on the present ages just as future ages of the mine workers and their dependants. It should likewise be noticed that the social dimension is not influenced by personal feelings or opinions, hard to quantify and perceived diversely by the different partners and stakeholders in the gold mining fraternity.

Moreover, environmental contemplations are connected with talks on wellbeing and security, settlements, and the effect of gold mining on subsistence lifestyles.

The social and environmental impact assessments must be carried out in areas with sited mining activities for all plans over a full yearly cycle and the environmental impact assessment and environmental management plan, just as social impact assessment, must be examined by the responsible government regulatory authorities (Williams and Drabu, 2012).

The essential duty regarding the organization of environmental and social issues of new Tailings Storage Facilities projects remains the sole prerogative of the regulatory authorities concerning preservation, environmentally sustainable development, spill and contamination control.

CHAPTER THREE

RESEARCH METHODOLOGY

4.1. INTRODUCTION

This chapter of the study presents discussion on how the study was conducted. It discussed the study area and its demographic features, source of data, research design and instruments, and the data collection techniques including the data analysis.

4.2. THE STUDY AREA

The research was conducted in the community of Ayanfuri, in the Upper Denkyira West District located in the Central Region of Ghana, West Africa, approximately 40 kilometers to the south-west of the regional town of Obuasi and 195 kilometers west-north-west of the capital Accra. It is bounded within the geographical makings Latitude (lat): 5°58'0"N Longitude (lon): 1°54'0"W and approximate reduced level of 157 m as coordinates and elevations respectively (Faanu *et al.*, 2016). Figure 4.2-1 presents the geographical position of Ayanfuri on the Ghana map. The predominant occupation of residents is Mining (Adu, 2018). Farming and trading are other economic activities in the community.

4.2.1. POPULATION SIZE OF STUDY AREA

The residents in the community of Ayanfuri is approximately 4660 in population size within a district of a total population size of approximately 60,054 (2010 PHC). The total male population being 2,401 while female population is 2,259 representing a 51.5% and 48.5% respectively (Ghana Statistical Service, 2014).

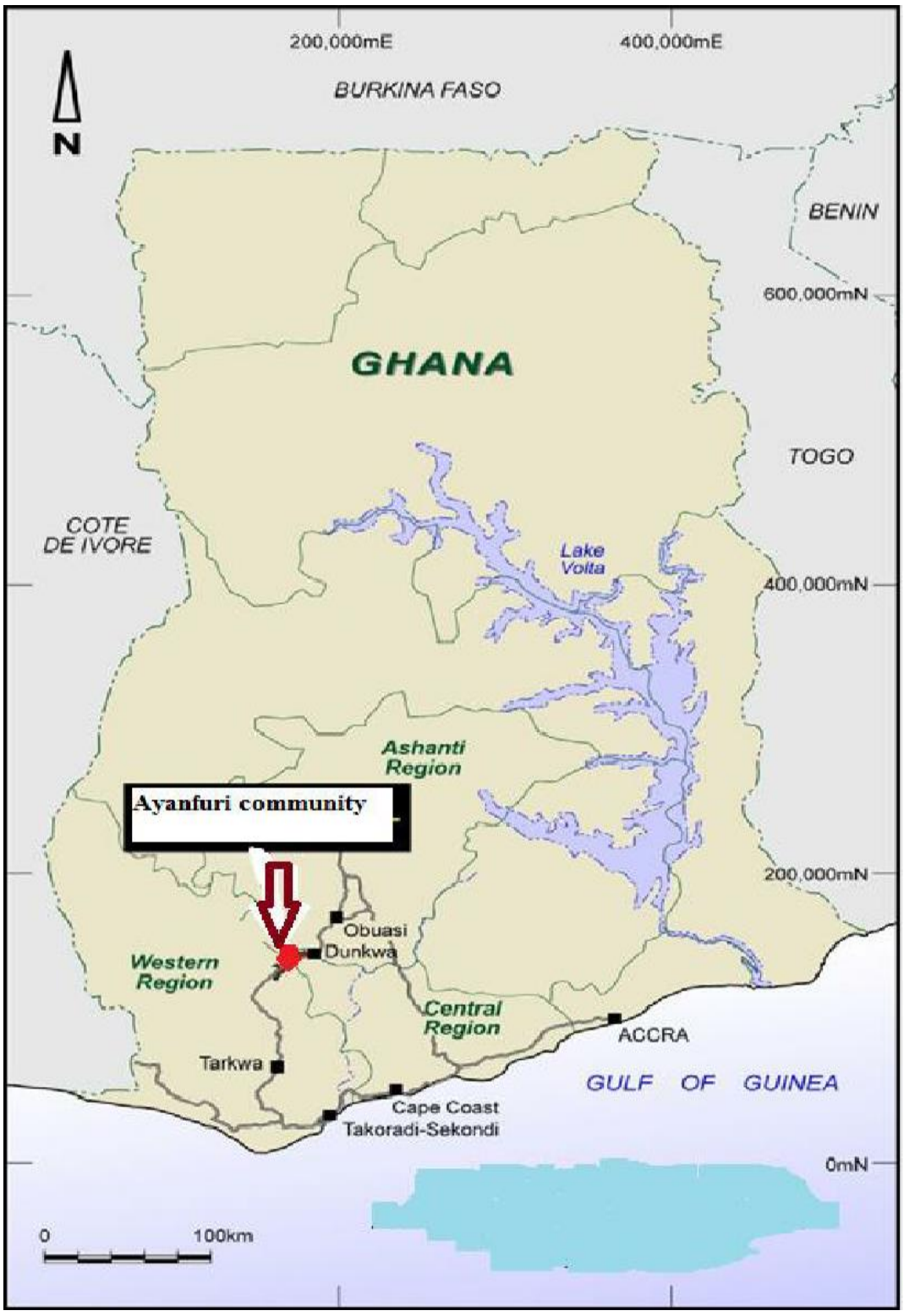

Figure 4.2-1: Direct Impact of Mining Operations

Source: (Amponsah et al., 2015)

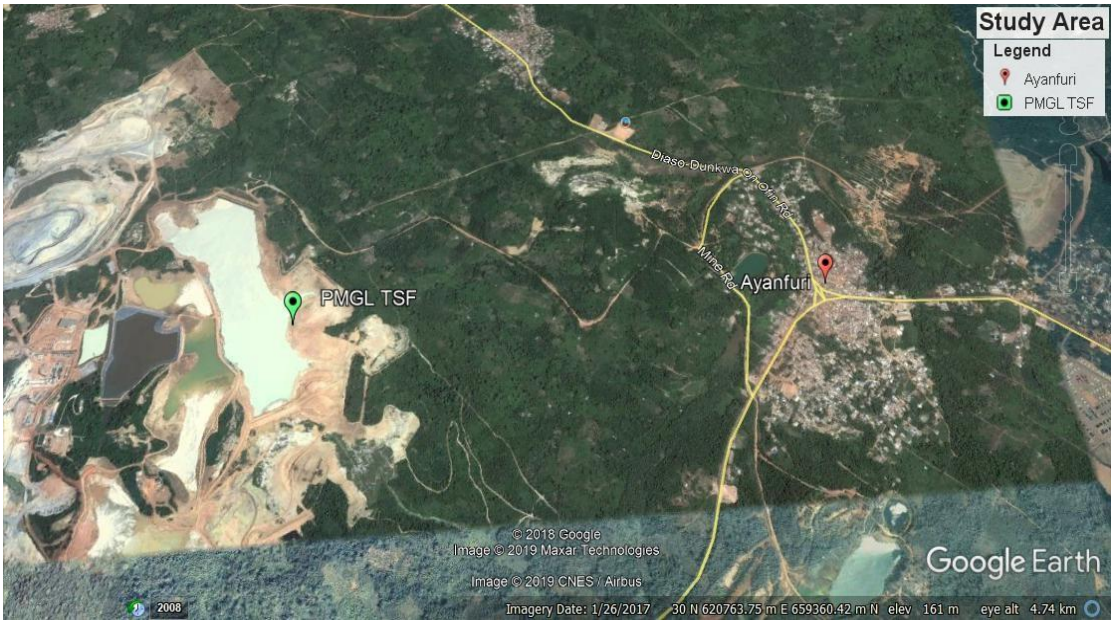

Figure 4.2-2: 3-Dimensional view of the Mine and the Ayanfuri community

(Source: Google Earth, 2019)

4.2.2. SOIL AND VEGETATION

The main soil type found in the zone of the mine is the deeply weathered soils of the latosol soil group. The shades of these soils stretch out among dark coloured and orange. The soils in the area comprise high amounts of soil supplements due to the decrease in the measure of precipitation in recent times (Amponsah *et al.*, 2015). From the view purpose of crop yield generation, they form part of the finest soils in the nation. Cash crops, for example, cocoa and oil palm flourish in these soil zones. Cocoa covers about half in portion of the areas entire arable land. Different harvests like cassava, plantain and maize likewise flourish in the soils within the area.

4.2.3. SOURCE OF WATER

Quality and safe drinking water is a fundamental necessity to man, considering its various ramifications for wellbeing/health and related activities. According to the Ghana Statistical Service report (GSS, 2014), the region the major source of clean

water within the district are borehole, open stand pipes, wells, secured spring and rain water and pipe borne. About 8.0 percent of the household units obtain their drinking water from rivers (waterway/stream) and this comes with serious health implications ranging from buruli ulcer to guinea infections and other water-borne diseases.

4.3. THE RESEARCH DESIGN

This section discusses how data for this study was collected and analysed. These include the research instrument, data collection methods and sources as well the approach used in the analysis of the data. The study espoused the case study approach as it aided a comprehensive discussion of the topic and provides detailed information on the subject matter with explicit reference to the host community of the mine.

4.3.1. RESEARCH INSTRUMENT

The research instrument utilized in conducting this research was a questionnaire through field survey. Owing to the broad nature of Social and Environmental Impact, for this study, questionnaires were thought to be the utmost useful and cost-effective tools in gathering required data. The scope of the questionnaire covers and is limited the social and environmental impacts associated with the Tailings Storage Facility constructed by PMGL. The objective of the questionnaire is to develop a tool that measures the actual effects of the constructed TSF by PMGL in terms of immediate social and environmental impacts.

4.3.2. CONTENT OF THE QUESTIONNAIRE

The questionnaires entailed four sections, that is Section ‘A’ ‘B’ ‘C and ‘D’. Section ‘A’ of the questionnaire was on the socio-demographic information related to the

respondents' such as age, sex, employment status, duration of residence and their relevant working experiences.

The section 'B' asked questions that were aimed at gathering the perception of community members in relation to the TSF projects. The section 'C' asked respondents to rate on Likert type scale questions on the extent of social and environmental impacts of the TSF on the community.

Finally, the Section 'D' gathered data on the possible ways to improve the positive impacts and reduce the negative impacts.

4.4. DATA COLLECTION/SOURCES

The data collection involved the administration of a well-structured questionnaires to the relevant stakeholders of the community in which the mine operates and the key professionals related to the Mine and the TSF project. The information collection was based on the response of the questionnaire, through online distribution of questionnaires to residents and key stakeholders and where possible the questionnaires were self-administered.

4.5. SAMPLING TECHNIQUE AND SAMPLE SIZE

The research was focused on the social and environmental impacts of the TSF construction on the host community, Ayanfuri within the central part of Ghana. The participants that formed the sample size of the study included, members of the host community, workers in the mining firm, and workers of the contractor engaged with the construction of the TSF. The purposive sampling technique was employed to collect data from the target population for the study. The purposive sampling system, is the purposeful choice of a participant due to characteristics the participant possesses

(Etikan *et al.*, 2016). Purposive sampling involves the conscious selection of certain group of participant to be included in a study where the actual population is unknown. The purposive sampling is used because a specific information is needed from a particular group of people due to their specialty or relation to the area of study. The questionnaires were distributed to 70 number participants as the estimated sample size.

4.6. DATA ANALYSIS

The collected data from the survey were coded and analysed using the statistical software (SPSS) – Statistical Package for Social Sciences and excel sheets programmed with Relative Importance Index formula (RII) were used to produce graphs and frequency distribution tables. Descriptive statistics were used to describe and summarize gathered data, while analysis were made using inferential statistics and variables obtained were used to present through the use of tables and graphs whilst descriptive statistics was used to analyse the demographic information on the data gathered from respondents.

CHAPTER FOUR

RESULTS AND DISCUSSION

5.1. INTRODUCTION

This chapter of the study deals with presentation of results and discussion. Questionnaires administered to various stakeholders seeks to reveal the social and environmental impacts associated with Tailings Storage Facility construction. The collated questionnaires were analysed according to the stated objectives of the research, deductions from the observations this study were presented in tables, graphs and figures in this chapter.

Descriptive statistics was utilized to examine the background study of each objective and relative importance index (RII) was the main statistical technique used to analyse the variables identified in the present literature pertinent to the social and environmental impact of Tailings Storage Facilities. The first section deals with the demographic characteristics of the respondents and the impact such characteristics have on the study. The other parts of the questionnaire deal with the detailed examination of the specific objectives of the study in connection to the community perceptions about TSF's its associated social and environmental impacts and the expected improvements for the identified positive impacts. Seventy number of (70) questionnaires in total were distributed and sixty-six (66) were received representing a response rate of 94.3%.

5.2. DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

Section A of the questionnaire seek to gather demographic details of the respondents. Details such as gender, age, employment status, duration of stay in host community etcetera.

5.2.1. GENDER OF RESPONDENTS

The purpose of this enquiry was to establish and confirm the gender categories of respondents who were sampled for the study. Figure 5.2-1 presents the category of respondent's gender and it posit itself in the following interpretation; a total of 7 representing 11% of the respondents were females and the remaining 59 representing 89% were males. It can therefore can concluded that, the majority of the respondents were males.

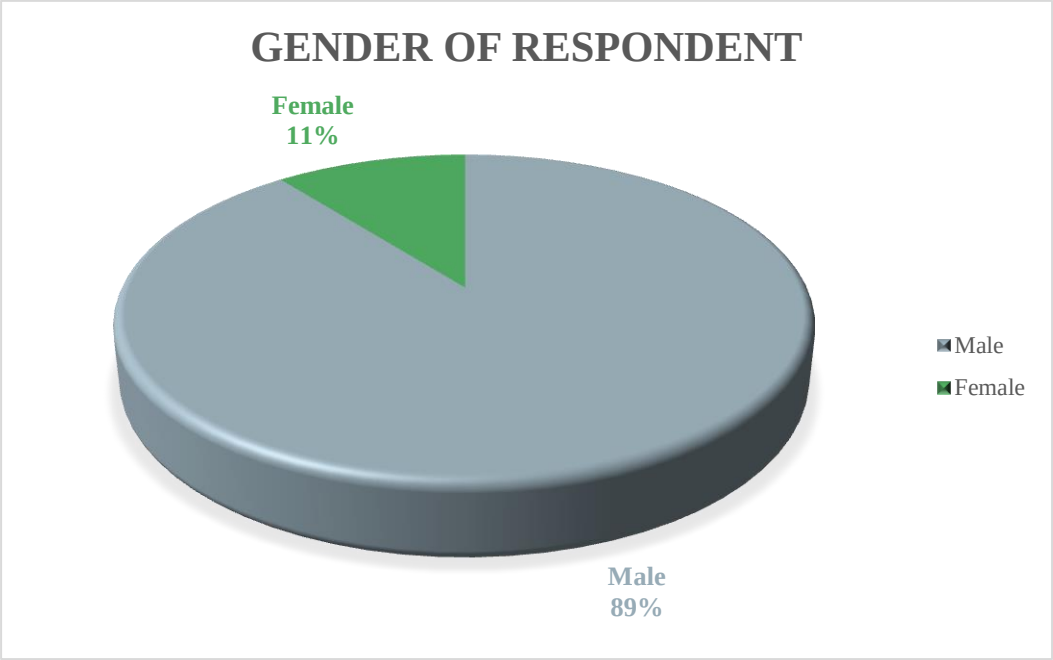

Figure 5.2-1: Gender of Respondents

(Field Survey, 2019)

5.2.2. AGE DISTRIBUTION OF RESPONDENTS

The purpose of this question was to determine the age groups of the respondents. Figure 5.2-2 indicates that 2 respondents, representing 3% were within the age interval of (18-25) years, 12 respondents representing 18% of the respondents were within (26-30) years, 14 respondents representing 21% of the respondents were within (31-35), 21 respondents representing 32% of the respondents were within (36-40) years, 8 respondents representing 12% of the respondents were within (41-45), 6 out of the 66 total respondents representing 9% were all between the age intervals of (36-40) years and a 5% of respondents with a total of 5 in numbers were aged above 51 years.

This age distribution depicted in Figure 5.2-2 below shows that, majority of the respondents sampled were within the age interval 36-40 years.

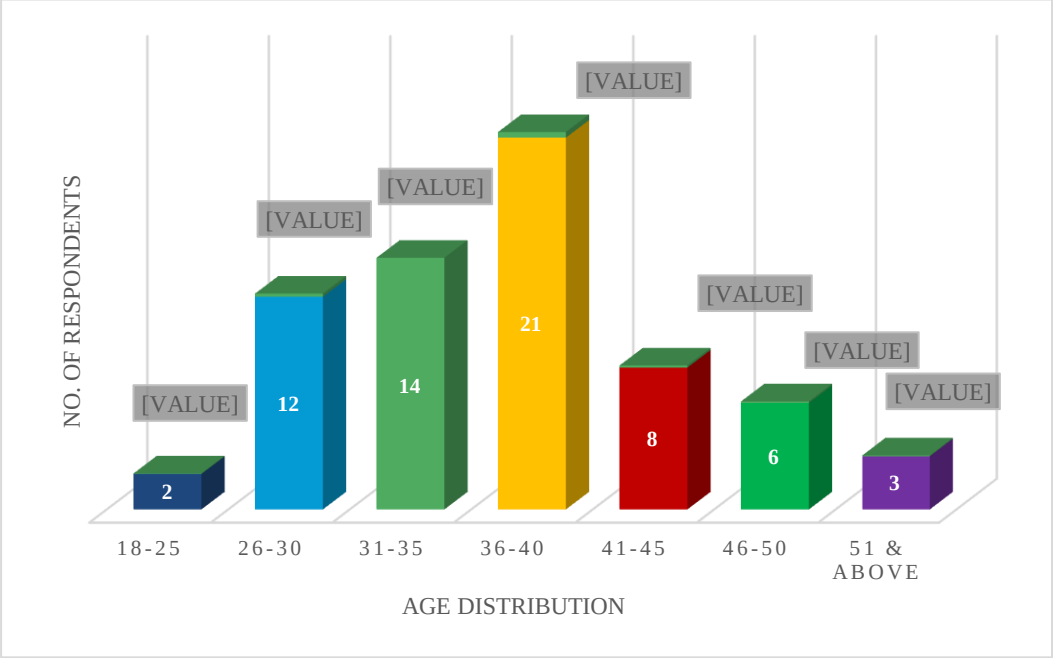

Figure 5.2-2: Age distribution of respondent (Field Survey, 2019)

5.2.3. DURATION OF RESIDENCE OF RESPONDENTS

The intent of this question was to determine the respondent's length of stay in the host community where the mine operates. This is because how long respondents have been in the mining community will affect the quality of responses that will be given so as to show their appreciation of the subject matter in respect of the impacts of the TSF construction on the host community.

As indicated in Figure 5.2-3, 1 respondent representing 2% lived within the Ayanfuri community in less than a year, 11 respondents representing 17% lived within the Ayanfuri community between (2-5) years, 38 respondents representing 58% of the respondents lived in the community between (6- 15) years, 7 out of the 66 respondents representing 11% of the respondents lived in the community between (16- 30) and 9 out of the total respondents representing 14% had lived in the community for more than 31 years.

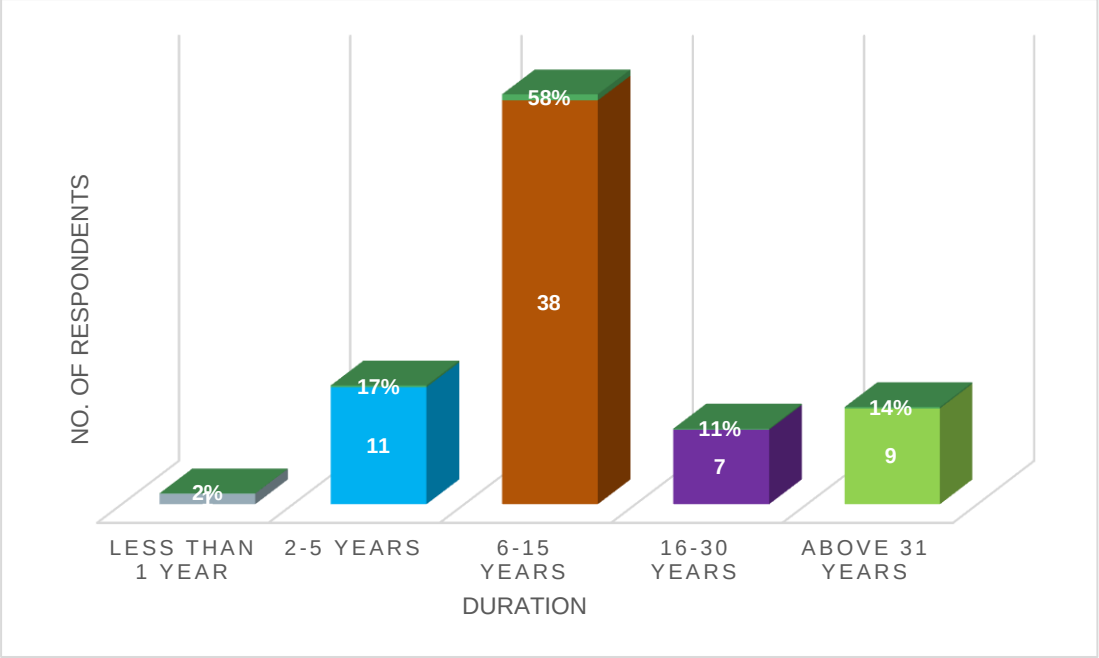

Figure 5.2-3: Respondent's duration of residence

(Field Survey, 2019)

The distribution of the duration of stay within the community depicted in Figure 5.2-3 shows that, majority of the respondents sampled have stayed in the Ayanfuri community for a minimum duration of 6-15 years. Also indicating that an appreciable majority number of the respondents had been in the community before the establishment of the mine 12 years ago and so were in able position to know the status of the community prior to the institution of the mine and the current status with respect to the impact of the TSF.

5.2.4. EDUCATIONAL LEVELS OF RESPONDENTS

The intent of this inquiry was to establish the highest level of education of the respondents. This is because the educational level of the respondent will influence the value of responses that will be given as well as their intellectual ability and understanding of the subject matter. Figure 5.2-4 presents the highest level of education of the respondents. The respondents were asked to indicate their highest level of education. 17% of the respondents indicated they held a minimum of BECE certificates, 23% of the respondents indicated they held Higher National Diploma degree (HND) certificates, 14% of respondents held a First degree certificates whilst the majority number of the respondents constituting 42% of the respondents showed they also held WASSCE certificates. Conversely, the rest 5% of the respondents were Secondary degree certificate holders It can therefore be inferred from the above results that most of the workers have certain minimum level of education and hence able to respond appropriately to questions posed in the questionnaire.

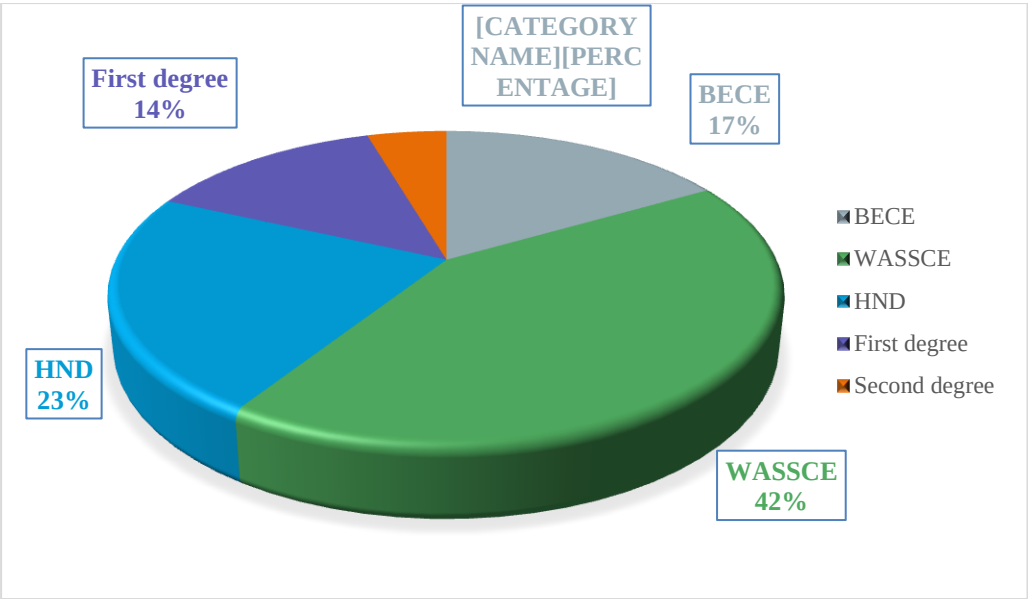

Figure 5.2-4: Educational Levels of Respondents

(Field Survey, 2019)

5.2.5. OCCUPATION OF RESPONDENTS

The intent of this question is to identify the various occupations of the respondents and to establish if they are in one way other related to the mine. Figure 5.2-5 graphically presents the category of respondent's occupation and Table 5.2–1: Occupation of Respondent represents details of the respondents occupation.

Table 5.2–1: Occupation of Respondent

Occupation	No. of Respondent	Percentage (%)
Farming	8	12
Carpentry	2	3
Trading	10	15
Mining related	45	68
Not working	1	2
Total	66	100

From Figure 5.2-5; out of the 66 total respondents, 8 were farmers representing 12%, 2 were into carpentry representing 3% of the total respondents, 10 were into businesses or petty trading which represented 15% of the respondent, whilst 45 out of the total number of the respondents indicated they were into mining representing 68%, and the remaining 2% was unemployed.

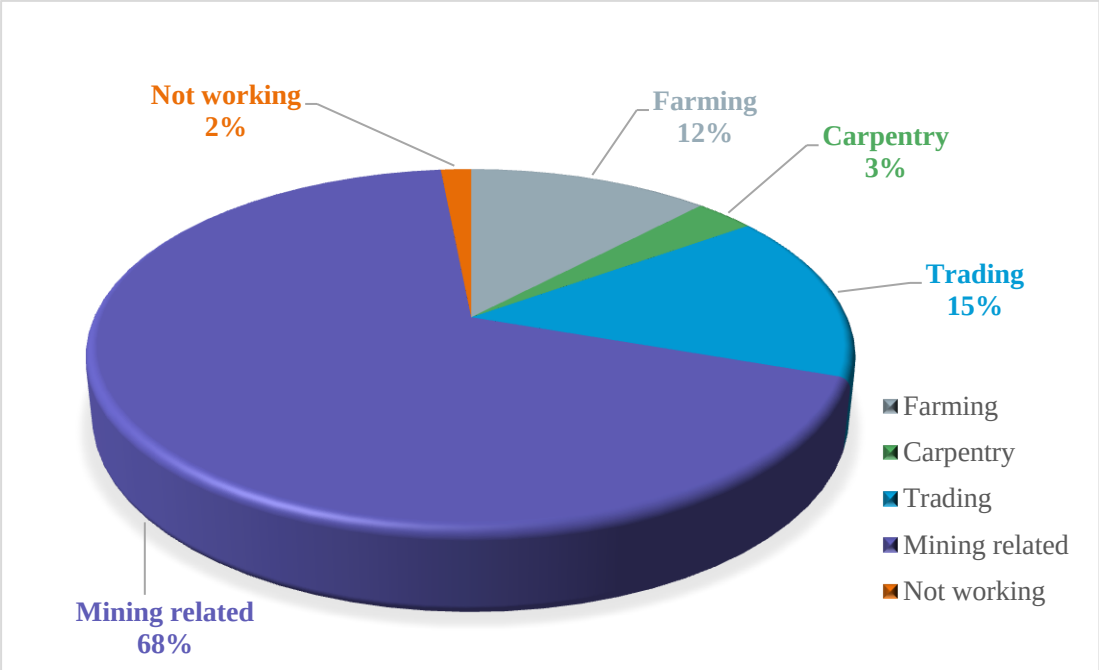

Figure 5.2-5: Occupation of Respondents

(Field Survey, 2019)

It was also observed that a majority number of 68% respondents were either employed by the mine or employed by third-party contractor companies that work for the mine. Hence it can be concluded that the community is dominated mostly with individuals that depend of the existence of the mine for a living. This assertion confirms the fact stated by (Mancini and Sala, 2018) that mining provides means of employment and by extension most of the members of the host community depend on the activities within the mine to make a living.

5.2.6. RESPONDENTS' KNOWLEDGE ABOUT TSF

This question of the questionnaire seeks to provide insight into respondent's knowledge about a TSF and/or to determine if the respondent have an idea of the subject they were responding to. For anyone to appreciate and respond to what the social and environmental impacts of a TSF can be on the host community, he/she should first have an idea of what the TSF is.

From the data collated all 66 responded "Yes" to the question of having any idea of the mine constructing a TSF. It is possible therefore that all the respondents have an idea, heard, seen or understand what the implications of a constructed TSF is.

5.3. COMMUNITY PERCEPTION OF THE TSF PROJECT BY THE MINE

This section of the questionnaire looked at what the respondent's general perception of TSF projects are vis-à-vis their social and environmental impacts on the host community in which the TSF is sited. Table 5.3–1 reveals that *the TSF project will offer employment opportunity to people from the community* being the most ranked perception of the TSF project by respondents, this is evident with an RII ranking of 0.752 and a corresponding mean value 3.758. The general perception of the TSF project offering employment opportunities as pointed out by the most of the respondent was affirmed by (Istvan, 2011) and (Tuokuu *et al.*, 2019) that TSF projects in general are perceived to be mining projects that offer job or employment opportunity for many unemployed indigenes from the host communities. Both skilled (with professional and technical know-how, such as Engineers, artisans, etcetera) and unskilled labour (such as labourers and casuals) are required for the construction, management and operation of TSF's. This was closely followed by *the siting of the dam has developed your community better than it was* and ranked 2nd by respondents

with RII of 0.730 and a corresponding mean value of 3.652. Most of the respondent agreed to this assertion that the construction activities of the TSF brings about development in host communities. (Chambers, 2003) also affirmed this perception. Additionally, as part of the cooperate social responsibility of the mine there are several development projects to improve the conditions of the host community hence the respondents agreed that the community has been developed much better than it was prior to the existence of the mining operations. Chambers further added that development projects such as improvement in road transport systems, markets, improved health service delivery, and other infrastructure developments are associated with communities that are found to host mining communities. (Azapagic, 2004) sees investment into community development projects as a way of giving back to the community for the value of resources taken from their lands.

The TSF albeit it provides several employment opportunities and results in community development however, brings about high cost of living for members of the host community. *The cost of living in the community has increased due to the TSF construction activities* was ranked 3rd by respondents with an RII and mean value of 0.721 and 3.606 respectively. This affirms (Antwi, 2010) assertion that the average cost of living for basic items in the mining communities in Ghana is generally high when contrasted with different communities without mining projects. The 4th most ranked perception by the respondents was *The TSF Project have a positive impact on the economy and development of local communities*, with RII of 0.658 and a corresponding mean value of 3.288. Most of the respondents believed that the construction of the TSF and by extension its presence provides economic benefit for the community. Some mining firms are attempting to help defeat difficulties faced by low-income and remote communities, for example with access to financial related

products such as start-up capital and cash crop seedlings for community members to set up businesses of their own. The assertion of economic development for the local community through TSF construction management and operation was affirmed by (Hamann, 2003) in that while dependable gold mining creates employment and economic opportunities, many mining firms likewise invest resources into social infrastructure outside of their prompt circle of operations. Frequently, this takes the form of associations or partnership with governments or community organisations, so that investments are focused to address the issues of local populaces. Some school of taught argue that at the local community level, the operation of a TSF (or a bunch of mine projects) affects outcomes through two channels. In one, it can attract assets/resources to the local community. For example, it can expand the proportion of workers with higher wages. To meet the unavoidable increment in the demand for goods and services by the pool of high-pay or high income workers, new local businesses may develop or existing ones may grow, leading to more demand for workers and merchandise and enterprises. This process could in the long run cause the concentration of economic activities in the local community thereby becoming self-sustaining (Document of World Bank, 2015). The 5th most ranked perception was *PMGL has plans ahead for closure of the TSF at the end of their operations to leave sustainable environment,* recording RII of 0.630 and a corresponding mean value of 3.152. This perception was shared by the respondents' who believed that the mine, PMGL has instituted measures towards the closure of the TSF after the mining operations have ceased in order to leave a sustainable environment. The author of Environmental Planning Considerations for the Decommissioning, Closure and Reclamation of a Mine Site, (Mchaina, 2001) states that Environmental awareness with respect to the mining fraternity, governments, the regulatory authorities, and

financial organizations has incited decommissioning, closure and reclamation aspects to be considered as integral parts of the mining cycle. The author added that it is presently a typical practice for mining organizations to save and set aside sufficient budgetary assets for progressive reclamation, closure, decommissioning and reclamation programs. By and large these budgetary allocations are evaluated costs for each period of the closure plan together with expenses related with monitoring and a long-term operation/management program. More so the acceptability of a financial assurance rests with the regulatory authorities that oversee the TSF operations in Ghana. The requirements for financial assurance vary from one jurisdiction to another. In some jurisdictions the regulatory authority requires of companies by the legislation to submit closure plans prior to the granting of a license to develop or operate a tailings storage facility. Financial related affirmation can be in different forms, for example, 'Trust Fund', 'Performance Bond', 'Irrevocable Letter of Credit', 'Insurance Policy', 'Parent Company Guarantees' and 'Company Stocks'. Be that as it may, the most ordinarily utilized types of financial assurance are bond securities and letters of credit.

The commitment to leaving a sustainable environment at the closure of the TSF project is affirmed by (PMGL, 2010) in the Design Document Tailings Storage Facility report that the in accordance with the Australian National Committee on Large Dams (ANCOLD) document captioned, 'Guidelines on Tailings Dam Design, Construction and Operations, PMGL, as operator of the TSF project, makes the following commitments:

- The TSF will be developed as per the details and drawings and the construction will be regulated and observed by a professional with experience in this sort of development.

- The TSF will be managed and operated in general accordance with the Operation Manuals, which will be reviewed on a yearly premise and revised as deemed fit. Independent audits and reviews will be performed on a yearly premise.
- A routine groundwater monitoring programme will be initiated around the TSF.

This commitment is also backed by (Robertson and Shaw, 2006) that in planning for closure of a TSF, there are four key objectives that must be considered. These includes:

- Protect general public health, wellbeing, safety and security
- Alleviate or wipe out environmental hazards
- Achieve a profitable utilization of the land, or a return to its original unique or a satisfactory alternative
- To the degree attainable, accommodate sustainability of social and financial advantages resulting from mine development and operations.

The authors also added that as we advance into the twenty-first century, there is increasing awareness with the need to provide 'sustainability' of environmental and social settings in which mines are created, operated and reclaimed.

Furthermore, the 6th ranked perception of the social and environmental impacts associated with the TSF was Compensations for lands taken for the TSF construction are lucrative than owning the farms with RII of 0.606 and a corresponding mean value of 3.030. This was followed by *Sexually transmitted infections have increased due to the TSF construction activities in the community* ranked 7th by the respondents with RII of 0.597 and a mean value of 2.985. Also followed by *The efforts at reducing the environmental impacts satisfactory and effective*, ranked 8th with RII of 0.591 and a

mean value of 2.955. The 9th ranked perception by respondents was *The TSF project has a negative health implication on members the community* recording RII of 0.521 and a corresponding mean value of 2.606. *PMGL has abided by all safety and environmental regulations with regards to the construction of the TSF* was ranked 10th by the respondents with an RII and mean value of 0.497 and 2.485 respectively. The 11th ranked perception was *The TSF projects in general have a negative impact on the environment*. This perception to some extent do exist whenever TSF's are mentioned. It ranked low probably because the negative impact of TSF's are very much evident only when there is a failure of the facility which obviously have detrimental effect on the health of a host community, *the presence of the dam has affected your health negatively*. This was the least ranked perception by the respondents with RII of 0.382 and a corresponding mean value of 1.909. The effect of tailings dam breaks on fish and animals and vegetation can be similarly as extreme. Medium- to longer-term impacts of tailings dam failures include; Contamination of water of water bodies, Contamination of soils and sediments, etcetera. This is in confirmation to (Kossoff *et al.*, 2014) that mining and processing activities of tailings storage generally represent to the most massive environmental liability. The sheer size and often poisonous state of the material impounded by the tailings dams implies that their disaster, and the subsequent release of the tails into stream and river channels, will invariably influence water and residue quality, aquatic and human life for possibly several kilometres downstream of the facility.

Table 5.3–1: Community perception of the TSF project by the mine

SECTION B	RATING									
COMMUNITY PERCEPTION OF THE TSF PROJECT BY THE MINE	**1**	**2**	**3**	**4**	**5**	**Total**	**∑W**	**Mean**	**RII**	**Rank**
The TSF projects in general have a negative impact on the environment	33	14	12	2	5	66	130	1.97	0.394	11
The TSF Project have a positive impact on the economy and development of local communities	7	3	31	15	10	66	217	3.288	0.658	4
The cost of living in the community has increased due to the TSF construction activities	5	8	15	18	20	66	238	3.606	0.721	3
The TSF project will offer employment opportunity to people from the community	3	8	12	22	21	66	248	3.758	0.752	1
The TSF project has a negative health implications on members the community	19	20	6	10	11	66	172	2.606	0.521	9
The presence of the dam has affected your health negatively	28	20	15	2	1	66	126	1.909	0.382	12
Sexually transmitted infections have increased due to the TSF construction activities in the community	13	15	8	20	10	66	197	2.985	0.597	7
Compensations for lands taken for the TSF construction are lucrative than owning the farms	8	22	4	24	8	66	200	3.03	0.606	6
The siting of the dam has developed your community better than it was	5	7	15	18	21	66	241	3.652	0.73	2
PMGL has plans ahead for closure of the TSF at the end of their operations to leave sustainable environment	12	20	1	12	21	66	208	3.152	0.63	5
The efforts at reducing the environmental impacts satisfactory and effective	9	7	34	10	6	66	195	2.955	0.591	8
PMGL has abided by all safety and environmental regulations with regards to the construction of the TSF	10	18	35	2	1	66	164	2.485	0.497	10

(***Source: Field Survey, 2019)***

5.4. IMPACT OF TSF ON ENVIRONMENTAL & SOCIAL ELEMENTS

This section of the questionnaire seeks to know what the respondents taught are with regards to the impact of a TSF on environmental and social elements in the community. From Table 5.4–1, *The construction of the TSF has taken over all farm lands meant for farming in the community* is the most ranked impact of social and environmental impact of TSF construction projects, evident with an RII of 0.818 and mean value of 4.091. This confirms Huang *et al* assertion that an imperative aspect of social impacts caused by TSF constructions projects is loss of large acres of agricultural farms (Huang *et al.*, 2018). (Heming *et al.*, 2001) and (Atindana *et al.*, 2015) affirmed that the construction of TSF's results in the loss of viable farmlands and crops that otherwise support and provides a means of livelihood for individuals of the community, for example, cocoa farms were a fundamental source of income for displaced project affected persons whose lands have to be cleared to pave way for the construction of TSF's and the farmers are left to suffer economic loss through the destruction of their cocoa farms. (Ampadu *et al.*, 2015) in research tried to investigate and comprehend the Vea Dam in the context of socio-economic and health impacts on the host communities revealed that 77% of the displaced individuals stated that loss of assets, for example, farmlands, economic trees, homes, graves of deceased relatives among others were their top-most problem. Subsequently noted by (Doso *et al.*, 2015) the continuous loss of agricultural land as a result of large-scale gold mining may add to higher joblessness in mining communities. This was closely followed by *More indigenes are employed from the community because of the TSF project* ranking 2nd with an RII of 0.815 and a corresponding mean value of 3.956, which is also very high indicating that the construction of the TSF provides an avenue for members of the host community to be gainfully employment. This assertion by the respondents

was affirmed by (Mancini and Sala, 2018) and (Istvan, 2011) that employment opportunities and increased income levels are the main positive impacts associated with mining and its related project activities. (Doso *et al.*, 2015) also affirmed the assertion of employment opportunities for members of the host community in their research and stated that A portion of the displaced community individuals, including farmers, are employed by the mining companies, either permanently or on contract basis. *Poor air quality* was ranked 3rd with an RII value of 0.755 and mean value of 3.773. This confirms studies by (Teper, 2009) which stated that The small squander dust particles from tailings are easily blown around in the wind. Some of which fall in the immediate vicinity of the dam while the finest particles stay noticeable all around as segments of atmospheric dust. The Sulphides decay creating acid rains. Strong particles falling in downpour enter soils and water, and others cover the leaves of plants and vegetation. Some of the suspended dust particles enters human and animal respiratory systems. *Displacement: Our settlements are destroyed as a result of siting of the TSF* was the fourth ranked identified social impact of the TSF with an RII value of 0.745 and a corresponding mean value of 3.727. The respondent believed that the activities from the TSF construction results in the displacement of individuals from the community. This assertion by the respondents was confirmed by (Doso *et al.*, 2015) that the displacement of communities for large-scale mining operations, particularly TSF and surface mining impacts on the livelihood of farmers. (Moore et al., 2010) in a world commission on dams report indicated that large dams likewise disrupted the environment of over a large portion of the world's streams and rivers, displaced more than 40 million individuals from their homes and left countries burdened with debt. The 5th ranked identified impact was *Distraction of habitat for living organisms* with RII of 0.733 and a corresponding mean value of 3.667. The

respondents sort to suggest that the activities of the TSF causes distraction to the homes of living organisms and rare species of animals. (Stornoway Diamond corporation, 2011) affirmed this in a report that about 90% of terrestrial and wetland habitat losses and 100% of aquatic habitat losses occur during the construction phases of TSF projects. (Kanbar, 2011) added in affirmation that a few dam construction projects cover such enormous areas that the habitat of entire species is destroyed. In some cases, attempts have been made to move some animals prior to the construction, yet when these animals can't be offered new natural surroundings, this this only delays extinction for some time. In others instances, attempts have even been made to move rare plants species that would have being left to their own fate and placed in secondary conditioned environments. Subsequently ranked at the 6th and 7th place following the impact of Distraction of habitat for living organisms was *Degradation of land and vegetation through clearing for the TSF construction* and *Vegetation and habitat destruction* respectively. These were scored with RII and mean value of 0.727,3.636 and 0.724, 3.621 for the 6th and 7th rank respectively. These were followed by *Poor water quality* at the 8th rank with RII of 0.718 and a corresponding mean value of 3.591, whilst *Gaseous emissions from construction equipment* was ranked 9th with an RII value of 0.694 and a mean value of 3.470. Followed by Prices of goods and services have increased hence cost of living is very high at the 10th with RII of 0.676 and a corresponding mean value of 3.379. Furthermore, among the least ranked impact was *Chemicals from the tailings cause land pollution* is also ranked 20th with an RII of 0.506 and mean value of 2.530. This preposition by the respondents was affirmed by (Schmidt, 2003) that higher concentrations of cyanide and other heavy metals from processed gold cause enhanced take-up by crops furthermore, influence plant development adversely, sometimes leading to plant

mortality. This assertion was also posited by (Wang *et al.*, 2017) that tailing spill do not only harm local and land resources, but also produce serious environmental contamination. *Creation of new communities* was ranked 21st with an RII of 0.488 and a mean value of 2.439. Resettlement of project affected persons from their homes to newly sited areas results in the creation of new communities. This action of creation of new communities by the mines is associated with positive and negative impact connotations. (Yuefang and Steil, 2013) posited that resettlement of project affected persons will keep up or enhance living standards of community members and create the fundamental conditions for social and economic development. Lastly, *there has been the outbreak of disease since the construction of the TSF* was the least ranked impact by respondents with an RII of 0.461 and a mean value of 2.303. A majority of the respondents disagreed with this assertion as TSF's are not directly linked to outbreak and there has been no report linking the particular TSF to any disease outbreak.

Table 5.4–1: Impact of TSF on Environmental and Social elements

SECTION C	RATING									
ENVIRONMENTAL/SOCIAL IMPACT	**1**	**2**	**3**	**4**	**5**	**Total**	**∑W**	**Mean**	**RII**	**Rank**
Poor air quality	4	9	10	18	25	66	249	3.773	0.755	3
Poor water quality	5	5	19	20	17	66	237	3.591	0.718	8
Vegetation and habitat destruction	6	10	6	25	19	66	239	3.621	0.724	7
Chemicals from the tailings cause land pollution	15	24	9	13	5	66	167	2.53	0.506	20
Diseases results from tailings seeping into the environment	7	10	26	19	4	66	201	3.045	0.609	14
Degradation of land and vegetation through clearing for the TSF construction	4	6	17	22	17	66	240	3.636	0.727	6
There is noise pollution due to the TSF construction	11	16	6	16	17	66	210	3.182	0.636	13
Distraction of habitat for living organisms	6	8	8	24	20	66	242	3.667	0.733	5
Gaseous emissions from construction equipment	7	9	12	22	16	66	229	3.470	0.694	9
Oil and fuel spills	7	11	26	18	4	66	199	3.015	0.603	15
There is presence of toxic chemicals in water bodies through seepage	15	23	9	10	9	66	173	2.621	0.524	18
The construction of the TSF has taken over all farm lands meant for farming in the community	1	3	6	35	21	66	270	4.091	0.818	1
The loss of agricultural lands has pushed a lot of active agricultural population out of job	8	14	22	15	7	66	197	2.985	0.597	16

SECTION C	RATING									
ENVIRONMENTAL/SOCIAL IMPACT	**1**	**2**	**3**	**4**	**5**	**Total**	**∑W**	**Mean**	**RII**	**Rank**
Prices of goods and services have increased hence cost of living is very high	0	17	15	26	8	66	223	3.379	0.676	10
There has been the outbreak of disease since the construction of the TSF	18	23	12	13	0	66	152	2.303	0.461	22
Displacement: Our settlements are destroyed as a result of siting of the TSF	5	7	9	25	20	66	246	3.727	0.745	4
The TSF project has enhanced the income levels of people in the area	2	23	10	20	11	66	213	3.227	0.645	12
More indigenes are employed from the community because of the TSF project	0	11	4	30	23	68	269	3.956	0.815	2
Population growth	1	12	27	18	8	66	218	3.303	0.661	11
Increase in crime and social vices	15	23	9	10	9	66	173	2.621	0.524	18
Competition for accommodation due to influx of foreign workers	7	26	14	12	7	66	184	2.788	0.558	17
Creation of new communities	18	22	8	15	3	66	161	2.439	0.488	21

(Source: Field Survey, 2019)

5.5. IMPROVEMENT OF POSITIVE IMPACTS

This segment of the questionnaire pursues to afford respondents the opportunity to designate on a five point Likert scale their level of agreement on the measures or the way forward to improve the positive impacts from the TSF on the community. From Table 5.5–1, it was gathered from respondents with a Relative Importance Index of 0.797 and a mean score value of 3.985 believes *Resettlement of affected communities*. With reference to this, Fitriani et al in an (IFC, 2014) report proposed that in cases where the option of resettlement is unavoidable; companies are expected to provide opportunities for the resettled individuals and the host communities in order to derive some development benefits from the project that are sited within their communities. There are approaches to lessen the hazards, dangers and socio-economic impacts of involuntary displacement and resettlements or ways to avoid, or at least reduce, specific instances. Socially dependable resettlement - that is resettlement guided by a value compass - can neutralize enduring impoverishment and produce benefits for both the regional and local economy. (Adam et al., 2015) suggested that with regards to mining, understanding the connection between prior vulnerability and how family units react to the possibility of impoverishment risk ought to be viewed as a critical part of the resettlement planning and livelihood reconstruction processes. Some mining companies have made it their core objective that the livelihoods of those resettled will be improved and be better off over the long term.

Compensation to affected communities, is the 2nd most ranked suggested improvement of positive impact according to the respondents with a mean value of 3.939 and an RII of 0.788. This assertion was affirmed by (Perera, 2014) that Land-for-land compensation, housing, migration to and/or near arable lands, and secure employment were viewed as essential components of a reasonable compensation. This can be

accomplished through conventional compensation and resettlement assistance programs, for example, cash- for-land, land-for-land compensation, limited and temporary job openings at project construction sites. However, between the two modalities, land-for-land pay is advanced as the better alternative. (Lo et al, 2016) also posited that compensation alone, by definition, is in this manner never adequate for restoring a sustainable socio-economic basis for re-settlers but professional retraining, offered to some re-settlers, can provide aptitudes and not necessarily jobs.

The 3rd ranked was *Re-afforestation of degraded forests* with an RII of 0.770 and corresponding mean values of 3.848. This position of the respondents was affirmed by (Mchaina, 2001) that reforestation forms part of the reclamation strategies for mine closure planning for most mining firms. (Karthikeyan *et al.*, 2009)confirms that reforestation of degraded lands from TSF construction projects is extremely essential to overcome its associated health risks and environmental problems and there is a requirement for a national arrangement of value control assessment for land reclamation sites and provisions for training in the special problems of managing reclaimed lands as Land which is 'reclaimed' must remain reclaimed. The quality of land after reclamation from TSF dam closure must be at any rate sustainable and better still self-sustaining.

Providing alternative sources of drinking water was ranked 4th by the respondent with an RII of 0.767 and corresponding mean values of 3.833. (Appiah and Abass, 2014) noted that there is history of various water contamination issues identified with mining in Ghana and the impacts of mining activities on the natural, social and cultural conditions have stayed to some degree a consistent issue, particularly for water resources in communities affected by mining in Ghana. The provision of alternative sources of drinking water is therefore a step in improving the quality of

water available to indigenes of the mining community. According to respondents *The mine has instituted measures to address the health needs of the community* is the 5th as a way of improving the positive impacts of their activities within the community. This was ranked with an RII of 0.748 and a corresponding mean value of 3.742. Furthermore, the 6th ranked improvement suggested by the respondents was *More indigenes should be employed by the mine*, with an RII of 0.676 and a corresponding mean value of 3.379. The Minerals and Mining General Regulations (2012), provides a minimum local content factor for mining companies in their engagements. The law required that mining organizations secured contributions from Ghanaian locals to the most extreme degree conceivable, reliable with the economy, productively and safely. This was followed at the rank 7th by *The mining company to invest in your community other than into the mine itself* with an RII of 0.655 and a mean value of 3.273 whilst at the 8th rank was *The mine make attempts to decrease or curb the adverse environmental effects of mining activities* with an RII and mean value of 0.648 and 3.242 respectively.

Lastly, *there is close communication between the mine and the community leaders* was the least ranked by the respondents with an RII of 0.494 and a corresponding mean value of 2.470. Stakeholder engagement with community leadership and the mine plays a major role in facilitating open communication and transparency. (ICMM, 2011) posited that a comprehensive commitment and communication procedure can likewise encourage a more extensive discourse and information exchange with host communities. At times, negotiating concurrences with community leadership may avoid issues and sentiments held by individuals from the community.

Table 5.5–1: Improvement of Positive Impacts

SECTION D	RATING									
IMPROVEMENTS	**1**	**2**	**3**	**4**	**5**	**Total**	**∑W**	**Mean**	**RII**	**Rank**
Resettlement of affected communities	2	7	2	34	21	66	263	3.985	0.797	1
Compensation to affected communities	3	5	7	29	22	66	260	3.939	0.788	2
Re-afforestation of degraded forests	5	9	1	27	24	66	254	3.848	0.77	3
Providing alternative sources of drinking water	3	8	5	31	19	66	253	3.833	0.767	4
The mine make attempts to decrease or curb the adverse environmental effects of mining activities	9	15	6	23	13	66	214	3.242	0.648	8
The mining company to invest in your community other than into the mine itself	4	17	13	21	11	66	216	3.273	0.655	7
More indigenes should be employed by the mine	5	15	5	32	9	66	208	3.379	0.676	6
The mine has instituted measures to address the health needs of the community	1	13	8	24	20	66	247	3.742	0.748	5
There is close communication between the mine and the community leaders	18	21	9	14	4	66	163	2.47	0.494	9

(Source: Field Survey, 2019)

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

6.1. INTRODUCTION

This chapter outlines the summary of the study, conclusion based on the research findings and recommendations for improvement that needs attention for further research.

6.2. SUMMARY OF FINDINGS

The rationale behind this study was to examine the social and environmental impact of the Perseus Mining Ghana Ltd (PMGL) TSF project on the host community and recommend improvements if there are identified social and environmental impacts. The data collated showed that all the respondents have knowledge of what a tailings storage facility is and have understanding of what the associated impacts exist.

6.2.1. RESPONDENTS PERCEPTION OF THE TSF PROJECT

The information obtained from the research indicated that the general perception of the respondents was that the TSF project offered employment opportunities to indigenes from the host community and not only did it provide job opportunities but also brought about development in the community and made it better than what it was previously before the existence of the mine. Besides the positive impacts of several employment opportunities and community development a negative impact of high cost of living was identified and the respondent indicated that this was as a result of the construction activities. Additionally, the respondents also affirmed that they perceive the mine PMGL has also instituted or put in places measure towards the

closure of the TSF at the end of their operations to leave sustainable environment. the least identified perception was that the presence of the dam has affected your health negatively. This was affirmed to be the least by Kossoff, that negative health implication do occur only when there is a failure of the storage facility, which can have detrimental impact on water and sediment quality, aquatic and human life (Kossoff *et al.*, 2014).

6.2.2. RESPONDENTS VIEWS ON SOCIAL AND ENVIRONMENTAL IMPACTS

In terms of the social and environmental it has come to light that the construction of the TSF has taken over all farm lands meant for farming in the community and the activities have results in the loss of viable farmlands and crops that otherwise support and provides a means of livelihood for individuals of the community. An identified positive social impact by the respondents was that the construction of the TSF served as an avenue of employment for members of the community with increased income levels which is a main positive impacts associated with mining and its related project activities. Also associated with the construction of the TSF is an impact of displacement which comes with it destruction of settlements. There were also incidences of air pollution of the environment and distraction of habitat for living organisms identified and rated highly to be a result of the construction activities by the respondents. Least ranked among the impacts was outbreak of diseases since the construction of the TSF which of the respondent disagreed to be part of the associated impacts of the TSF project.

6.2.3. RESPONDENTS VIEW ON IMPROVEMENT OF POSITIVE IMPACTS

Among the highest ranked improvements of positive impacts was resettlement of project affected communities and the payment of compensation to project affected persons. Which are key issues identified because the issues of resettlement and compensations can result in impoverishment and untold hardship to members of the host community and the nation at large if not handled in a fair and professional manner. A can affect the performing organization negatively or positively depending on the balance. Literature also pointed that resettlement and compensation payments to PAPs are expected to provide opportunities for the resettled individuals and the host communities in order to derive some development benefits from the project that are sited within their communities. It was realized from the study among other suggested improvements was re-afforestation of degraded forests and provision of alternative sources of drinking water to the PAPs.

6.3. CONCLUSION

From the analysis and discussions done, it concluded that there is economic benefits and advantages of mining activities in Ghana, however, there is the need to also know the environmental and health perils that accompany these activities so as to discover methods and means for managing them. This knowledge can be through research hence the focus of this study.

The respondents have indicated that by the rankings from the data collated and analysed that the construction of the TSF have a positive impact on the economy and development of local communities, thereby making the community a much better place than it was prior to the establishment of the mine. However, the respondents

have also indicated that despite the development achieved the construction of the TSF came some negative impacts such as poor air quality and degradation of lands and forest reserves. Notwithstanding the respondents have also pointed out some improvements to the existing positive impacts identified such as the resettlement of project affected communities, compensation to affected communities and reforestation of degraded forests among others.

6.4. RECOMMENDATIONS

Per the result of the analysis, discussions, observations and conclusions, the following recommendations were drawn:

- Previous researches on the subject matter has demonstrated that no financial remuneration nor livelihood restoration projects could supplant the annihilated genealogical land and conventional means of a making a living of project affected persons. The answer for re-establishing the standards of living and to curtail the changeless devastation of the earth is to halt harmful large-scale corporate mining and close unviable tailings dams. And adopt alternatives that, for example uses less destructive chemicals in mining operations.
- It is also recommended that nations that are home to trans-national and local mining companies ought to put in place enactment, regulations and laws that will require the mining firms to work and abide by the set standards of mining operations as it is practiced in other part of the world in order to leave a sustainable environment after their operations and closure of the mining activities. This will ensure that host communities of these mining companies can still have a life even after the mine is closed and gone.

- The global mining community ought to develop at least minutest principles for the safeguard of the environment and social rights that are officially binding on all countries and mining companies, in view of the highest existing guidelines and with viable monitoring and endorses prohibitions on companies or donor partners that are found to flaunting the set regulations, be it the foreign firms, local firms, or state-owned firms.
- The country's enactment and policy on the mining industry need to be reviewed to ensure that the environment and natives in diverse parts of the nation are protected from illegal mining and discriminate destruction of forest and involuntary displacement and non-rewarding resettlements.
- The policy governing TSF construction operation and management should support the individuals and the host mining community's effort towards industrial development and guarantee the provision of employments, a steady economy, extenuation of environmental deprivation, and reclamation.
- The government should address the shortcomings in environmental policies on TSF's and strengthen their enforcement by equipping the regulatory authorities so as to achieve sustainability of the environment.
- In spite of the enormous number researches conducted on the subject of social and environmental impacts, there is as yet a requirement for leading an exhaustive research to consider and evaluate all facets of social, environmental, cultural, and economic impacts of both small and large-scale tailings storage facilities.

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APPENDIX

APPENDIX - DESIGNED QUESTIONNAIRE

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF CONSTRUCTION TECHNOLOGY AND MANAGEMENT

QUESTIONNAIRE

EXAMINING THE SOCIAL IMPACT OF TAILINGS DAM PROJECTS IN GHANA: A CASE STUDY OF PERSEUS MINING TSF PROJECT

The purpose of this survey is to gather information on the above subject matter. This is purely an academic exercise and any information provided will be accorded confidential treatment. You are required to select an option amongst the alternatives provided for each question.

SECTION A

RESPONDENT DETAILS

1. Gender: Male ☐ Female ☐
2. Age:
   18-25 ☐ 26-30 ☐ 31-35 ☐ 36-40 ☐ 41-45 ☐ 46-50 ☐ 51 & above ☐
3. How long have you lived in the Ayanfuri community?
   Less than 1year ☐ 2-5years ☐ 6-15years ☐ 16-30years ☐ above 31years ☐
4. What is your highest level of education?
   BECE ☐ WASSCE ☐ HND ☐ First degree ☐ Second degree ☐
5. What is your occupation?
   Farming ☐ Carpentry ☐ Trading ☐ Mining ☐ Not working ☐
6. Are you employed by the mine or employed by a company working with the mine?
   Yes ☐ No ☐
7. Do you have any idea about the mine constructing a Tailings Storage Facility (TSF) in this community?
   Yes ☐ No ☐

SECTION B

COMMUNITY PERCEPTION OF THE TSF PROJECT BY THE MINE

What is your perception of TSF projects vis-à-vis their social and environmental impacts on the community? Please indicate on a Likert scale of 1 – 5 your level of agreement on the perception. On a scale where:

Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
1	2	3	4	5

SN	PERCEPTIONS	1	2	3	4	5
1.	The TSF projects in general have a negative impact on the environment	☐	☐	☐	☐	☐
2.	The TSF Project have a positive impact on the economy and development of local communities	☐	☐	☐	☐	☐
3.	The cost of living in the community has increased due to the TSF construction activities.	☐	☐	☐	☐	☐
4.	The TSF project will offer employment opportunity to people from the community?	☐	☐	☐	☐	☐
5.	The TSF project has a negative health implications on members the community	☐	☐	☐	☐	☐
6.	The presence of the dam has affected your health negatively	☐	☐	☐	☐	☐
7.	Sexually transmitted infections have increased due to the TSF construction activities in the community	☐	☐	☐	☐	☐
8.	Compensations for lands taken for the TSF construction are lucrative than owning the farms	☐	☐	☐	☐	☐
9.	The siting of the dam has developed your community better than it was	☐	☐	☐	☐	☐
10.	PMGL has plans ahead for closure of the TSF at the end of their operations to leave sustainable environment	☐	☐	☐	☐	☐
11.	The efforts at reducing the environmental impacts satisfactory and effective	☐	☐	☐	☐	☐
12.	PMGL has abided by all safety and environmental regulations with regards to the construction of the TSF	☐	☐	☐	☐	☐

SECTION C

IMPACT OF TSF ON ENVIRONMENTAL & SOCIAL ELEMENTS

What do you think will be the impact of a TSF on some of the environmental elements in your community? Please indicate on a Likert scale of 1 – 5 your level of agreement on the environmental and social impacts. On a scale where:

Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
1	2	3	4	5

SN	ENVIRONMENTAL/SOCIAL IMPACT	1	2	3	4	5
1.	Poor air quality	☐	☐	☐	☐	☐
2.	Poor water quality	☐	☐	☐	☐	☐
3.	Vegetation and habitat destruction	☐	☐	☐	☐	☐
4.	Chemicals from the tailings cause land pollution	☐	☐	☐	☐	☐
5.	Diseases results from tailings seeping into the environment	☐	☐	☐	☐	☐
6.	Degradation of land and vegetation through clearing for the TSF construction	☐	☐	☐	☐	☐
7.	There is noise pollution due to the TSF construction	☐	☐	☐	☐	☐
8.	Distraction of habitat for living organisms	☐	☐	☐	☐	☐
9.	Gaseous emissions from construction equipment	☐	☐	☐	☐	☐
10.	Oil and fuel spills	☐	☐	☐	☐	☐
11.	There is presence of toxic chemicals in water bodies through seepage	☐	☐	☐	☐	☐
12.	The construction of the TSF has taken over all farm lands meant for farming in the community	☐	☐	☐	☐	☐
13.	The loss of agricultural lands has pushed a lot of active agricultural population out of job	☐	☐	☐	☐	☐
14.	Prices of goods and services have increased hence cost of living is very high	☐	☐	☐	☐	☐
15.	There has been the outbreak of disease since the construction of the TSF	☐	☐	☐	☐	☐
16.	Displacement: Our settlements are destroyed as a result of Siting of the TSF	☐	☐	☐	☐	☐
17.	The TSF project has enhanced the income levels of people in the area	☐	☐	☐	☐	☐
18.	More indigenes are employed from the community because of the TSF project	☐	☐	☐	☐	☐
19.	Population growth	☐	☐	☐	☐	☐
20.	Increase in crime and social vices	☐	☐	☐	☐	☐
21.	Competition for accommodation due to influx of foreign workers	☐	☐	☐	☐	☐
22.	Creation of new communities	☐	☐	☐	☐	☐

SECTION D

IMPROVEMENT OF POSITIVE IMPACTS

What do you think will be way forward to improve the positive impacts from the TSF on your community? Please indicate on a Likert scale of 1 – 5 your level of agreement on the environmental and social impacts. On a scale where:

Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
1	2	3	4	5

SN	IMPROVEMENTS	1	2	3	4	5
1.	Resettlement of affected communities	☐	☐	☐	☐	☐
2.	Compensation to affected communities	☐	☐	☐	☐	☐
3.	Re-afforestation of degraded forests	☐	☐	☐	☐	☐
4.	Providing alternative sources of drinking water	☐	☐	☐	☐	☐
5.	The mine make attempts to decrease or curb the adverse environmental effects of mining activities	☐	☐	☐	☐	☐
6.	The mining company to invest in your community other than into the mine itself	☐	☐	☐	☐	☐
7.	More indigenes should be employed by the mine	☐	☐	☐	☐	☐
8.	The mine has instituted measures to address the health needs of the community	☐	☐	☐	☐	☐
9.	There is close communication between the mine and the community leaders	☐	☐	☐	☐	☐